Sept. 4, 1945. W. B. KLEMPERER ET AL 2,384,036

TORPEDO DIRECTOR

Filed Dec. 23, 1942 3 Sheets-Sheet 1

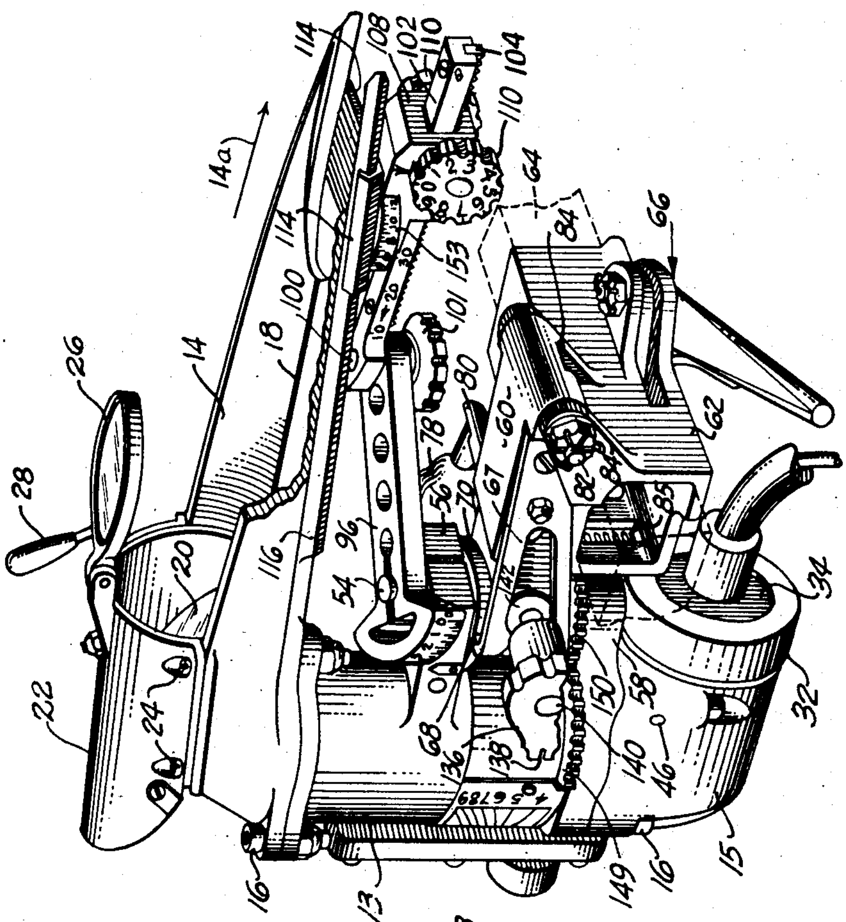

Fig. 1

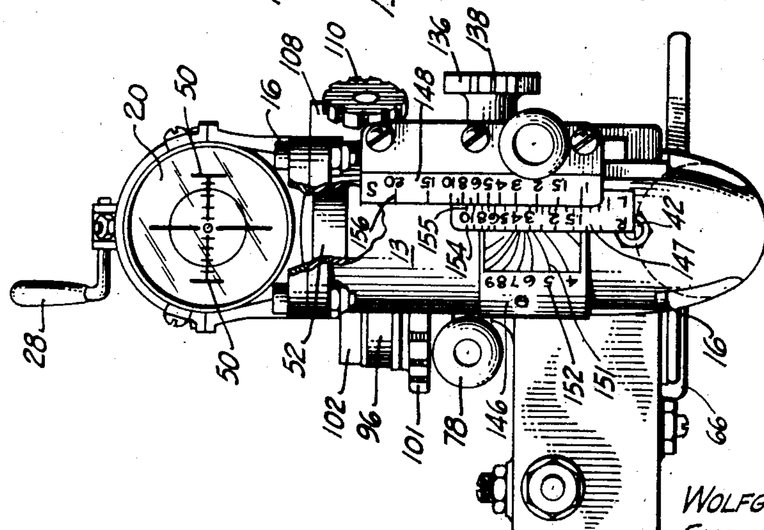

Fig. 2

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TORPEDO DIRECTOR

Filed Dec. 23, 1942 3 Sheets-Sheet 2

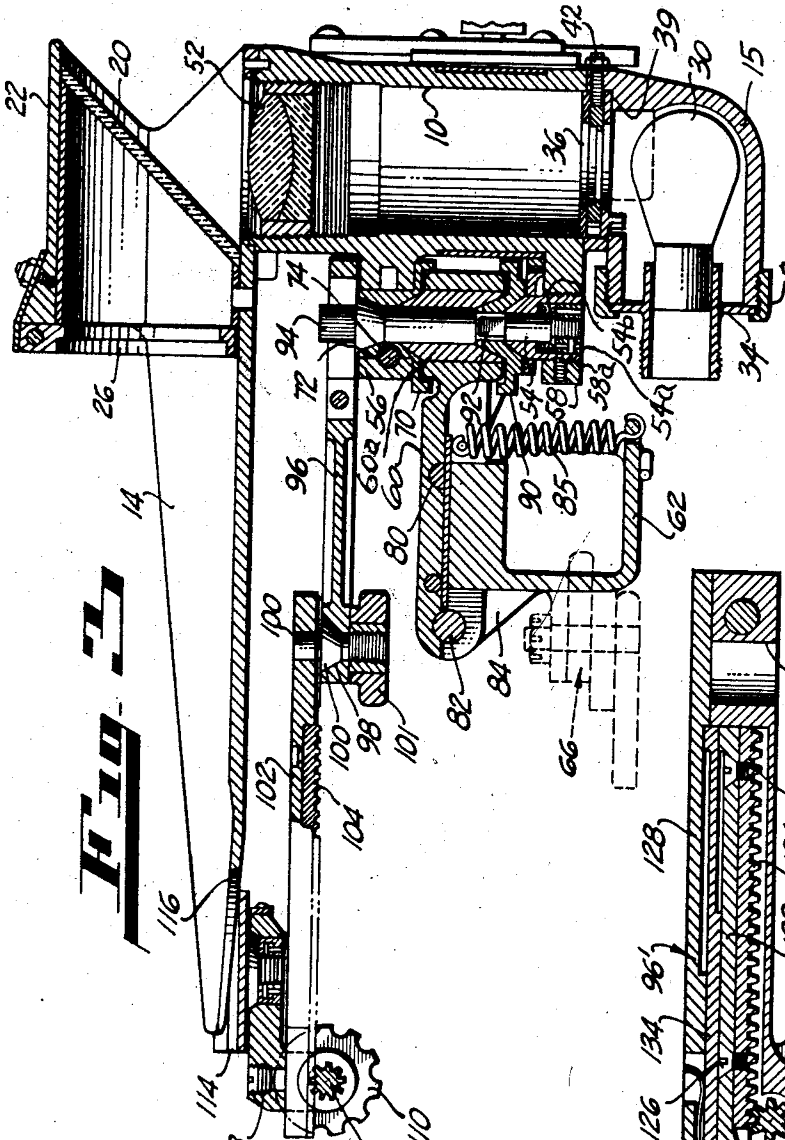

Fig. 3

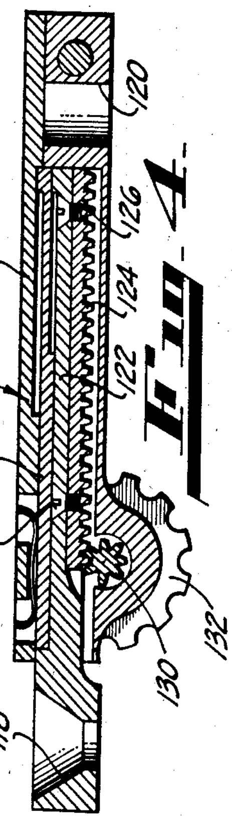

Fig. 4

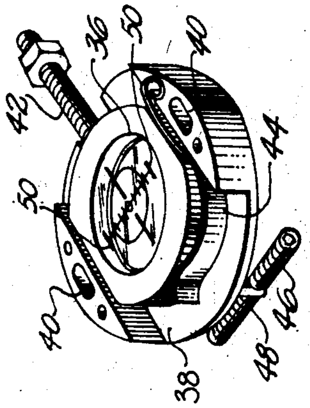

Fig. 5

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TORPEDO DIRECTOR

Filed Dec. 23, 1942 3 Sheets-Sheet 3

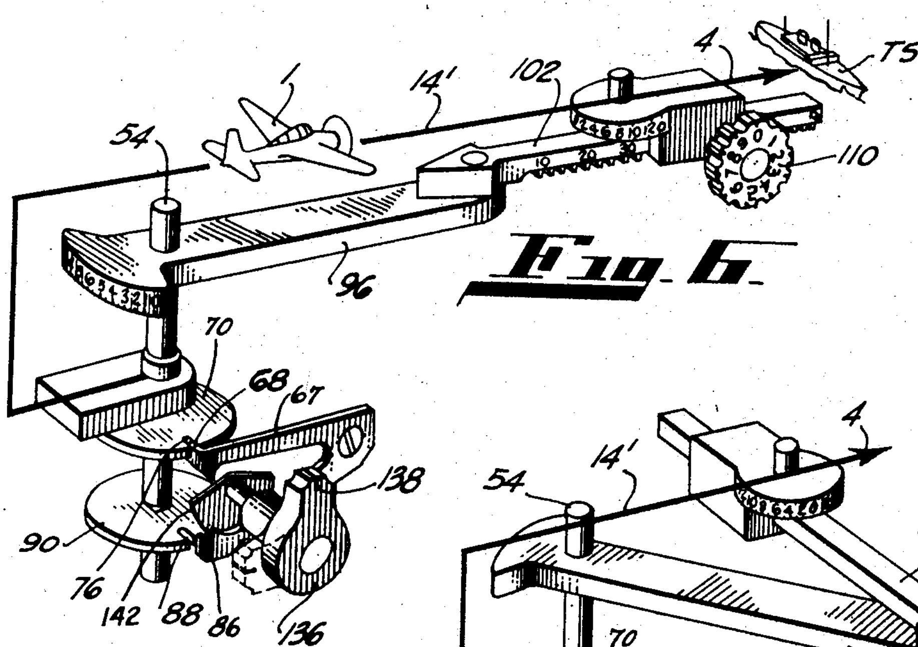

Fig. 6

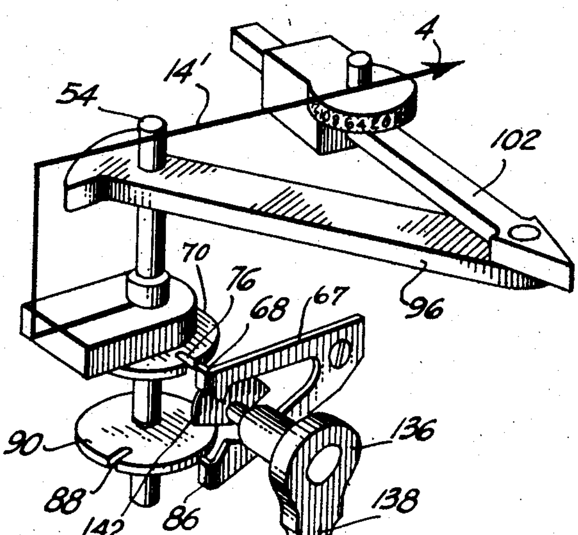

Fig. 7

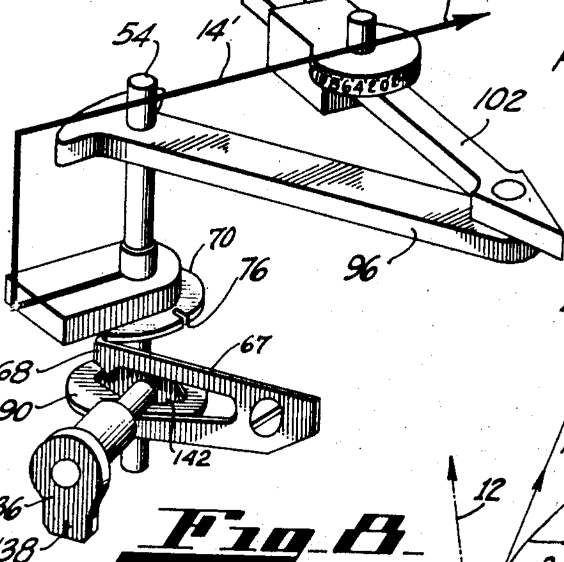

Fig. 8

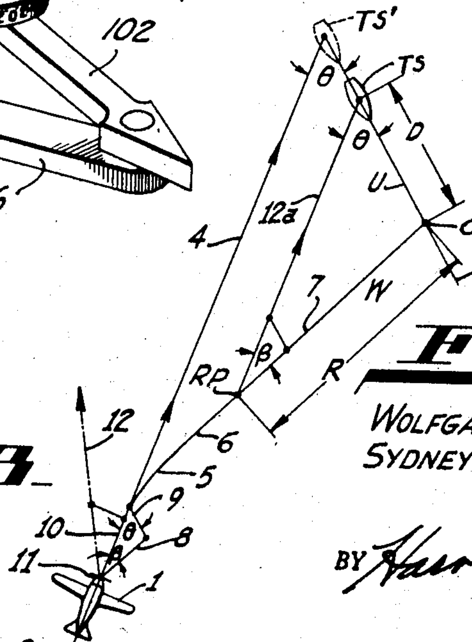

Fig. 9

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UNITED STATES PATENT OFFICE

2,384,036

TORPEDO DIRECTOR

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Application December 23, 1942, Serial No. 469,934

5 Claims. (Cl. 33—46.5)

This invention relates to a sighting device and has particular reference to a sighting device to be employed on torpedo-carrying aircraft to determine the direction in which a torpedo should be launched to hit a moving target and to determine the point in the approach of the plane to a moving target at which the torpedo should be launched.

In the launching from aircraft of torpedoes intended to strike moving vessels, it is necessary for the pilot of the plane to take into consideration a large number of factors including the direction of the attack approach of the plane to the target relative to the direction in which the target ship is travelling, the speed of travel of the target ship, approach of the aircraft, the calculated speed and trajectory of the torpedo during its fall through air, its loss of speed upon striking the water, and its calculated speed in the water. By ascertaining or calculating these and other factors, the pilot determines the lead angle with which the torpedo must be launched to arrive at the collision point coincident with the arrival of the target ship at such point and the range point at which he must launch the torpedo.

All of these calculations and the manipulation of the plane to the range point and in the proper direction for the launching of the torpedo must be made in an extremely short space of time due to the fact that in fast moving aircraft the length of time between the sighting of the target and the actual launching of the torpedo may be a matter of seconds only. The aeroplane comes quickly into a given firing range and leaves that given range just as quickly by reason of its great speed, therefore, it is necessary to make rapid computations and adjustments on the torpedo director and fire in a very short space of time. Surface and undersea craft, on the other hand, being relatively slow moving, permit the torpedoes to be fired at leisure by comparison.

The torpedo director comprising the present invention has been developed especially for use on fast moving craft under conditions requiring rapid and simple calculations, and light, simple equipment.

Accordingly, it is an object of the invention to provide a means of rapidly determining the lead angle for firing a projectile at any given target, whether moving or stationary.

It is a further object to provide such a means that is light in weight and small so that it may be conveniently used in the limited space available in modern aircraft cockpits, and without unduly adding to the weight of the aircraft.

A further object is to provide a sighting device for use on aircraft which is readily stowable and quickly movable into position for use.

Another object is to provide a sighting device which is adaptable for use alternatively as a torpedo director or as a gun sight under emergency conditions.

A still further object of the invention lies in the combination of an open diopter sight mounted upon a mechanical interception triangle.

It is another object of the invention to incorporate in a torpedo director a relatively simple range solving device as a part of the optical system.

Other objects and advantages of the invention will be apparent from a study of the following specification, read in connection with the accompanying drawings, wherein:

Fig. 1 is a perspective view looking at the right side of the instrument of the invention;

Fig. 2 is an end elevational view of the instrument of Fig. 1 as seen from the operator's position;

Fig. 3 is a longitudinal vertical sectional view of the instrument;

Fig. 4 is a sectional view of an embodiment of one of the forms of the mechanical triangle portion of the instrument;

Fig. 5 is an enlarged perspective view of the reticule incorporated in the device;

Fig. 6 is a partially schematic perspective view of a portion of the torpedo director in what might be termed a "neutral" position;

Fig. 7 is a similar view of the device wherein two of the legs of the triangle have been adjusted in the steps of sighting the target;

Fig. 8 is another view similar to Figs. 6 and 7 wherein the device has been adjusted to its final position preparatory to firing; and

Fig. 9 is a diagram showing the target, the target path, the firing aircraft, sighting line and torpedo path and the geometrical relationship between them and the parts of the sighting device.

Referring to the drawings, Fig. 9 illustrates the geometry of a typical sighting problem, Fig. 9 having particular reference to the problem of so launching a torpedo from a moving aircraft as to cause it to strike a moving target such as the target ship represented by the reference character TS in Fig. 9.

In Fig. 9 it has been assumed that an aircraft 1 carrying a torpedo is proceeding along a course represented by the line 2. This course is so directed as to intersect the target ship TS at its then position represented by the dotted line outline of a ship bearing the reference character TS'. The ship TS is assumed to be proceeding along a course represented by the line **3** at a velocity U, the course **3** making an angle θ with a line of sight **4** extending from the aircraft **1** to the target ship TS'.

The pilot of the aircraft, through the use of the torpedo director disclosed herein, determines the angle by which the target ship TS must be led in order to permit a torpedo when dropped from the aircraft to proceed along such a course as will cause it to collide with the target ship TS. This lead angle is represented in Fig. 9 as the angle β. After determining the angle β the pilot alters the course of the aircraft as by a veering maneuver represented by the curved line **5** to cause the aircraft to proceed along a course **6** to a release point RP, at which point the pilot releases the torpedo.

The torpedo when released falls into the water and is propelled by its self-contained propulsion mechanism along a course **7** for a distance termed the "torpedo travel range" and represented by the symbol R. At the end of the torpedo travel equal to the travel range R the torpedo arrives at the collision point O and through proper determination of the lead angle β the time of arrival of the torpedo at the point O is made coincident with the arrival of the target ship TS at the collision point O. In travelling from the point on the diagram represented by the ship outline TS to the point O, the target ship TS traverses a distance D.

By virtue of the circumstances above set forth, there exists an interception triangle defined by the points RP, O and TS. This triangle is characterized by having two sides of lengths D and R, respectively, and opposite angles β and θ, respectively. From the law of sines it may be seen that

$$D/R=\sin\beta/\sin\theta \qquad (1)$$

This may be rewritten as

$$\sin\beta=(D\sin\theta)/R \qquad (2)$$

From the fact that the time required for the target ship TS to traverse the distance D is precisely equal to the time required for the torpedo to traverse the distance R, it may be stated that

$$D/R=U/W \qquad (3)$$

Substituting in Equation 2, supra, the value of D/R given by Equation 3, results in

$$\sin\beta=(U\sin\theta)/W \qquad (4)$$

From Equation 4 it will be seen that if U, W and θ are determined, the interception triangle is thereby described and the angle β is thereby defined. In this connection it is to be noted that W represents the average velocity of the torpedo as defined by the total time required for the torpedo to traverse the distance R. It will also be noted that except as W may vary with variations in R, the angle β is determined by Equation 4 independently of the torpedo travel range R.

The torpedo director which is disclosed herein operates to mechanically solve Equation 4 by defining a mechanical interception triangle RP, O, TS in that the length of the sides of the mechanical interception triangle are proportional to the length of the respective sides of the actual interception triangle while the angles which the various sides of the mechanical interception triangle make with each other are equal to the angles which the various sides of the actual interception triangle make with each other.

Bearing in mind the relationship between the mechanical interception triangle and the actual interception triangle, reference may again be had to Fig. 9 wherein the mechanical interception triangle is indicated adjacent to the nose of the aircraft **1** by a side **8** which parallels the torpedo course **7**, a side **9** which parallels the course **3** of the target ship TS and a side **10** which comprises a sighting leg of the mechanical triangle and which is directed to define the sighting line **4** extending to the target ship TS at its position TS'.

In operation the sighting leg **10** is adjusted to bring the sighting line **4** to bear upon the target ship TS at its then position TS'. The pilot appraises the tactical situation and chooses the torpedo travel range which will be used in the proposed attack. The side **8** of the mechanical interception triangle is then adjusted in length to represent to a predetermined scale the magnitude of the average torpedo velocity W corresponding to the chosen range R. The side **9** is turned to parallelism with the estimated direction of the course **3** pursued by the target ship thus defined between the sides **9** and **10** the angle θ.

The velocity U of the target ship is estimated or determined from known facts relating to the particular nationality and type of ship comprising the target ship TS and the side **9** is adjusted in length to represent the determined velocity U of the target ship TS to the same predetermined scale as was used in adjusting the length of the side **8**. When these adjustments are made, the mechanical interception triangle is fixed and the angle between the sides **8** and **10** comprises the angle β which is the correct angular amount by which the target must be led in order to cause a collision between the released torpedo and the target ship.

The entire mechanical triangle **8, 9, 10** is then pivoted about a point **11** in such direction and by such amount as is required to bring the side **8** into parallelism with the then course of the aircraft **1**. This disposes the mechanical interception triangle in the position illustrated by dotted lines in Fig. 9 and extends the sighting line defined by the sighting leg **10** in the direction indicated by the dotted arrow **12**. By the veering maneuver **5** the pilot of the aircraft so changes the course of the aircraft as to bring the sighting line **12** to again bear on the target ship TS.

Having completed this maneuver, the pilot then proceeds along the course **6, 7** which is so chosen as to maintain the sighting line **12** on the target ship TS as is represented, for example, by the line **12***a* in Fig. 9. As the aircraft proceeds along the course **6** it approaches a release point RP which is chosen to be distant from the collision point O a distance equal to the chosen torpedo travel range R. Mechanism to be described hereinafter indicates arrival at the point RP and the torpedo is released and the desired collision between the torpedo and the target ship ensues.

Fig. 9 represents an approximate diagram of the geometry involved in the launching of a torpedo and differs from the actual conditions encountered in practice in that certain of the courses, such as the course **6**, are shown as a straight line, whereas, in fact, the course **6** is slightly curved to comprise a "homing path." The approximate representation in Fig. 9 is, however, correct for all practical purposes since it may be readily shown that the error introduced by ignoring the curvature of the line and treating it as a straight line is of such small magnitude as to be substantially negligible, and since, further, the direction of the side 9 may be adjusted from time to time as may be required to maintain the same in approximate parallelism with the course 3 being pursued by the target ship TS, this latter adjustment serving to recorrect the angle β to compensate for any differences that may result from the course of the aircraft being curved rather than straight.

With reference now to Figs. 1 and 2 the torpedo director comprising the invention includes a vertical tubular member 13 carrying at its upper end a horizontally extending channel-shaped leg or sighting member 14 and at its lower end an elbow-shaped light and reticle housing 15. These members are fastened together by a plurality of bolts 16 so that they may be readily disassembled. The director is placed in the aircraft or other vehicle upon which it is to be used, in a position such that the leg 14 may parallel the longitudinal center-line of the aircraft with the leg 14 extending forwards from the tubular member 13 in the direction of the arrow 14*a* in Fig. 1.

As stated above the leg 14 is of channel shape with the curved-up sides thereof tapering from a maximum height at the rear to a minimum height at the front. The bottom portion of the channel is cut out at the rear so as not to overlie the tubular member 13 and to permit the light from the elbow section 15 to exit therefrom. The bottom portion is similarly cut out at the front so as not to unduly interfere with the pilot's downward vision as he sights through the device. The leg 14 actually serves as one leg of the mechanical interception triangle; that is, it is the sighting leg and is provided with a sighting line in the form of a groove 18 extending longitudinally along the center and painted white so as to be readily visible in event of failure of the artificial illumination. As a matter of fact this line is used for sighting only in just such an emergency since normal sighting is by way of a reticule pattern reflected upon an angularly positioned light transmitting reflector or mirror 20 which may be of approximately twenty-five (25%) percent reflecting quality.

The mirror section is covered by a cap 22 fastened at 24 to the aft end of the channel-shaped leg 14, and this cap mounts a hinged filter 26 of light polarizing material which may be snapped down to close off the forward end of the capped portion to eliminate glare or blinding when the sight is being used against sunlight reflected from the water. A small lever 28 fixed to the filter permits it to be quickly moved to the desired position.

The elbow-shaped housing 15 at the lower end of the vertical tubular member 13 is adapted to receive a light bulb 30 as best shown in Fig. 3. The bulb may be removed readily for replacement by merely unscrewing a knurled collar 32 which releases the bulb socket 34. When the bulb is properly in place and lighted, it illuminates a reticule 36 mounted in the elbow at the upper end thereof. The reticule is shown in detail in Fig. 5. An annular member 38 mounted within a recess 39 provided in the elbow 15 supports the reticule and is provided with upstanding portions 40 serving as guides to hold the reticule in its proper position. The reticule may be adjusted relative to the member 38 by means of a long screw 42 threaded through the elbow 15 and bearing against the reticule. Any movement of the reticule by the screw 42 is resisted by a leaf spring 44 secured to one of the upstanding portions 40 of the annular member 38 and this spring is of sufficient strength to move the reticule toward the screw 42 as the latter is backed off. The spring also serves to hold the reticule securely against vibration. Rotational adjustment of the reticule about its center is accomplished by a pair of screws 46, one threaded throughout each side of the elbow 15 and bearing against a pin 48 subtending from the annular member 38.

The reticule is provided with two stadia lines 50, one at either end of the horizontal cross hair, and this length is further divided by a plurality of short vertical lines to further assist range determination. The stadia lines 50 are preferably so spaced that they appear ten percent of the sighted range apart, each being approximately five percent of the sighted range from the centerline.

The reticule appears to the eye of the pilot as a luminous reflection on the mirror 20 as shown in Fig. 2, being projected thereon by the light 30 shining through the reticule in the elbow and a lens 52 mounted in the upper portion of the vertical housing 13 a distance above the reticule equal to its focal length. The optics of the reflector sight are so collimated that movement of the eye across the field of the reflector will cause no substantial error. The eye may be positioned at any desired distance from the mirror 20 and in each chosen position the luminous reticule lines appear to be projected upon the object sighted so that the object and the cross hairs are simultaneously in focus and appear to be substantially equally distant from the observer.

The entire director is adapted to pivot on a king pin 54 interconnecting two forwardly projecting ears 56 and 58 which are an integral part of the vertical tubular member 13, thus permitting the sighting line defined by the sighting member 14 and the optical system just described to be moved to any desired angular position. Between the ears 56 and 58 the king pin mounts a horizontally extending bracket 60 which is bolted at its opposite end to a short length of square tube 62 or the like. The square tube 62 is slidable over a slightly smaller tube 64 partially shown by dotted lines in Fig. 1, the latter extending the full or a substantial part of the width F of the aeroplane cockpit so as to permit the director to be moved to one side or the other for stowage and to be adjusted to the pilot's convenience for sighting. A braking device 66 incorporating a spring-loaded cam action is provided to arrest the movement of the director along the tube 64 and securely hold it in any desired position along the tube's length.

As stated, the entire director is adapted to pivot on the king pin relative to its mounting tube, but it also may be locked in a position normal to the tube 64 so that the sighting leg 14 is parallel to the longitudinal centerline of the aircraft. This locking action is accomplished by a bifurcated spring arm 67 secured to the bracket 60, the upper division of the arm 67 being bent over to form a lug 68. The lug rides along the periphery of a flange 70 forming an integral part of a bearing 72 in which the upper portion of the king pin 54 rotates. The bearing is locked to the upper ear 56 by a bolt 74 so that it must rotate therewith whenever the sighting member 14 is angularly moved.

The flange 70 has a single notch 76 cut therein which is adapted to receive the lug 68 of the bifurcated spring arm 67, the spring forcing the lug into the notch as soon as they come into alignment. The parts are so adjusted that as long as the lug and notch are in engagement, the sighting leg 14 of the director is held parallel to the longitudinal centerline of the aircraft and normal to the transverse mounting tube 64.

The lower division of the bifurcated spring arm 67 is also bent over to form a lug 86 which functions in a manner similar to the lug 68, on the upper division. In other words, it is adapted to engage a notch 88 in the periphery of a flanged member 90 having a squared center fitting over a squared portion 92 of the king pin 54. By reason of the squared mating parts the flanged member 90 is forced to rotate with the king pin whenever the latter is turned therefore the notch 88 will assume different positions upon rotation of the king pin.

The portion of the king pin which extends above ear 56 is serrated at 94 and fits tightly into a bore in the rear end of a second arm 96 of the mechanical interception triangle, hereinafter referred to as the torpedo arm as it represents the velocity vector of the torpedo in water. Any rotation of the arm 96 will cause a corresponding rotation of the king pin 54 and the flanged member 90, the position of which is so adjusted that when the lug 86 engages the notch 88 the torpedo arm 96 will be held parallel to the axis of the aircraft.

The construction and mounting of the spring arm 67 is such that either division of the bifurcation may be moved into or out of engagement with the flange notches without affecting the position of the other division. In setting the director these divisions are alternately moved as will be later described and this movement is accomplished by the rotation of a knob 136. The knob is provided with an indexing pointer 138 and is adapted to rotate a shaft 140 upon which a cam 142 is fixed. The cam lies behind the upper and lower divisions of the bifurcated spring arm and is adapted by its eccentricity to contact one or the other or both or neither of the spring arm divisions so that either, both or neither of the lugs 68 and 86 will be in a position to engage their respective notches in the flanges 70 and 90.

When both notches are in vertical alignment, all parts of the director being in the neutral position, rotation of the knob index 138 to the aft position will move the cam from contact with both spring arm divisions and permit both of the divisions thereof to move into notch engaging positions and lock all parts of the director against movement. Rotation of the index to an upward pointing position will cause the cam 142 to raise the lower division lug to a notch free position releasing the torpedo arm 96 but holding the sighting leg 14 in alignment with the axis of the aircraft. Further rotation of the index to a forward pointing position will cause the cam to raise both lugs into a notch free position in which both the torpedo arm 96 and the sighting leg 14 may be moved. When the index is pointed downward, the upper lug is raised and the lower lug is in notch engaging position to hold the torpedo arm 96 in alignment with the axis of the aircraft. If either notch is not in alignment with its respective lug and the lug is released by the cam, it will merely ride along the flange and snap into the notch when they become aligned.

Referring particularly to Fig. 3, it will be noted that during the time of making the various adjustments and settings of the torpedo arm 96 and the third arm 102, these arms should be readily movable relative to each other and to the body of the director which defines the sighting line or third side of the triangle when force is applied to them to set them at the correct angles and yet they should be so connected together as to remain in the positions to which they are set while the various adjustments and settings are being made.

This may be readily accomplished by employing the king pin construction illustrated in Fig. 3 in which the upper bearing 72 (which carries the upper flange 70) is provided with an inwardly and downwardly tapering bore for frictionally receiving a tapered enlargement of the king pin 54. Also the under surface of the bearing member 72 is provided with an upwardly and inwardly extending taper to receive and frictionally engage a bearing sleeve 60a.

The lower flange member 90 is likewise provided with an upwardly and inwardly tapering upper surface adapted to engage a corresponding surface on the bearing sleeve 60a and is provided at its under surface with an inwardly tapering bore adapted to engage a correspondingly shaped surface on a bearing nut 58a which is adjustably threaded into the lower ear 58. Thus by tightening the nut 58a all of the parts of the bearing assembly are drawn into accurate alignment with each other and any desired amount of friction between the flange member 90 and the body of the sighting device may be imparted by the upward thrust of the nut against the flange member 90, which thrust will be imparted through the sleeve 60a to the upper or fixed bearing member 72.

Likewise the king pin 54 may be accurately centered in the bearing member 72 by separately drawing the king pin downwardly relative to the bearing member as by a second locking nut 54a threaded upon the lower end of the king pin 54 and bearing against a spring 54b interposed between the nut 54a and a shoulder on the counterbore of the main lock nut 58a.

With reference to the attachment of the bracket 60 to the transverse tube 62, it is so arranged that the front portion of the director may be lowered approximately seven degrees by manipulation of a lever 78 mounted upon a cam shaft 80, the cam forcing the director to tilt upon rotation of the shaft. The director tilts about a horizontal axis coaxial with a bolt 82 extending through two lugs 84, which are a part of the short square tube 62, and connecting the horizontal bracket 60 thereto. Forced tilting of the director relative to the square tube is resisted by a spring 85 so that the director will be held firmly at all times and will return to its normal position immediately upon being relieved by rotation of the cammed shaft 80. The tilting feature is provided for the purpose of allowing greater downward vision when needed as the aircraft may be nosed up to be slowed down during the torpedo attack approach. The degree of tilt may be varied to suit the requirements of different aircraft designs.

The end of the torpedo arm 96 opposite to the king pin 54 is provided with a bore 98 having one side thereof countersunk to receive a tapered bearing 100. One end of the bearing protrudes below the arm 96 and is threaded to receive a locking knob 101. The other end of the bearing protrudes above the arm 96 and is serrated so as to fit tightly into a bore in the end of a third arm 102 of the mechanical interception triangle. This arm represents the velocity vector of the target in water and is consequently called the target arm. In the adjustment of the triangle the torpedo and target arm pivot about the bearing 100 and, when the proper adjustment is had the locking knob 101 is tightened to hold the two arms against further relative movement.

The length of the target arm is adjustable to correspondence with the velocity of the target and so is provided with an inset rack 104 which is adapted to mesh with a pinion gear 106 disposed in a small housing 108, the gear 106 being provided for the purpose of moving the arm longitudinally relative to the housing 108 in response to rotation of a knob 110. The housing 108 may carry indexing pointers 112 for use in conjunction with suitable calibrations on the target arm 102 and knob 110 for determining the settings of both the target arm and the pinion knob.

The housing 108 is pivoted to a plate 114 which is adapted to slide on tracks 116 provided on each side of the sighting leg 14 and by such sliding motion the effective length of the sighting leg may be varied to suit different conditions. Thus it may be seen that with the sighting leg adjustable in effective length as just described and the target leg adjustable in effective length by operating the rack and pinion, the entire triangle may be adjusted at will both as to the length of the respective legs and their included angles.

It will be noted in the embodiment of the torpedo director shown in Figs. 1 and 3 that the torpedo leg 96 is not adjustable. In that embodiment the leg is of an effective length corresponding to a predetermined torpedo speed, which speed is that averaged by the torpedo throughout a preselected standard travel range when dropped from an aircraft at a standard altitude and travelling at a standard speed. This is in accordance with one of the conventional torpedoing practices. However, it is conceivable that conditions may arise under which one might desire to release the torpedo at a different height and speed. In such an instance an inversely proportional correction may be applied to the adjustable length of the target arm, or else the torpedo speed leg would have to be of a length corresponding to the different average torpedo travel speed. For that reason an adjustable torpedo leg 96' has been developed and is shown in detail in Fig. 4.

The two terminals of the adjustable leg are substantially identical with the corresponding terminals of the fixed length leg 96. That is, one end is provided with a tapered bore 118 for pivotal connection to the target leg 102 and the other end has a bore 120 adapted to fit tightly over the serrated top portion of the king pin 54. The inner portion 122 of the adjustable leg carries a rack 124 fastened thereto by screws 126. It is this portion that extends from and retracts into the outer portion 128 of the leg. The outer portion carries a small pinion 130 in mesh with the rack teeth and is rotated by a knob 132 to move the rack translationally in either extension or retraction.

An intermediate member 134 lies between the inner and outer portions of the leg and is adapted to improve the rigidity thereof as it approaches its maximum extension. To enhance quick adjustment of the leg, the pinion knob 132 should be calibrated in knots corresponding to average torpedo speeds at different leg lengths, or it may be calibrated in a manner to give different combinations of launching heights and speeds with the length of the leg automatically being set to the proper torpedo speed for any given launching height and speed condition.

It will be understood that the instrument with fixed torpedo arm length is readily adaptable to correction for any deliberate deviation from the standard torpedo travel range. As each different torpedo travel range would correspond to a slightly different average torpedo speed, a proportional correction of the scale in which the mechanical triangle represents the interception triangle will take care of the variation in the torpedo travel range. All that is necessary is to apply an inversely proportional correction to the estimated target speed U. Such corrections may be derived from charts previously prepared or other suitable calculating aids.

The mode of operation of the apparatus just described may perhaps be best understood by having reference to Figs. 6, 7 and 8 wherein the moving parts of the director are shown in perspective and divorced from the remainder of the apparatus. As before stated, the first operation which is performed by the pilot of the aircraft in approaching the target ship TS is to so position the sighting leg 14 as to extend the sighting line 4 defined thereby in a direction to bear upon the target ship TS. This may be conveniently accomplished in the manner illustrated in Fig. 6 by locking the director in the neutral position; that is, with the lug 68 engaging the notch 76 and with the lug 86 engaging the notch 88.

This is accomplished by turning the knob 136 to an aft position of the indexing pointer 138. When this condition obtains, the torpedo arm 96' and the sighting leg 14 (represented by the black arrow 14' in Fig. 6) are both aligned with the axis of the aircraft. The sighting line 4 defined by the sighting leg 14 may then be maintained on the target ship TS by merely so guiding the aircraft that the forward extension of its course will intersect the target ship TS. When the adjustable torpedo arm 96' is employed, the pilot then appraises the tactical situation and chooses the torpedo travel range best calculated to provide for a successful attack upon the target ship. By means of the knob 132 the length of the torpedo arm 96' is then adjusted to correspondence with the average torpedo velocity which corresponds to the chosen range. If the director is equipped with the fixed torpedo arm 96, this operation is, of course, omitted and the torpedo travel range is preferably chosen as closely as possible to that corresponding to the average torpedo velocity represented by the length of the fixed arm 96.

The pilot of the aircraft then turns the target arm 102 to parallelism with the course 3 of the target ship and through use of the knob 110 adjusts the length of the target arm 102 to represent the determined velocity of the target ship. This operation must of necessity result in a rotation of the torpedo arm 96 and so must be preceded by the turning of the knob 136 to an upward pointing position such as illustrated in Fig. 6 to remove the lug 86 from the notch 88 and release the king pin 54 to permit the arm 96 to be rotated. The sighting leg 14 is in the meantime held aligned with the axis of the aircraft through engagement of the lug 68 with the notch 76.

When the target arm 102 is set as above described, the knob 101 is manipulated to lock the target arm 102 and torpedo arm 96 immovably relative to each other and this operation fixes the mechanical interception triangle. The result of this operation is represented by the new relative disposition of parts which is shown in Fig. 7.

Having fixed the mechanical interception triangle, the pilot must next execute the veering maneuver 5 and as a prelude to this, the position of the mechanical interception triangle is shifted from that illustrated by the solid lines in Fig. 9 to that illustrated by the dotted lines in that figure. This is accomplished by turning the knob 136 to a downwardly pointing position of the pointer 138 as is illustrated in Fig. 7. By so doing the lug 68 is also removed from the notch 76 permitting the sighting member 14 to be pivotally moved about the king pin 54. The sighting leg 14 is then so pivotally moved as to bring the torpedo arm 96 into alignment with the axis of the aircraft. This can be conveniently accomplished through turning of the knob 136 to the position illustrated in Fig. 7, by which procedure the lug 86 is released to resiliently bear against the periphery of the flanged member 90. The notch 88 will be brought into a position registering with the lug 86 through rotation of the flanged member 90 by movement of the mechanical interception triangle and the king pin 54 the amount required to bring the torpedo arm 96 into alignment with the axis of the aircraft.

When this condition obtains the lug 86 will spring into the notch 88 by virtue of the resilient character of the bifurcated member 67 and will thus serve to hold the torpedo arm 96 in the desired aligned position. The veering maneuver 5 is then effected to bring the sighting line 4 to again bear upon the target ship TS, the relative positions of the parts when this condition obtains being illustrated in Fig. 8. Having thus established the desired torpedo course and having started the aircraft along that course, the pilot proceeds to the release point RP and releases the torpedo.

The foregoing description has been carried forward on the assumption that the pilot of the aircraft will in some way be aware of his arrival at the release point RP. As hereinbefore noted, the shape of the interception triangle is dependent upon the chosen torpedo travel range R only to the extent that the average velocity W of the torpedo is dependent upon the distance the torpedo travels. For relatively long ranges and low launching velocities the effect of a change in torpedo travel range from the average velocity of the torpedo is relatively small so that an accurate determination of the location of the release point RP is not required. However, for ranges differing widely from that to which the length of the torpedo arm 96 or 96′ corresponds or for relatively high launching velocities, the requirement for accurately determining the location of the release point RP becomes more stringent.

The torpedo director disclosed herein is accordingly provided with ranging equipment which will permit the location of the release point RP to be accurately determined in terms of the sighting range; that is, the distance from the release point RP to the position of the target ship TS at the time the torpedo is released. This mechanism includes the calculating mechanism comprising a rotatable member 146, a sliding member 147 and an indicating scale 148. The rotatable member 146 comprises a sleeve surrounding the vertical tubular portion 13 of the director and is equipped with a gear segment 149 which meshes with a second gear segment 150 secured to the king pin 54 so as to be rotated by pivotal movement of the torpedo arm 96.

Upon the exterior surface of the member 146 is engraved a family of θ curves 151, these curves being provided with suitable reference indicia 152 and representing various values of the target approach angle θ.

To permit the pilot to measure the target approach angle θ, the housing 108 is provided with a protractor 153 which coacts with a suitable index carried by the sliding plate 114 to indicate directly on the protractor 153 the magnitude of the target approach angle θ. The sliding member 147 is provided with graduations 154 representative of the chosen torpedo travel range. In operation the sliding member 147 is moved vertically to a position such that the "R" scale graduations 154 corresponding to the chosen travel range lie opposite that one of the family of curves 151 which corresponds to the target approach angle θ indicated on the protractor 153.

The sliding member 147 is also provided with a second set of graduations 155 representative of the known length of the target ship TS. This length is considered to be known by the pilot of the airchaft since he will be able to determine from its appearance the nationality and type of the target ship and from these facts the pilot will know or have at his disposal the pertinent data relative to the target ship TS including its actual length. The pilot then observes the position relative to the fixed indicating scale 148 of that one of the graduations 155 on the "L" scale which represents the known length of the target ship TS.

The scale 148 is provided with graduations 156 so that the pilot may read on the "S" scale 148 opposite the graduations 155 representing the length of the target ship TS the number of stadia divisions of the reticule through which the apparent observed length of the target ship TS should extend when the aircraft has arrived at the release point RP. The pilot then proceeds along the course 6 until the apparent size of the target ship has expanded to just exactly subtend the number of stadia divisions indicated on the scale 148 and by noting the expansion of the apparent size of the target ship to this extent, the pilot is thereby apprised of his arrival at the release point RP.

From the foregoing it will be observed that the torpedo director disclosed herein provides for the ready and accurate determination of the lead angle β and provides also a sighting means whereby the course of the aircraft may be so maintained that the torpedo when released will proceed along a course leading to target ship TS by the amount required to effect collision between the torpedo and the target ship.

It will also be observed that there is provided a ranging mechanism by which the pilot may be readily apprised of his arrival at a release point corresponding to a torpedo travel range previously chosen with due regard to the tactical situation involved in the attack.

It will also be noted that the device described is so arranged that the director may be moved to one side out of the way of the pilot when not in use and so that it may be moved to any desired operative position most convenient and accessible to the pilot when the device is being employed to direct a torpedo.

Further, the fact that the instrument is readily slidable along its mounting tube 64 allows the instrument to be aligned with the line of vision of the pilot when sighted at any ordinary angle upon a target and also when the instrument is swung to the latched position after sighting without necessitating the pilot's leaning to one side or the other or, in fact, changing the normal comfortable position of his head, an item which is of importance in the restricted space of an aeroplane cockpit.

It should also be noted that the device is readily susceptible to use as an emergency gun sight by merely locking the sighting leg 14 in a position aligned with the axis of the aircraft as by engaging the lug 68 with the notch 78 through turning of the knob 136 to an upwardly pointing position of the index 138. By this means the aircraft may be so guided as to bring the line of fire of fixed guns mounted on the aircraft to bear upon any target upon which the sighting line 4 is brought to bear.

It may be found more convenient to mount the instrument in a position inverted from that shown in the drawings, and it will be apparent that such inverted mounting will not in any way affect the operation of the instrument to perform all of the functions described herein.

While there has been shown and described the preferred embodiment of the invention, it is not desired that the same be limited to any of the details of construction shown or described herein, except as defined in the appended claims.

What is claimed as new is:

1. In a torpedo director for use on an aircraft carrying a torpedo, the combination of: an adjustable mechanical triangle for reproducing on a reduced scale the velocity vector triangle defining the relative motions of said aircraft, said torpedo, and the target intended to be hit by said torpedo, said triangle including a sighting arm defining a sighting line and a torpedo arm representing the velocity vector of said torpedo relative to the water into which it is to be launched; means mounting said triangle for pivotal movement as a unit to a position disposing said torpedo arm parallel to the motion of said aircraft; latching means carried by said aircraft for selectively engaging said sighting arm and said torpedo arm and holding the same against movement and in positions respectively parallel to the direction of motion of said aircraft; and a movable control member coacting with said latching means and operable upon movement to one position to engage said latching means only with said sighting arm and operable upon movement to another position to engage said latching means only with said torpedo arm.

2. In a torpedo director for use on an aircraft carrying a torpedo, the combination of: an adjustable mechanical triangle for reproducing on a reduced scale the velocity vector triangle defining the relative motions of said aircraft, said torpedo, and the target intended to be hit by said torpedo, said triangle including a sighting arm defining a sighting line and a torpedo arm representing the velocity vector of said torpedo relative to the water into which it is to be launched; means mounting said triangle for pivotal movement as a unit to a position disposing said torpedo arm parallel to the motion of said aircraft; latching means carried by said aircraft for selectively engaging said sighting arm and said torpedo arm and holding the same against movement and in positions respectively parallel to the direction of motion of said aircraft; and a control member coacting with said latching means, said control member being movable to four unique positions, in the first of which said latching means is held out of engagement with both of said arms, in the second of which said latching means is engaged with both of said arms, in the third of which said latching means is engaged with one only of said arms, and in the fourth of which said latching means is engaged only with the other of said arms.

3. A projectile director for use on a mobile vehicle comprising a mechanical triangle for reproducing on a reduced scale the velocity vector triangle representing the respective magnitudes and directions of the speed of the projectile relative to the earth, the speed of the vehicle relative to the target to be torpedoed, and the speed of the target relative to the earth, means mounting said mechanical triangle on the vehicle for pivotal movement about a center coincident with the vertex formed between the sides of the triangle representing respectively the projectile direction and the direction of the vehicle, means for latching said director in a position about said pivot means aligning said vehicle direction side in a position extending fore and aft of said vehicle, means movable relative to said mounting means and to said first named latching means in correspondence with the angular deviation of said projectile direction side of said triangle to define a second latch position disposed relative to the fore and aft line of the vehicle at the same angle as the angle between said two sides of said triangle, and detent means engageable with the first of said latch means when said vehicle direction side of said triangle is aligned with the fore and aft line of the vehicle and engageable with the other of said latch means when the projectile direction side of said triangle is aligned with the fore and aft line of said vehicle.

4. A projectile director for use on a mobile vehicle comprising a mechanical triangle for reproducing on a reduced scale the velocity vector triangle representing the respective magnitudes and directions of the speed of the projectile relative to the earth, the speed of the vehicle relative to the target to be torpedoed, and the speed of the target relative to the earth, and means mounting said mechanical triangle on said vehicle for lateral translatory movement at right angles to the fore and aft line of the vehicle and for lateral pivotal movement about a substantially vertical axis passing through the vertex formed between the sides of the triangle representing respectively the speed of the projectile and the speed of the vehicle, whereby either of said sides may be aligned with the fore and aft line of the vehicle and may be shifted into the line of vision of the operator of the projectile director in either of said angular positions.

5. In an aircraft, a device for so launching a torpedo as to cause it to strike a target moving in a given direction relative to said aircraft and at a given speed, comprising: a sighting arm for defining a sighting line; means mounting said arm on said aircraft for movement to a position directing said sighting line toward said target; a second arm for representing the speed of said target; a third arm having a length representing the average speed of said torpedo, said third arm being pivotally connected at opposite ends to said sighting arm and said second arm; means for adjusting the effective length of said second arm to correspondence with said given target speed;

means for adjusting the angular relation of said sighting arm and said second arm in accordance with the direction of motion of said target; pivotal means about which the position of said triangle may be adjusted as a whole relative to said vehicle in an amount sufficient to bring said third arm into a position paralleling the course of said aircraft, said pivotal means interconnecting said third arm and said sighting arm; and means for imparting friction between said vehicle, said sighting arm and said third arm, whereby said arms will be yieldably held in any angular position relative to each other to which they may be moved and the sighting arm will be yieldably held in any position relative to the vehicle to which it may be moved.

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