

R E S T R I C T E D

DOLPHIN "BORESIGHT"
for rack-launched torpedoes

ALIGNMENT KIT (TORPEDO RACK) MARK I...MOD. 0

REPORT
S - 42



RADIATION LABORATORY
MASSACHUSETTS INSTITUTE OF TECHNOLOGY
CAMBRIDGE • • • • MASSACHUSETTS

R E S T R I C T E D

This pamphlet has a dual purpose. In addition to its normal function as a report, it is to serve as an instruction manual for operating personnel.

Pages 1 to 7 are essentially descriptive.

OPERATING PERSONNEL SHOULD BE THOROUGHLY ACQUAINTED WITH THE ENTIRETY BEFORE ATTEMPTING TO USE THE ALIGNMENT KIT.

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Radiation Laboratory

Report S-42 March 17, 1945

ALIGNMENT KIT (TORPEDO RACK) MARK I...MOD. O

ABSTRACT

Described herein is an instrument for finding the horizontal angle between the vertical plane containing a Torpedo Director's "zero-axis" and the vertical plane containing the longitudinal axis of a rack-launched torpedo. Formerly known as the "Dolphin Torpedo-Boresight", the combination of instrument, accessories, and carrying case, has been designated ALIGNMENT KIT (Torpedo Rack) Mark I Mod O, by the Bureau of Ordnance. It was especially designed for use with PT Boats, but is not restricted to these craft. In fact, it may be employed to ascertain the vertical plane containing the axis of any cylinder which measures between eighteen and twenty-six inches (outer diameter).

A rough model was first constructed in the spring of 1944 by Mr. G. D. Sheckels of Radiation Laboratory, previous studies under "Project Dolphin" (Naval Ordnance Project #172) having revealed the necessity for such an instrument.

The production model was engineered by Mr. G. S. Perkins of Radiation Laboratory from sketches and descriptive material furnished by the author.

An instrument-error of less than ± 0.05 may be obtained if adjustments are made carefully and properly.

Gordon F. Duvall

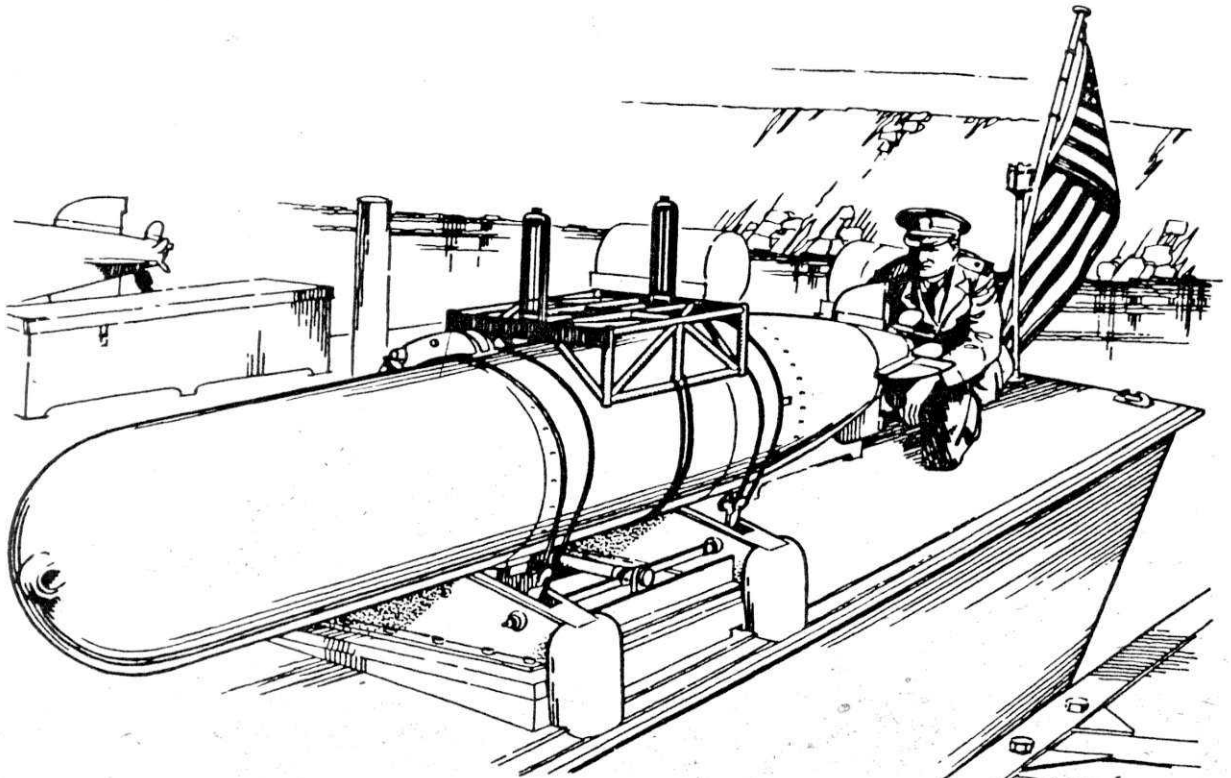
Approved by:

Richard M. Emberson
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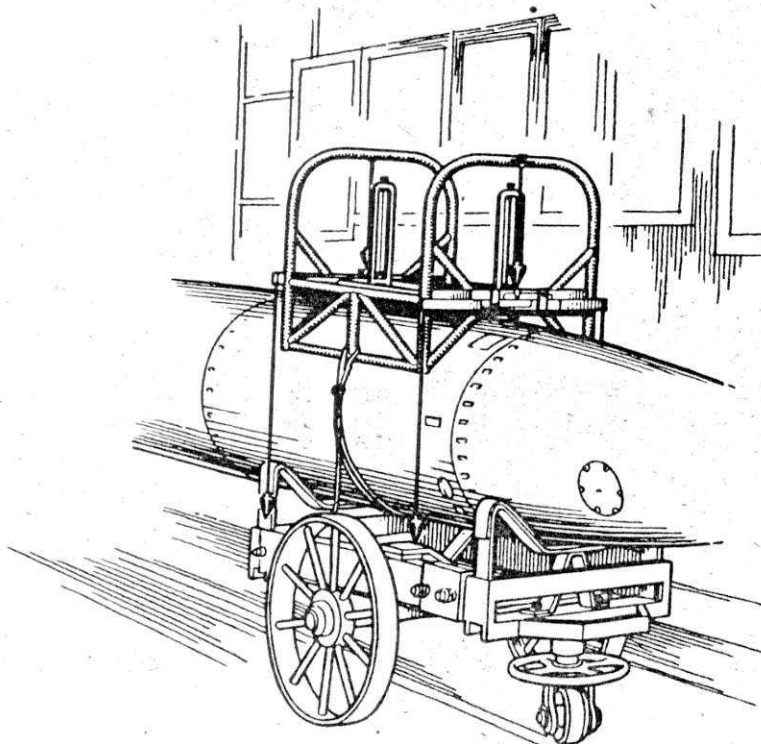
J. C. Ostrud
Division Head

RESTRICTED

ALIGNMENT KIT (*torpedo rack*) MARK I MOD. 0



"Boresighting"
THE TRAD IN USE



INSTRUMENT ALIGNMENT

The TRAD with
Alignment Frames
shipped

PROJECT DOLPHIN

"YOU CAN'T SOLVE A PROBLEM BY IGNORING IT"

Project Dolphin was initiated for the development of methods, procedure, and equipment to be used in blind, semi-blind, and visual firing of torpedoes from PT Boats.

FOREWORD

In experimental work for development of the Torpedo Director Mark 33-1, accurate alignment of Director, Director Sights, Compass, Compass Repeater, Control Box, Radar, Tracking Indicator, Firing Indicator, and Torpedo Racks, each with respect to the Boat's keel-line proved impossible. No suitable trams or tram-marks are provided, and the addition of such devices did not appear feasible. Moreover, exact alignment of each item with respect to the keel-line is *NOT* essential, but mutual alignment of all components, each with respect to all others is vital to precision firing. Consequently, the Director's "Zero-Axis" was chosen as the reference line for *all* alignment. On installing the Director its "Zero-Axis" was properly aligned with respect to the keel; and the keel was then forgotten. A procedure for alignment was established, and excellent results were obtained. As these problems of alignment were kept in mind during the development and design of the Director System, suitable means of ascertaining and making adjustments were provided. The racks, however, are "standard equipment", with no such provision incorporated. Something *had to be devised*, if precision firing from PT Boats was ever to be realized. This instrument, known as the TRAD,* is another "product of necessity". Its purpose is:

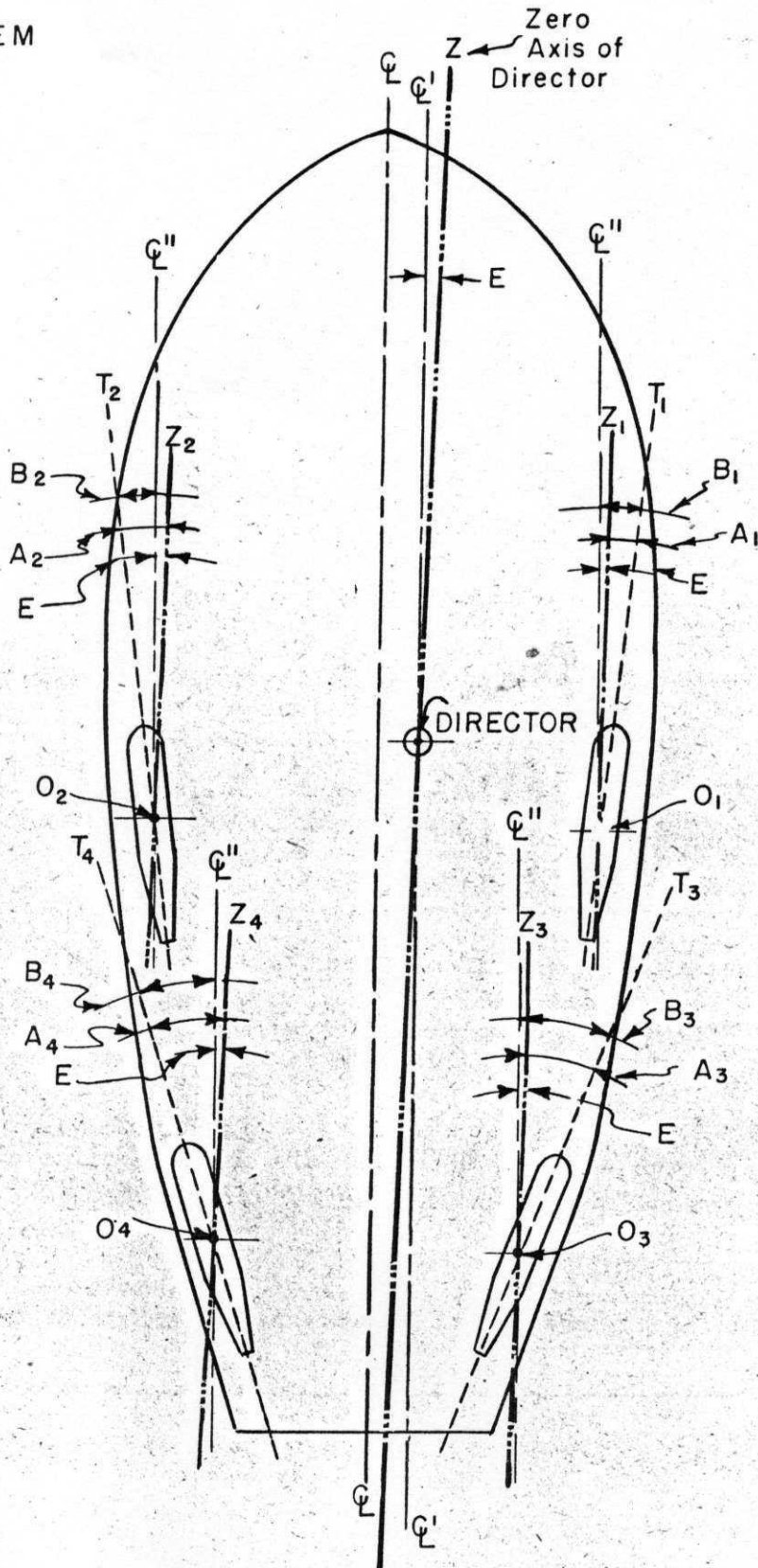
TO ASCERTAIN THE RACK-ANGLE

[The "Rack-Angle" is the horizontal angle between the vertical plane containing the Director's Zero-Axis and the vertical plane containing the longitudinal axis of the torpedo as it is carried in the rack.]

Although designed in connection with the "Mark 33 System", the ALIGNMENT KIT (Torpedo Rack) Mark I Mod 0 may be used with any director. Proper employment should increase materially the percentage of hits with any system, as large errors on rack-alignment data-plates are not uncommon.

* [See pages 6 and 7 for description and definition of "TRAD"]

THE PROBLEM



THE PROBLEM (continued)

The diagram on Page 2, facing, is a distorted plan-view with the various angular values exaggerated.

\mathcal{C}_L - Vertical plane containing boat's keel.

\mathcal{C}' - Plane parallel to \mathcal{C}_L containing director's axis of rotation.

O_1, O_2, O_3, O_4 - "Centers" of torpedoes 1, 2, 3, and 4, respectively. In each case it is the vertical line which intersects the torpedo-axis midway between the points of rack-support.

\mathcal{C}'' - Planes parallel to \mathcal{C}_L containing O_1, O_2, O_3 , and O_4 .

Z - Vertical plane containing the "zero-axis" of the director.

E - Horizontal angle between \mathcal{C}' and Z .

Z_1, Z_2, Z_3, Z_4 - Planes parallel to Z containing O_1, O_2, O_3 , and O_4 .

T_1, T_2, T_3, T_4 - Vertical planes containing the torpedo axes.

A_1 - Horizontal angle between T_1 and Z_1 .

B_1 - Horizontal angle between T_1 and \mathcal{C}'' .

A_2 - Horizontal angle between T_2 and Z_2 .

B_2 - Horizontal angle between T_2 and \mathcal{C}'' .

A_3 - Horizontal angle between T_3 and Z_3 .

B_3 - Horizontal angle between T_3 and \mathcal{C}'' .

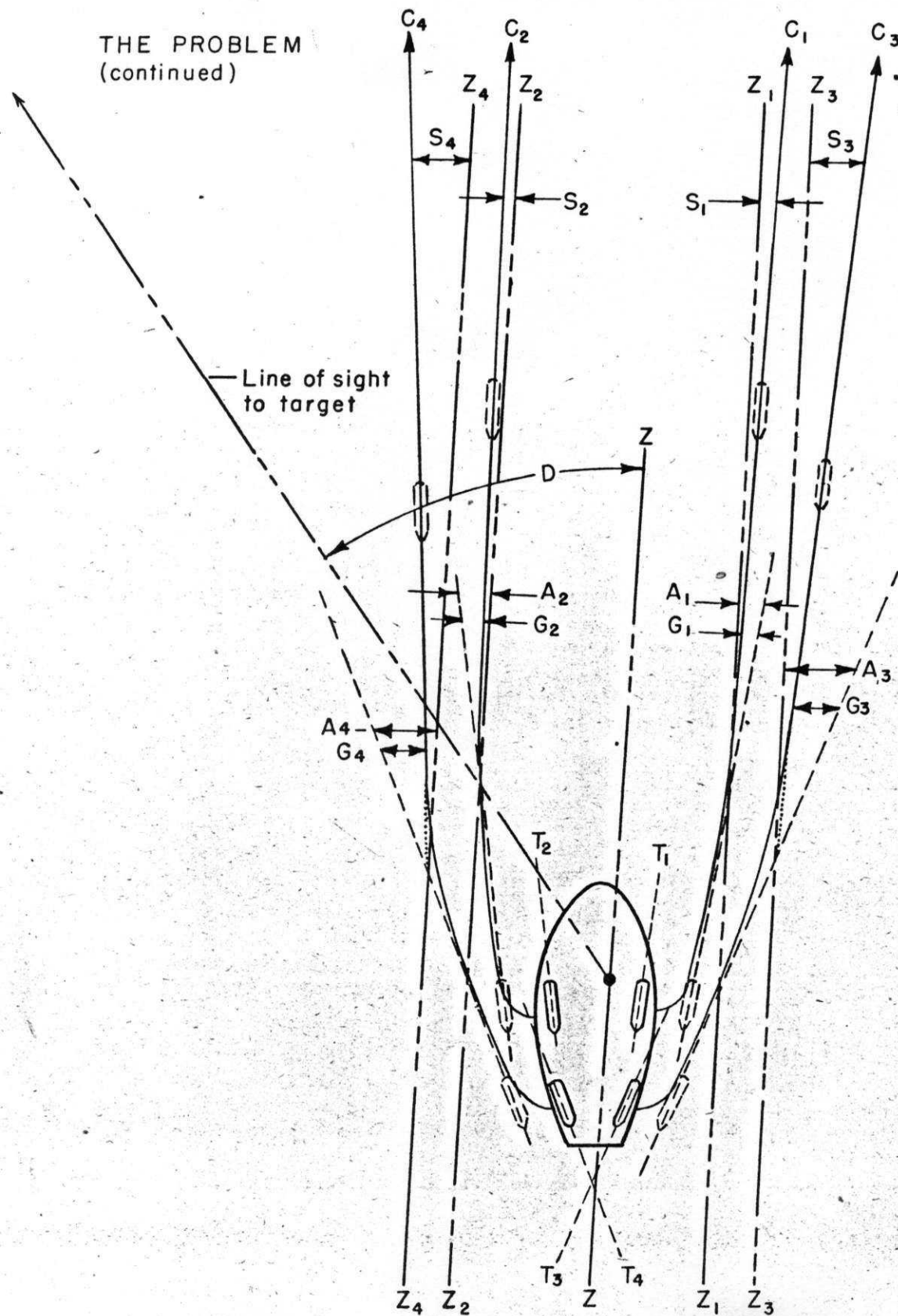
A_4 - Horizontal angle between T_4 and Z_4 .

B_4 - Horizontal angle between T_4 and \mathcal{C}'' .

Obviously, A_1, A_2, A_3 , and A_4 are the REAL Rack-Angles; B_1, B_2, B_3 , and B_4 are not. If "B" values are used the director alignment-error "E" will be applied to the entire salvo.

The TRAD determines T_1, T_2, T_3 , and T_4 . Angles A_1, A_2, A_3 , and A_4 are read on the director.

The significance of these angles is illustrated on Pages 4 and 5, following.

THE PROBLEM
(continued)

THE PROBLEM (concluded)

The distorted diagram on Page 4, facing, illustrates the significance of the angles involved in relation to the overall problem.

D = Sight-Angle; Lead-Angle; "Director-Angle."

A_1 = Rack-Angle (Rack #1)

A_2 = Rack-Angle (Rack #2)

A_3 = Rack-Angle (Rack #3)

A_4 = Rack-Angle (Rack #4)

C_1 = Intended Track of Torpedo #1

C_2 = Intended Track of Torpedo #2

C_3 = Intended Track of Torpedo #3

C_4 = Intended Track of Torpedo #4

Z = Vertical plane containing the Director Zero-Axis; "center" of spread.

S_1 = Angular divergence of Torpedo #1 from Z. [$S_1 = A_1 - G_1$]

S_2 = Angular divergence of Torpedo #2 from Z. [$S_2 = A_2 - G_2$]

S_3 = Angular divergence of Torpedo #3 from Z. [$S_3 = A_3 - G_3$]

S_4 = Angular divergence of Torpedo #4 from Z. [$S_4 = A_4 - G_4$]

$S_1 + S_2$ = Spread (between torpedoes).

[also, spread = $S_4 - S_2 = S_3 - S_1 = 1/3 (S_3 + S_4) = 2S_1 = 2S_2 = 2/3 S_3 = 2/3 S_4$]

G_1 = Torpedo Gyro-Angle (Torpedo #1) [$G_1 = A_1 - S_1$]

G_2 = Torpedo Gyro-Angle (Torpedo #2) [$G_2 = A_2 - S_2$]

G_3 = Torpedo Gyro-Angle (Torpedo #3) [$G_3 = A_3 - S_3$]

G_4 = Torpedo Gyro-Angle (Torpedo #4) [$G_4 = A_4 - S_4$]

$A_1 - G_1 = S_1$; $A_2 - G_2 = S_2$; $A_3 - G_3 = S_3$; $A_4 - G_4 = S_4$.

If A_1 , A_2 , A_3 , and A_4 are accurately determined with the TRAD (in the manner described on pages 8 to 13, following), G_1 , G_2 , G_3 , and G_4 may be computed and set on the respective torpedo-gyros so as to give the desired values of S_1 , S_2 , S_3 , and S_4 . Obviously, errors in determination of A_1 , A_2 , A_3 , and A_4 will appear as errors in C_1 , C_2 , C_3 , and C_4 . "Boresighting" should be done carefully and frequently. The values of "A" should be recorded and used. There is no "magic" in the number which may happen to be inscribed on a rack data-plate. It is easy to see, from a study of the diagram facing, that \angle , \angle' , \angle'' , B_1 , B_2 , B_3 , B_4 , and E (Pages 2 and 3) may be and should be eliminated from the problem.

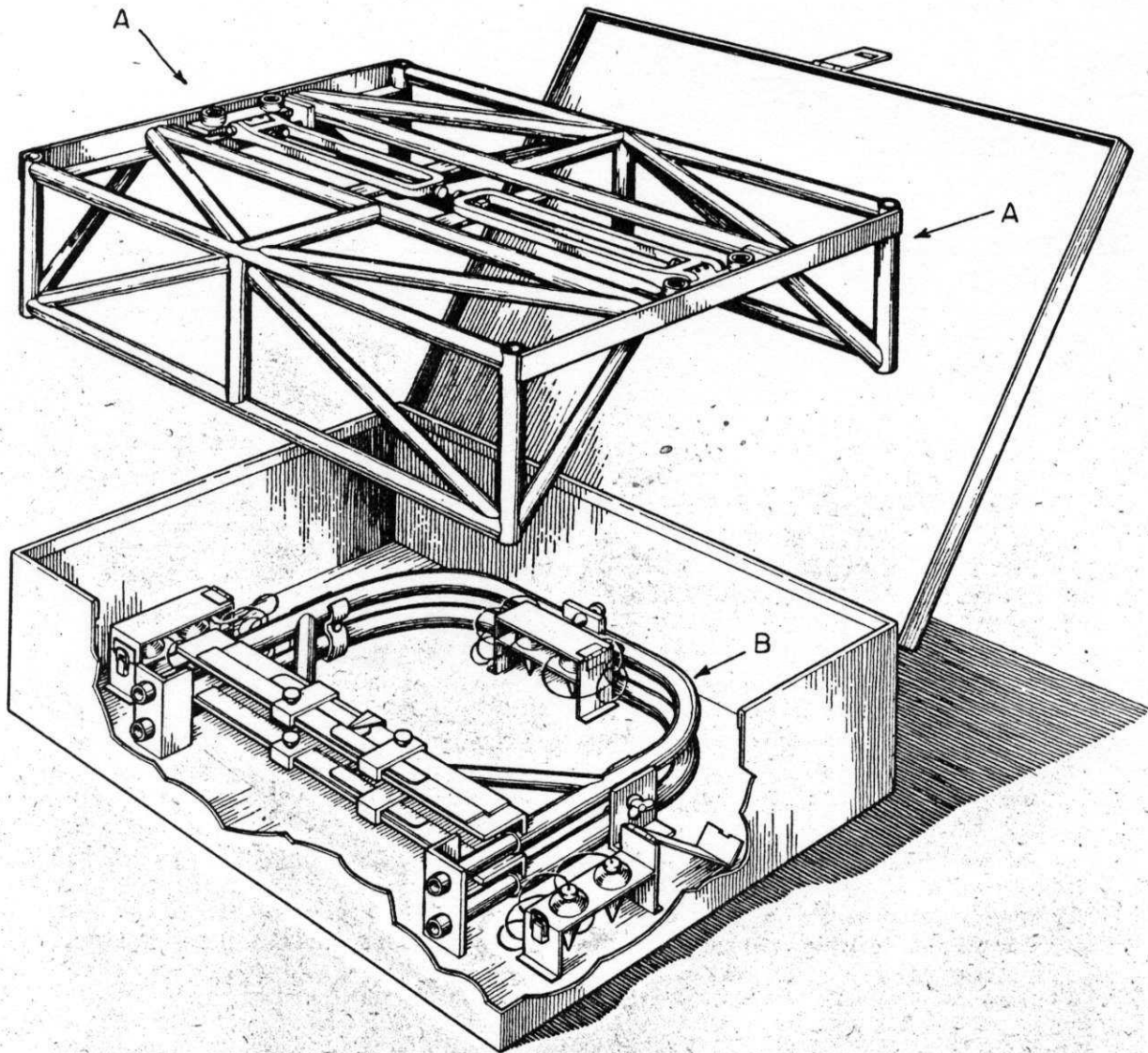
Although torpedoes are carried at some inclination to the horizontal, all angles are measured in the horizontal plane. After the torpedo-gyro has been spun and uncaged, only the horizontal-component of the gyroscopic-moment affects the torpedo steering mechanism. As the torpedo moves through the water, the locking-ring on which the Gyro-Angle is set lies in the horizontal plane. Hence the fixed inclination of the torpedo's fore-and-aft axis does not enter into the problem and may be disregarded.

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ALIGNMENT KIT (torpedo rack) MARK I MOD. O

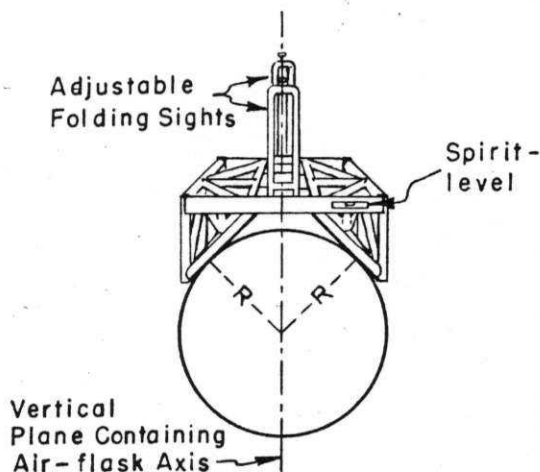
DESCRIPTION

THE ALIGNMENT KIT



DESCRIPTION (continued)

A. The TRAD - Torpedo-Rack Alignment Device
(Unit for Torpedo-Rack Axis Determination)



This unit consists of a welded, tubular frame which is fitted with adjustable folding sights and a spirit-level.

When placed on a torpedo air-flask and leveled with the spirit-level it determines the vertical plane containing the torpedo's longitudinal axis. This operation is commonly referred to as "boresighting".

B. ALIGNMENT FRAME WITH ATTACHED ACCESSORIES

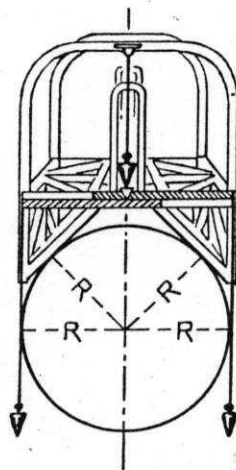
Two of these units are in each kit. Each unit consists of a tubular frame with three plumb-bobs, a pair of sliding scales, and a small pointer. Two of the plumb-bobs (the "torpedo-bobs") are attached to the ends of the sliding scales forming an "outside-caliper". One plumb-bob (the "sight-bob") is attached to a fixture at the top of the alignment frame.

When these two units are affixed to the TRAD they provide gravitational references for adjusting the TRAD sights and spirit-level to proper alignment. This operation is ALWAYS DONE ASHORE and preferably indoors. The Alignment Frames are NEVER used in the "boresighting" operation.

Tools required for adjustment of the TRAD are:

- 2 #48 torpedo tools.
- 1 screw driver which fits Spirit Level Lock.
- 1 thin crescent wrench for Spirit Level Adjusting Nuts.

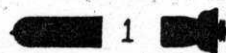
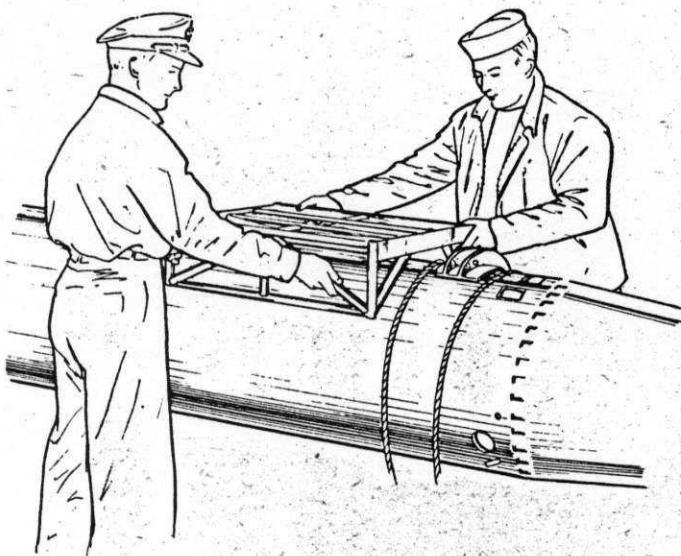
As the foregoing are always available in any torpedo work-shop they are not provided in the kit.



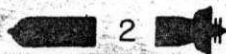
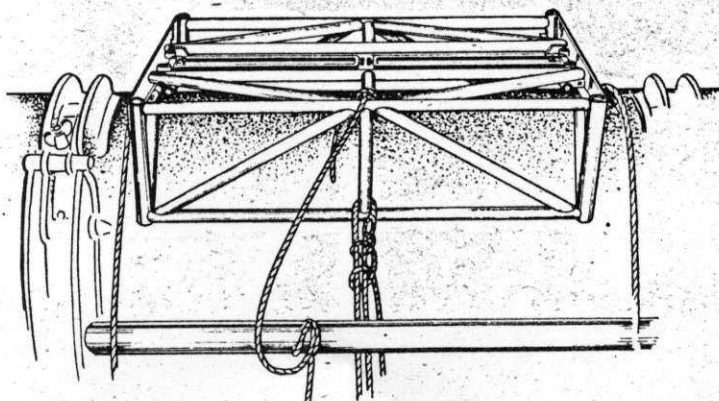
USING THE TRAD

[Pages 8 to 13 describe proper procedure for use of the TRAD assuming that the instrument has already been put in proper adjustment by operating personnel, in the manner described on pages 14 to 21. Operating personnel should make no "assumptions", however, in regard to adjustment of the instrument. Sight alignment *should be checked* before every use. Presumably, the instruments are "factory adjusted" but no reliance should be placed on this specification when a TRAD is first received].

Have the boat on an even keel and trimmed so as to approximate the normal planing position at 15-20 knots. The two primary stations (The TRAD and the Director) should be manned by officers or torpedoman's-mates especially trained and practiced in the operations. Boat officers and torpedoman's-mate should be present to assist, to check and to record data. Sufficient personnel to warp the boat slowly and carefully should be detailed and placed under competent supervision.

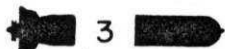


Place TRAD on Torpedo Air-Flask

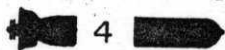
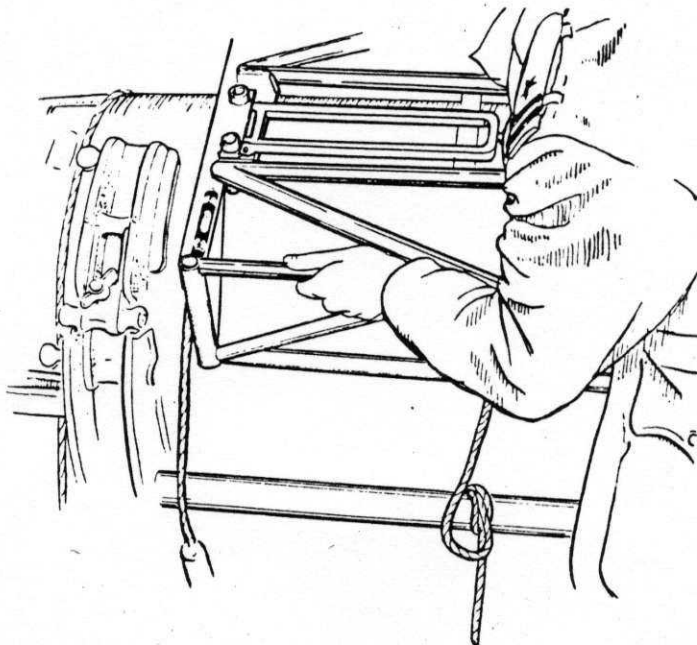


Fasten Preventer to Cross-Bar and sling cinch loosely.

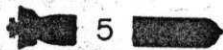
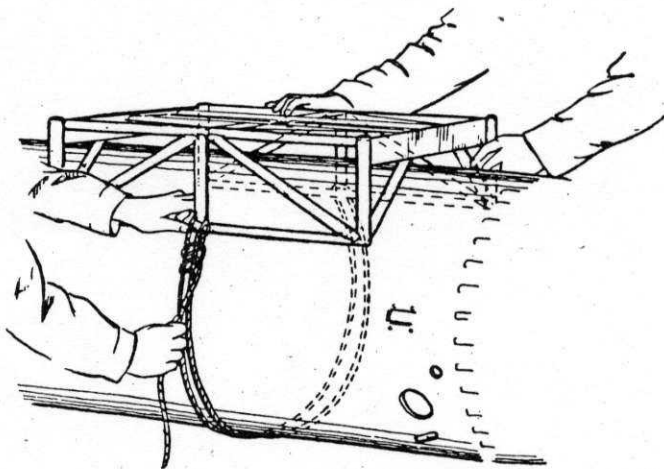
USING THE TRAD (continued)



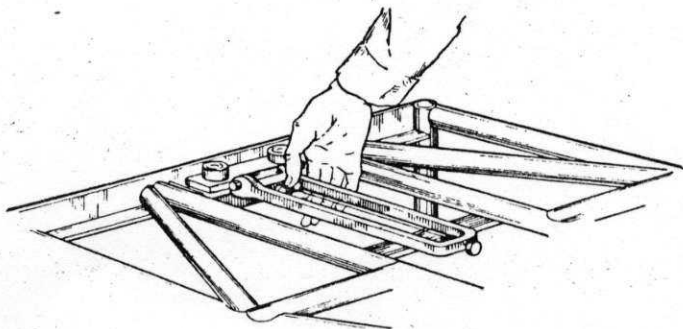
Level the instrument
using the spirit-level



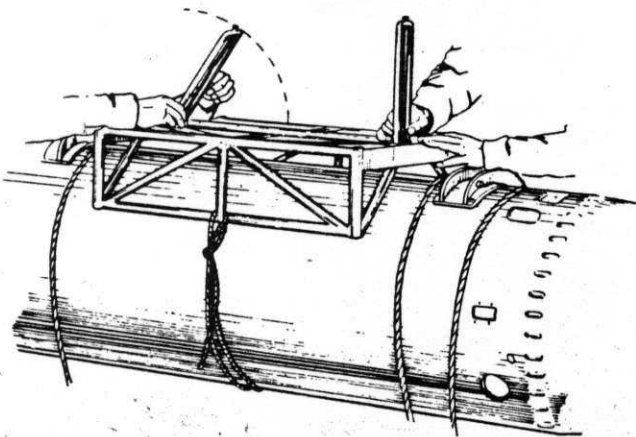
Tighten CINCH
Recheck LEVEL



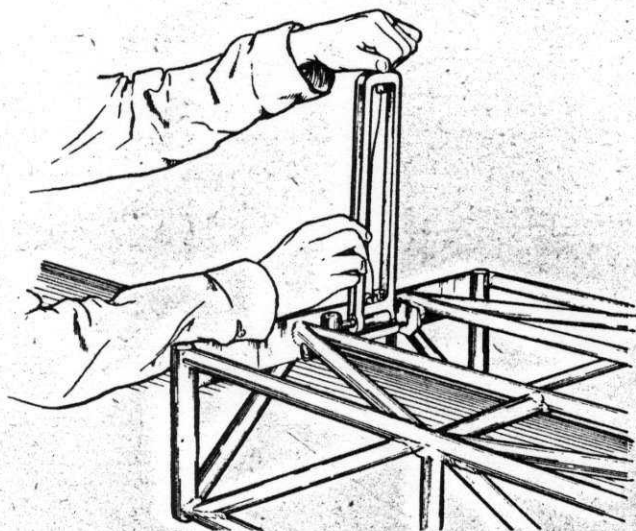
Unclamp Sight-Locks



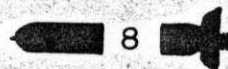
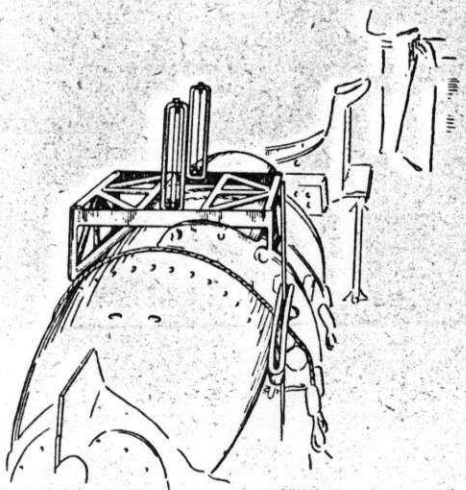
USING THE TRAD (continued)



Raise SIGHTS and reclamp sight-locks



Tighten sight-wires until they are straight. Put under light tension only.



Recheck level. Instrument is now in place and ready for use.

USING THE TRAD (continued)

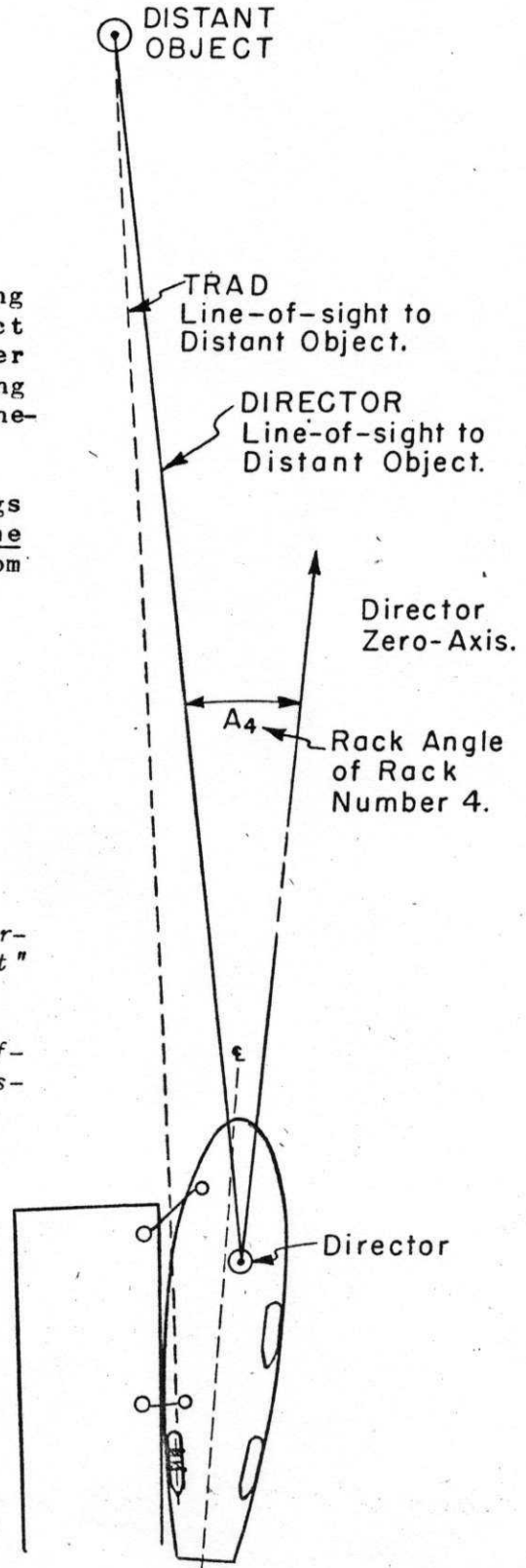


PROCEDURE:

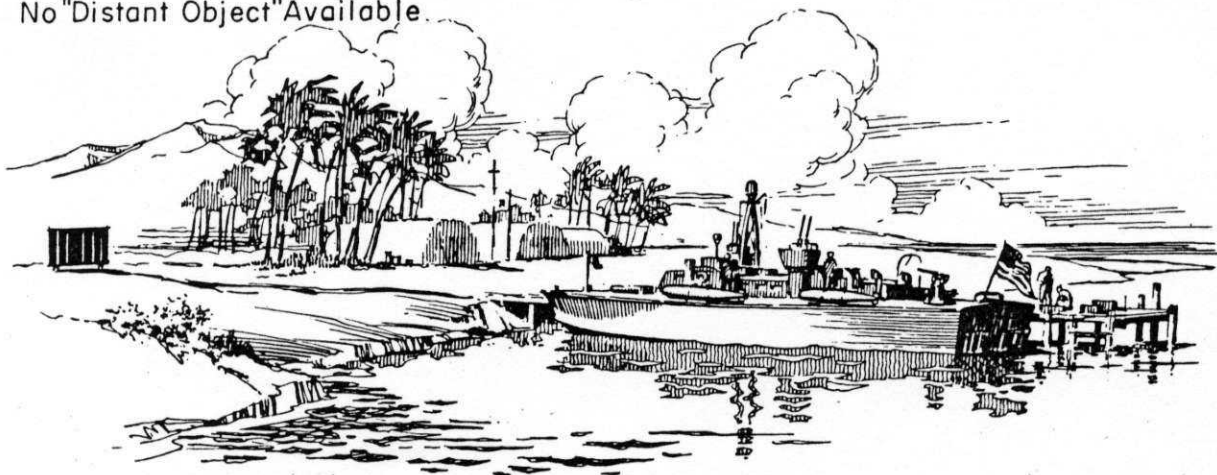
- (a) Using lines to pier, warp boat to bring TRAD line-of-sight on a distant object (2000 yards or more away)*. The officer manning the TRAD coaches the men handling the lines and calls out "Mark" when the line-of-sight is "ON".
- (b) The officer manning the Director brings his line-of-sight to bear on the same object** as "Marks" are called out from the TRAD.
- (c) Read RACK-ANGLE on Director.
- 1) Take at least ten readings.
- (e) Shift stations and repeat procedure.

* See pages 12 and 13 for description of material and procedure, if no "distant object" is available.

** Take care to insure that both lines-of-sight are brought to bear on the SAME "distant object".



USING THE TRAD (continued)
No "Distant Object" Available.



If no suitable "distant object"* is available, sighting-battens may be constructed and used in the manner suggested by the illustration above. Care should be exercised to make certain that batten-measurements are correct,[#] that batten-lines are parallel,⁺ that battens are set up so as to lie along a line which is approximately perpendicular[‡] to the line-of-sight from the boat, that battens are 50 to 100 yards from the bow of the boat, and that batten-lines lie in a vertical plane.[‡]

The illustrations on page 13, facing, show the measurements needed, how to get them, and how to use them.

Warping of the boat, to bring the TRAD line-of-sight to bear on the proper batten is not necessary. The boat can be snubbed up tightly against the pier and the batten-frame shifted laterally until the proper batten is in line with the TRAD line-of-sight. The Director line-of-sight is then brought to bear on the Director-batten and the Rack-Angle read on the Director in the usual manner.

* "Distant Object" - 2000 yards or more away.

Within ± 1 inch.

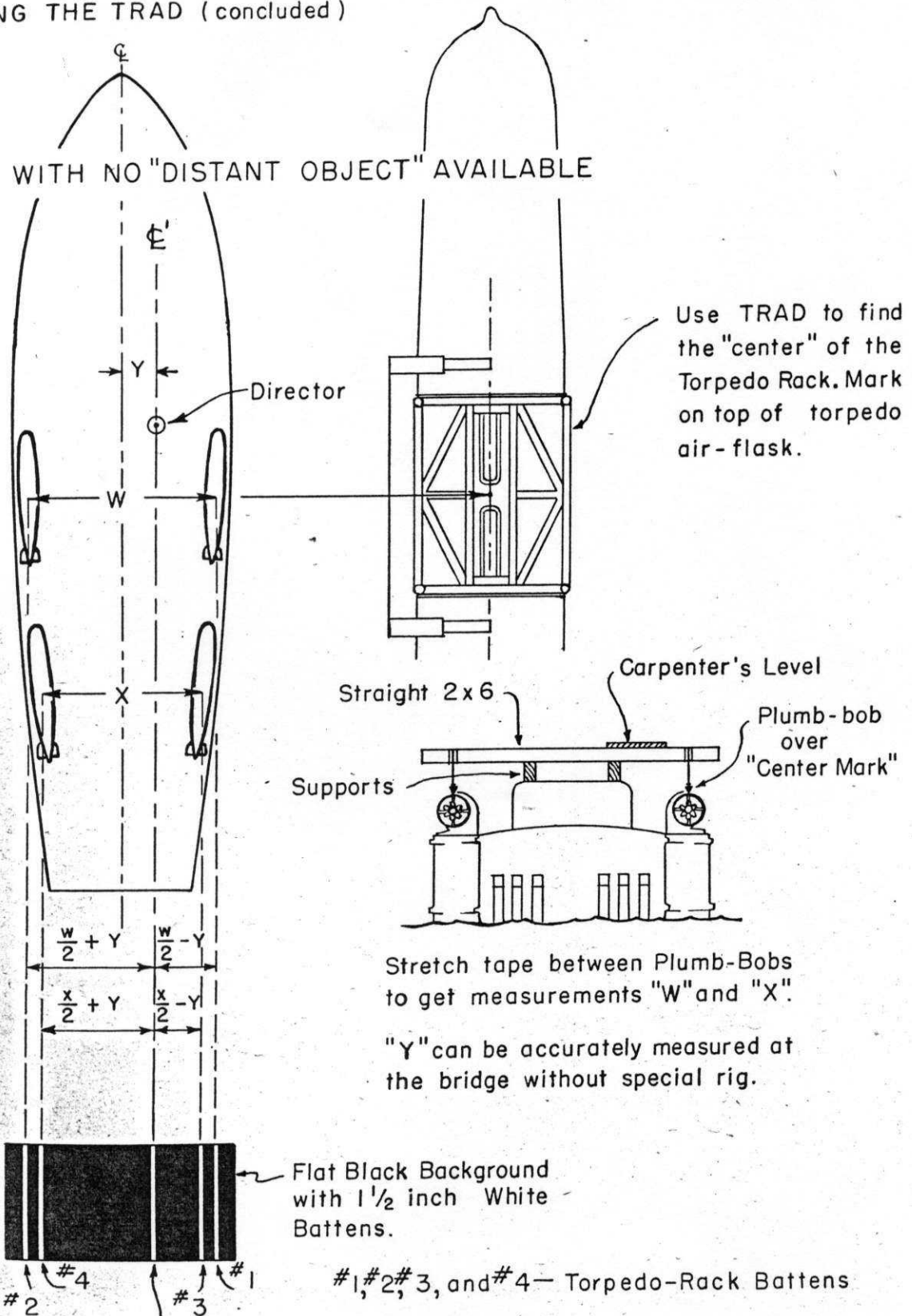
+ Top measurements between batten-lines should agree with bottom measurements (to $\pm \frac{1}{4}$ inch).

‡ Within $\pm 10^\circ$.

‡ The plane of the TRAD sight-wires.

USING THE TRAD (concluded)

WITH NO "DISTANT OBJECT" AVAILABLE



INITIAL ADJUSTMENT OF THE TRAD

The following adjustment procedure should be followed in making original factory alignment and resorted to in the field whenever a check on adjustment (as described on page 21) reveals that sights are very decidedly out of alignment. If adjusting screws are properly set up on initial adjustment, routine checks should reveal no errors in alignment, unless the instrument is dropped, struck, or otherwise damaged through accident or carelessness. If the TRAD is used only by the base-personnel who are responsible for its condition it will probably stay in perfect adjustment. With this in mind each carrying case has been provided with a pad-lock.

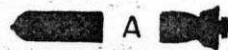
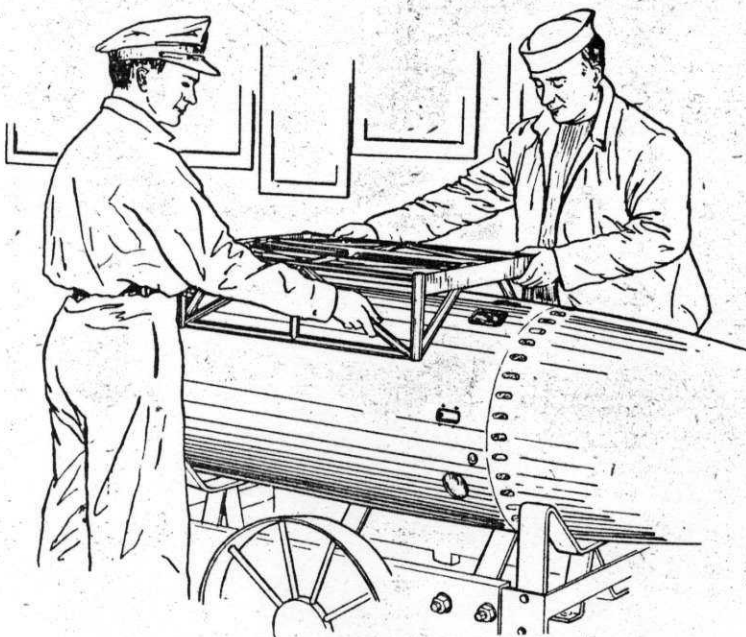
Adjustments and checking of alignment should be made *inside*, where wind cannot affect the plumb-bobs.

Lateral and vertical adjustments of each sight are made by opposing screw action, using two No. 48 tools. Before attempting to move a sight the tension on the screw threads should be relieved and then the two screws should be worked slowly and simultaneously to secure the motion desired. When an adjustment is completed both screws should be tightened slightly putting threads under a light stress, thus "locking" the adjustment. A normal grip on each No. 48 wrench is sufficient. After setting-up, recheck adjustments. The rims and counter-bores surrounding each adjusting screw head were provided to make use of a No. 48 tool mandatory thus prevent "barnyard adjustments" and "twiddling" by unauthorized personnel.

Misalignment of the TRAD is usually caused by accidental blows on the sights. These may be largely obviated by adhering to two simple rules:

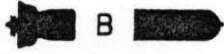
NEVER RAISE THE SIGHTS UNLESS THE TRAD IS SECURELY MOUNTED ON A TORPEDO AIR-FLASK.

NEVER CARRY THE TRAD WITH SIGHTS RAISED.

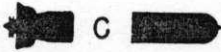
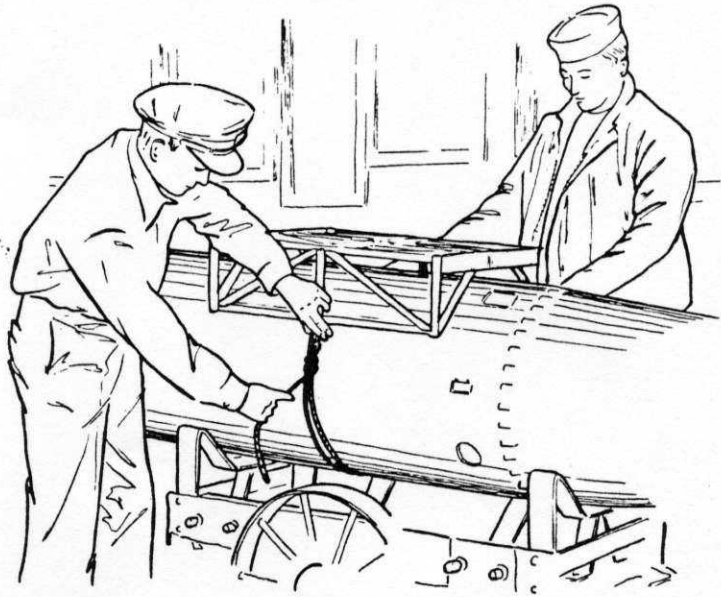


Place TRAD on Torpedo Air-Flask

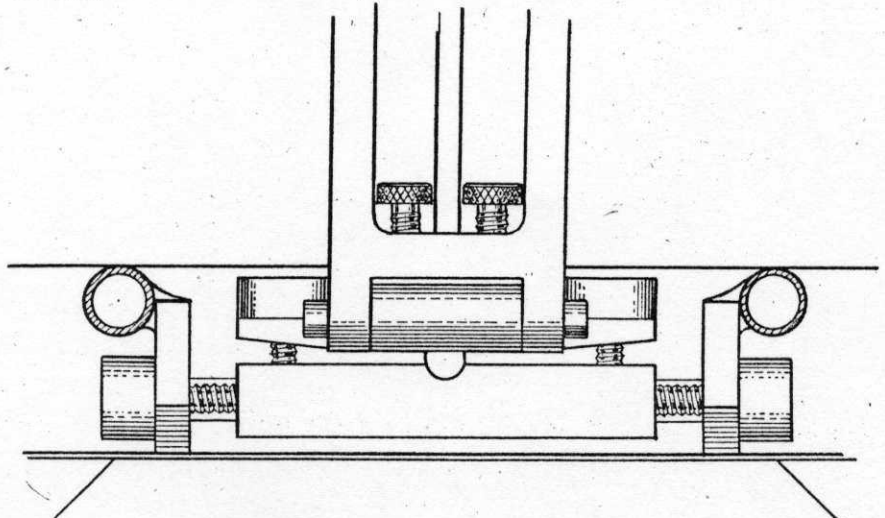
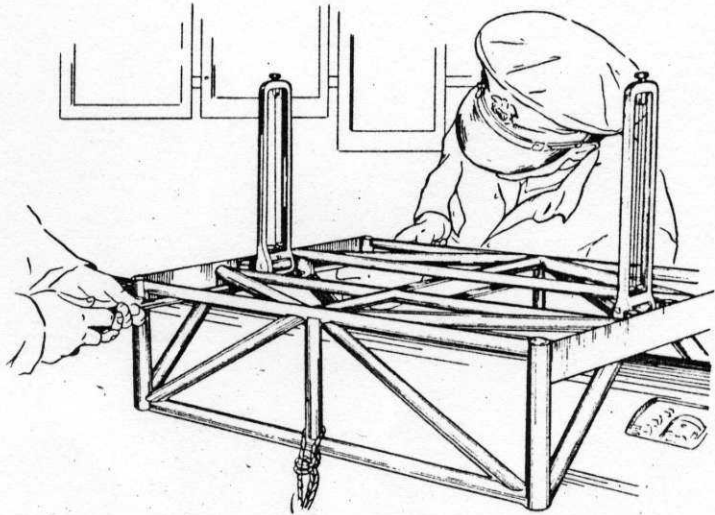
INITIAL ADJUSTMENT (continued)



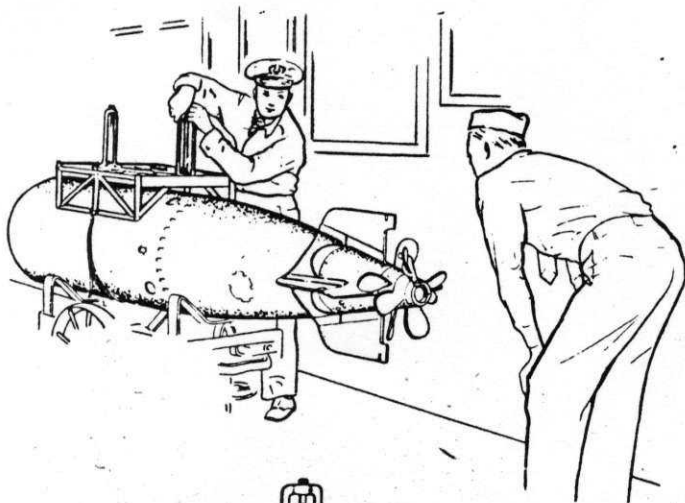
Draw CINCH up lightly



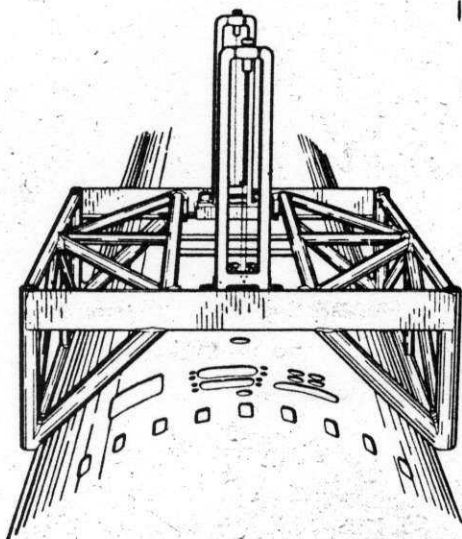
Raise SIGHTS and put all
adjusting points at mid-
position



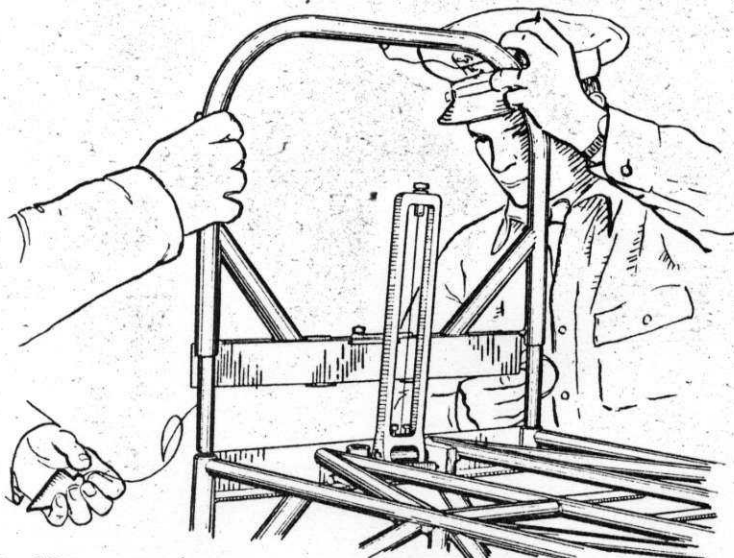
INITIAL ADJUSTMENT (continued)



Adjust sights to bring front-sight wire and rear-sight wires parallel with each other.



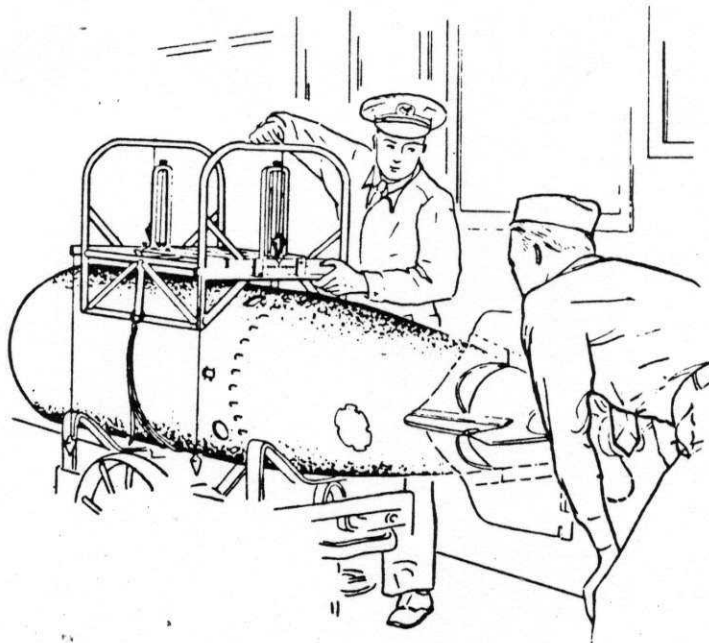
Ship the Alignment Frames



INITIAL ADJUSTMENT (continued)



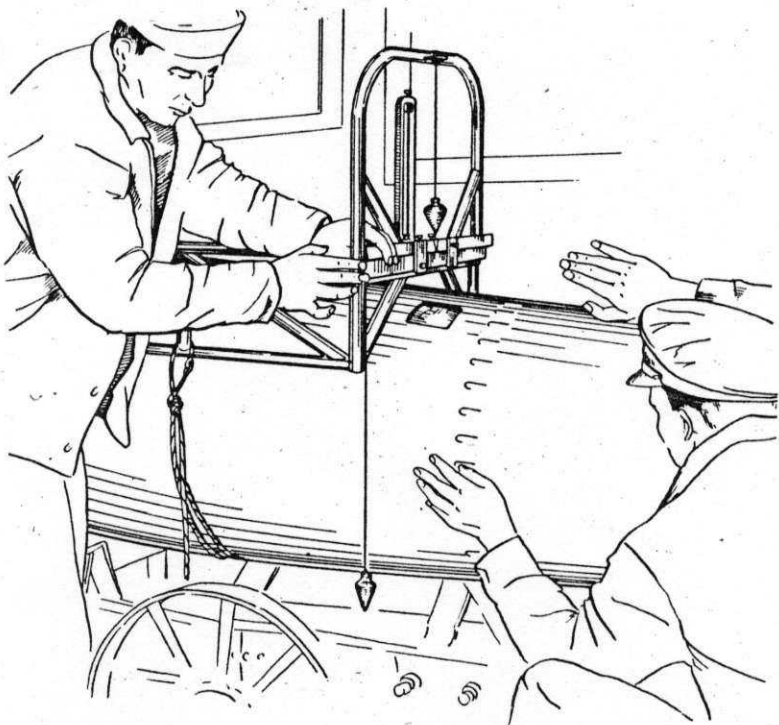
Rotate TRAD on air-flask to bring sights into vertical plane as indicated by the sight plumb-bobs. Shift sight-bobs laterally as necessary. Tighten CINCH.



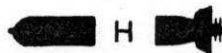
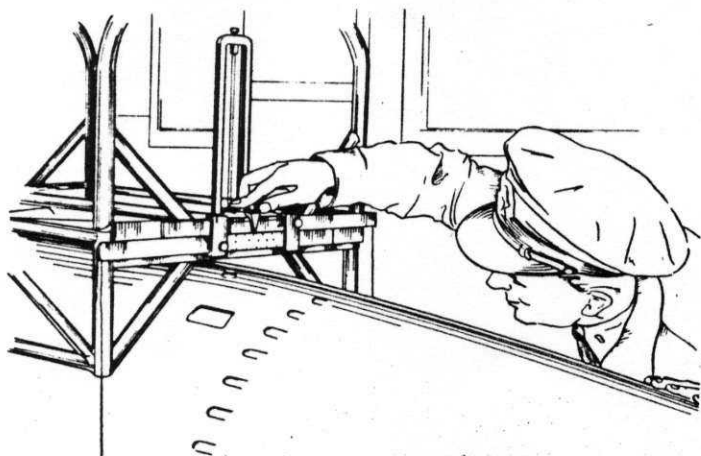
(With these preliminary adjustments completed, the next step is to find the vertical plane containing the torpedo's longitudinal axis, and to move sights laterally so that they both lie in this plane.)



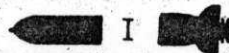
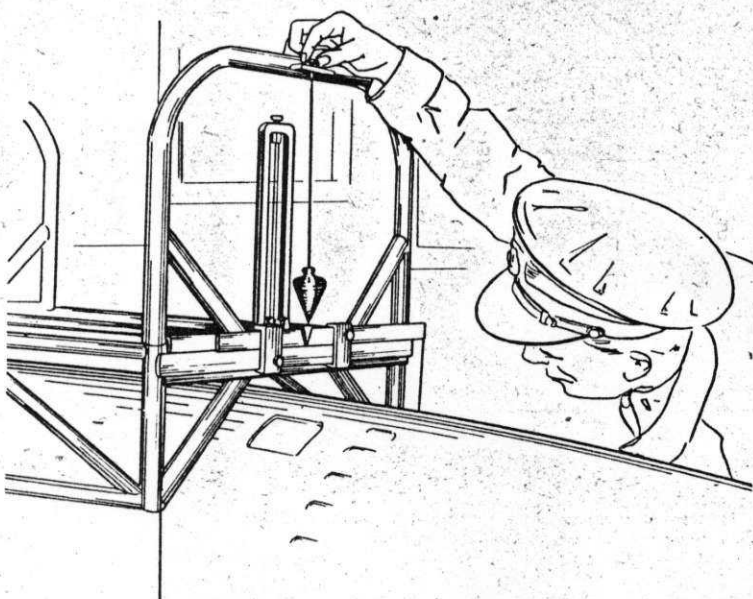
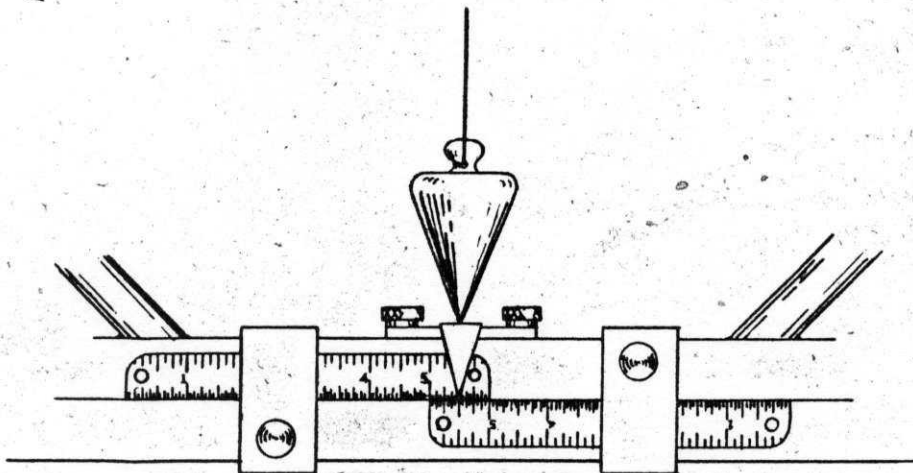
Adjust plumb-bob arms until Torpedo plumb-bob wires are just tangent to the torpedo air-flask.



INITIAL ADJUSTMENT (continued)



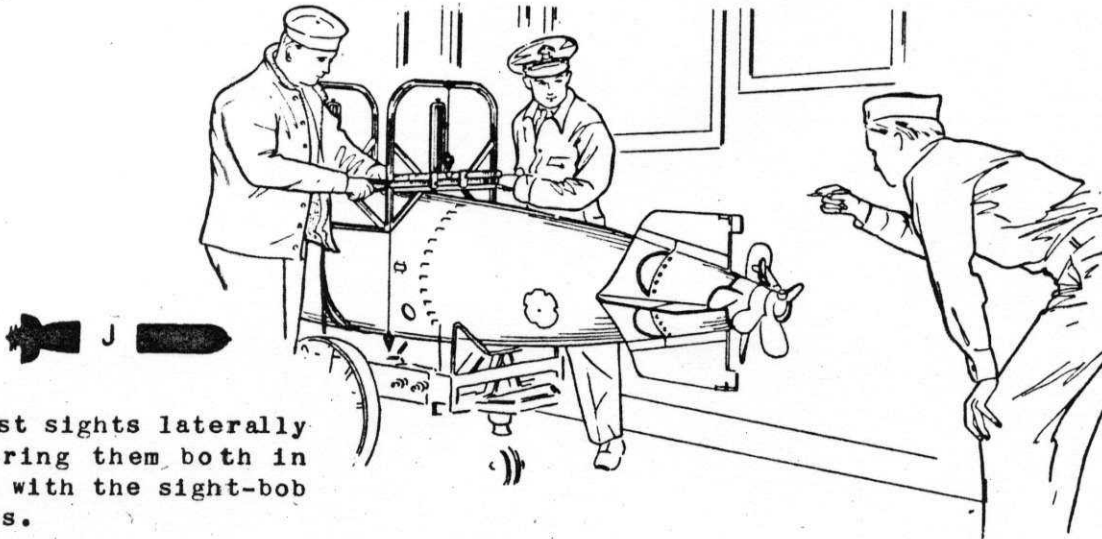
Find point of equal reading on upper and lower scales. Bring pointer of index to this point. (DO THIS ON EACH FRAME)



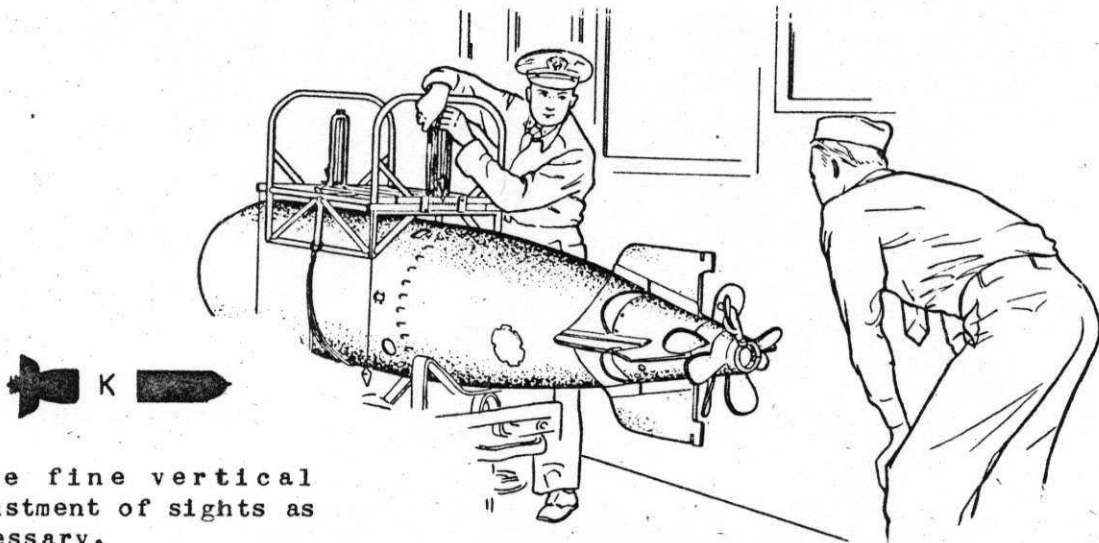
Move sight-bobs to grooves on pointers. (DO THIS ON EACH FRAME).

INITIAL ADJUSTMENT (continued)

With Step "I" completed, each sight-bob wire determines a vertical line which intersects the Torpedo's fore-and-aft axis. The two sight-bob wires thus determine the vertical plane containing this axis.



Adjust sights laterally to bring them both in line with the sight-bob wires.



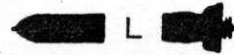
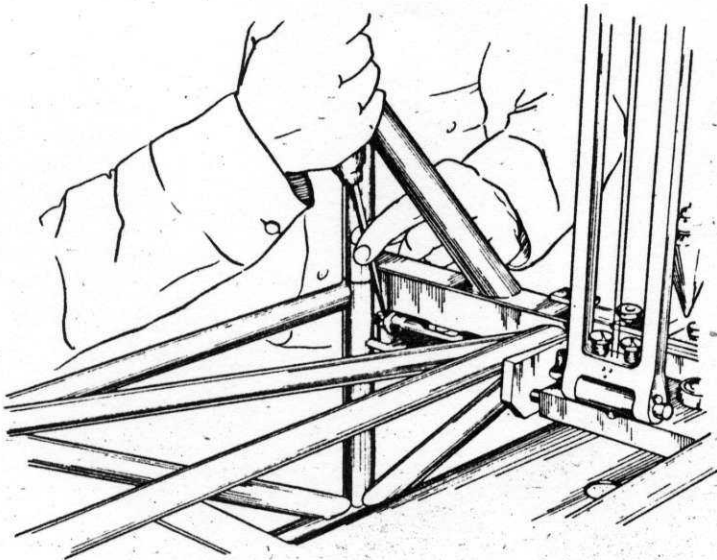
Make fine vertical adjustment of sights as necessary.

Repeat Steps "J" and "K", and continue to do so, making fine lateral and vertical adjustments until both sights are truly vertical and definitely in the plane determined by the sight-bob wires. On each repetition check to see that each torpedo-bob wire is barely tangent to the torpedo air-flask, that each pointer still lies at the point of equal scale-reading, and that sight-bobs are actually in their grooves.

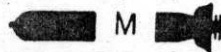
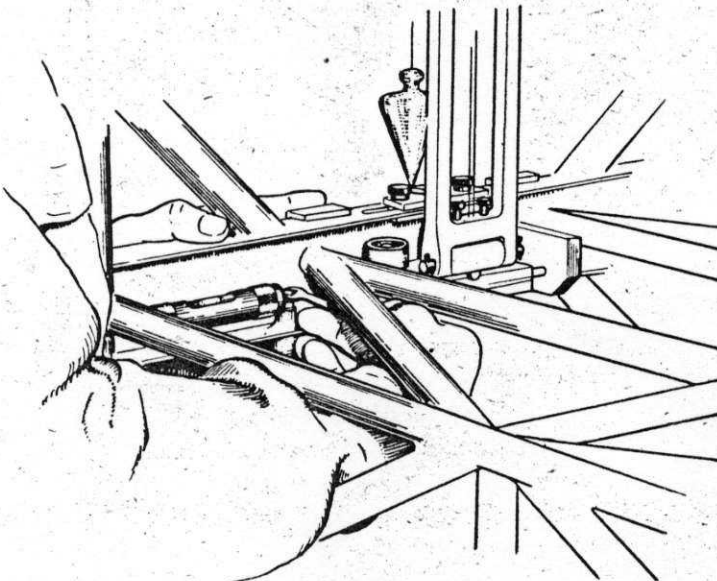
INITIAL ADJUSTMENT (concluded)

[As plumb-bobs would be highly impractical to use in the open on a boat, the TRAD frame is fitted with an adjustable spirit-level. This provides a really practical gravitational reference for use when actually "boresighting."]

The next step in alignment of the TRAD is to adjust the bubble to read "level" while the sights lie in the vertical plane determined by the sight-bobs. Be careful not to rotate the TRAD on the air-flask. Use a "light touch" so that the TRAD remains undisturbed.



Loosen Bubble-Adjustment
Locking-Screw



Adjust level, bring
bubble to "zero". Relock.

FINAL CHECK OF ADJUSTMENTS

1. See that all pairs of adjustment screws are under sufficient stress, effectively "locking" the adjustments.
2. Check all four torpedo plumb-bobs to see that wires are still barely tangent to the torpedo air-flask.
3. Check each index pointer to be sure that it has remained precisely on equal readings of upper and lower scales.
4. See that both sight-bobs have not moved from their respective pointer-grooves.
5. Check alignment of sights with sight-bob wires.
6. See that spirit-level adjusting and locking nuts and screws are tight.
7. Check reading of spirit-level.

ROUTINE CHECKING OF ADJUSTMENTS

1. Place TRAD on Torpedo air-flask as described in Steps "A" and "B" preceding.
2. Level TRAD with spirit level.
3. Ship Alignment Frames (Step "E").
4. Raise sights and tighten sight-wires.
5. Adjust torpedo plumb-bob arms to bring wires tangent to air-flask (Step "G").
6. Bring pointers to equal readings (Step "H").
7. Bring sight plumb-bobs to index grooves (Step "I").
8. Check alignment of sights to see that they lie in the plane of the two sight-bob wires.
9. Carefully check to see that adjusting screws are under stress, and that plumb bob screws are tight.
10. Recheck to see that spirit-level is actually reading "level", that all four torpedo plumb-bob wires are still barely tangent to the air-flask, that pointers remain on equal readings with sight-bobs in their grooves, and that both front-sight and back-sight lie entirely in the plane determined by the two sight-bob wires.

USING THE TRAD DATA

As mentioned previously, we merely ascertain the RACK-ANGLE* with the TRAD. We can introduce this value into our overall problem in either of two ways:

- Re-align the racks to some preset "standard" value (as $2\frac{1}{2}^{\circ}$ left and right forward; 5° left and right aft).
- Set each special Rack-Angle (plus or minus any angular spread-value desired) on the corresponding Torpedo-Gyro Locking-Ring.

The first method is probably the best, considering re-loading conditions in the field, providing that time and facilities for making rack re-alignment are available, and further, that *all* boats in a given locality or squadron can use THE SAME "STANDARD" VALUES. Otherwise confusion may result.

Precise re-alignment of racks is a long, hard, tedious job. When the extent of re-alignment is less than 1° it is usually done by *driving* the racks into proper position (using a fourteen-pound sledge for the principal tool). The TRAD must be removed before each attempt with the sledge, or it may be jarred out of adjustment. Only an uncharged air-flask and *not* a complete torpedo should be used, as rather severe shock can be transmitted through the rack. Otherwise, the torpedo, too, will have to be removed before each attempt to drive the rack into place to prevent possible damage. The operation may be shortened somewhat by simple computations and measured pencil marks on the wooden pads. When the operation is completed and stud-nuts on the rack have been tightened make a final check of rack alignment. If the boat carries a Mark 33 Director the *maximum* allowable deviation from "standard" should not be over $\frac{1}{4}^{\circ}$. Recheck alignment after about a week of operation and again following the first particularly heavy weather to make certain that the rack is, indeed, securely fastened in its new position.

The advantages of "standard" rack-alignment values are well-known to operating personnel. Gyro-Angles will be set more accurately, if the same four values are always set; re-loading may be done without the delay of re-setting gyro-angles to special values; and the probability of confusion is greatly reduced.

If "standard" values of rack-alignment should prove unfeasible in a given locality or for any unit the various values of Rack-angle will have to be incorporated in specially set gyro-angles, or precision firing at long ranges cannot be realized. Innumerable methods and techniques for setting gyro-angles have been developed by operating personnel. These are well known and not within the scope of this book. Some methods are quite accurate while others are decidedly "rough". Final *value* of using the TRAD will depend on the accuracy with which gyro-angles are set.

* Rack-Angle--The horizontal angle between the vertical plane containing the Director's zero-axis and the vertical plane containing the longitudinal axis of the torpedo lying in the rack.

NOTES ON PROPER USE, CARE, AND UPKEEP

The ALIGNMENT KIT (Torpedo Rack) Mark I Mod O, is an *INSTRUMENT* and should be treated with reasonable care. Only those officers and men who have been designated by proper authority to supervise "boresighting" should handle the KIT or the TRAD. When not in use all parts should be locked in the case.

As *checking* of TRAD Sights and Spirit-level alignments takes only a few moments it is advisable to make this check before and after each use of the instrument.

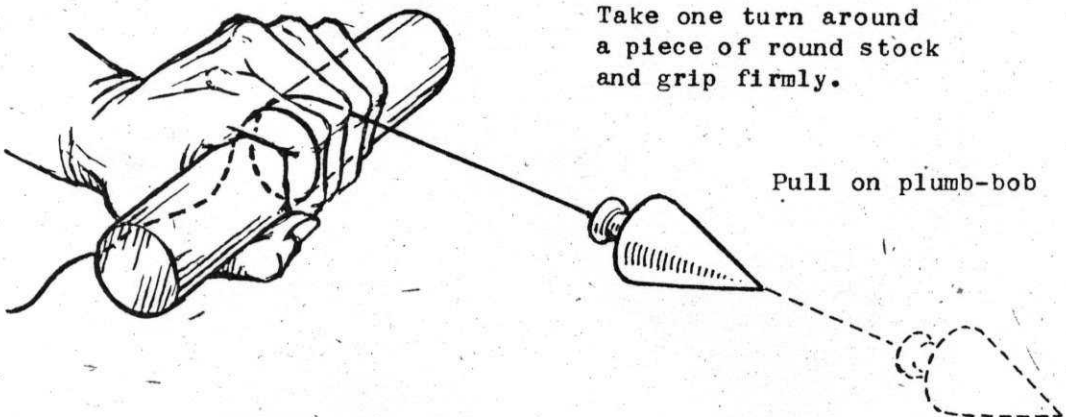
Two men should always be employed to handle the TRAD and *each* Alignment Frame to avoid damaging the parts. When handling the Alignment Frames hold the plumb-bobs (particularly the Sight-Bobs) to prevent damage to the points.

Fasten Preventer to Torpedo-rack *immediately* after placing the TRAD on a torpedo, so that it won't fall off into the water while the Cinch is being rigged.

When raising or lowering a TRAD sight be sure that both locking screws are completely disengaged.

Keep sights DOWN (locked in the "folded" position) except when the TRAD is securely cinched to a torpedo air-flask.

If plumb-bob wires get "kinked" they can be straightened, as illustrated below:



As wire, under tension, slides slowly over the round stock, the kinks will straighten out. Repeat until all kinks are removed.

NOTES ON PROPER USE, CARE AND UPKEEP (continued)

Keep the protective shield of the spirit-level rotated over the glass except when the level is actually being used.

Do not remove the scales on the plumb-bob arms. They are accurately set with respect to the plumb-bob holes.

The faces of the scales should be smeared frequently with light oil or vaseline as they are *not* rustproof. The under side of the scales have a protective coating.

Use only "No. 48's" for adjusting TRAD sights.

Avoid excessive pressure when "locking" sight-adjustments, but bring opposing screws up tight with a little stress on screw-threads.

If the "distant object" is located on a shoreline, take special precaution that both lines of sight are brought to the SAME distant object simultaneously. In order to obviate confusion or mistakes in identity of the objects, personnel manning the director and the TRAD should shift positions after several "Marks".

G. F. Duwall



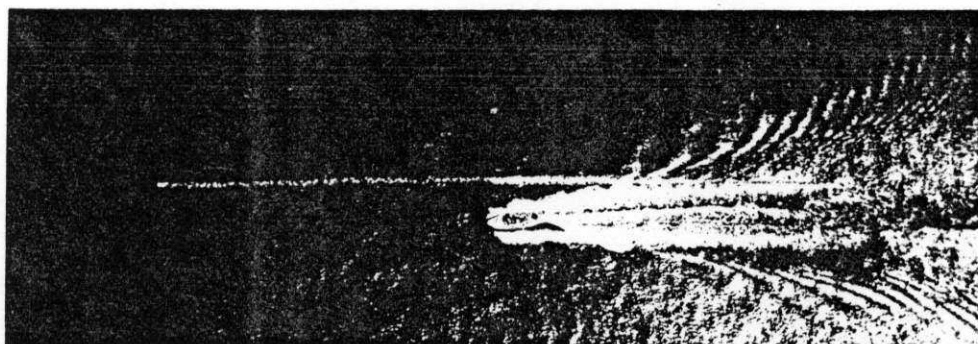
RESTRICTED

ALIGNMENT KIT (*torpedo rack*) MARK I MOD. O

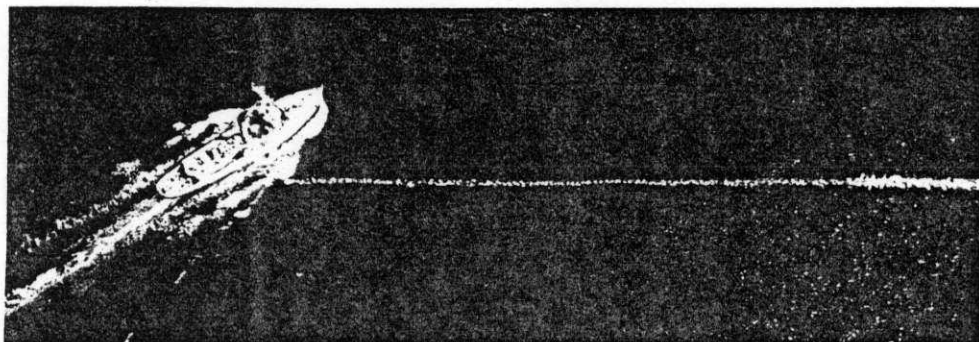
ACKNOWLEDGMENT

Enthusiastic cooperation from officers and enlisted personnel of MOTOR-TORPEDO-BOATS SQUADRONS-TRAINING-CENTER, Melville, Rhode Island (Commander David J. Walsh, Commanding), is gratefully acknowledged.

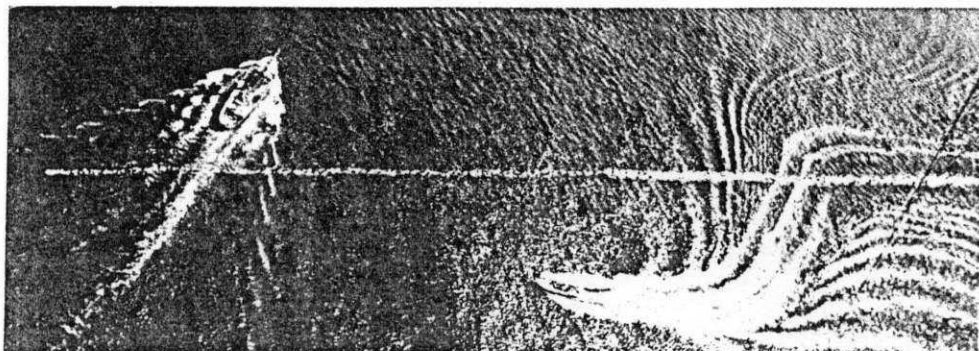
Blind firing from PT315, during tests off Brenton Reef, September 25, 1944.
[TRAD was used to ascertain Rack-Angles.]



Torpedo Released at 5000 Yards



Torpedo Approaching Target



Torpedo Has Passed Under After-Superstructure

The TRAD is an instrument. Handle with care.

Stow TRAD in the case provided.

Lock case. Only designated personnel should handle the TRAD.

Check alignment of TRAD before and after use.

Always use *two men* to handle the TRAD.

Always use *two men* to handle each Alignment Frame.

Avoid damage to Sight-Bob points.

When stowing Alignment Frames coil bob-wires into case carefully.

Fasten preventer immediately, while one man is still holding the TRAD.

Take up on cinch until TRAD is securely held in place.

Rotate spirit-level shield over glass when not in use.

The scales on the plumb-bob arms are permanently fixed. Leave them alone.

Protect faces of scales with light oil or vaseline.

Use only #48 tools for adjusting sights.

Be sure that stress on opposing screw-threads locks adjustments.

Keep sights folded except when in use.

Unlock sights before raising and lowering.

Always make sight adjustments ashore, preferably indoors.

Allow at least two hours for *complete* re-adjustment of the TRAD.

Check adjustments in accordance with "Routine Check" procedure on Page 21.

Study this book carefully before using TRAD.

- Don't handle the TRAD roughly or carelessly.*
- Don't leave TRAD lying around when not in use.*
- Don't let unauthorized personnel handle the TRAD.*
- Don't use TRAD until alignment of sights and spirit-level have been checked.*
- Don't try to handle the TRAD alone. Use two men.*
- Don't try to ship an Alignment Frame alone. Use two men.*
- Don't let plumb-bobs dangle when handling Alignment Frames.*
- Don't put kinks in bob-wires when stowing Alignment Frames.*
- Don't let go of TRAD until the preventer is secured.*
- Don't spring TRAD Frame with excessive tension on Cinch.*
- Don't leave spirit-level glass unprotected.*
- Don't remove scales from plumb-bob arms.*
- Don't allow scale-faces to corrode.*
- Don't use anything but "#48's" to adjust sights.*
- Don't use excessive pressure in locking sight-adjustments.*
- Don't carry TRAD with sights raised.*
- Don't try to raise or lower sights until certain that they are unlocked.*
- Don't try to use Alignment Frames in the wind.*
- Don't attempt a "rush-job" of alignment.*
- Don't use TRAD until adjustments are checked (See Page 21)*
- Don't use TRAD until all procedures are understood, fully and completely.*