Lieut.Comdr.Gilbert P.Chase Personally responsible [redacted]

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Ordnance Pamphlet No. 460

Register No 990

Ord 460

FORD RANGE KEEPER

MARK II

INSTRUCTIONS FOR CARE AND MANIPULATION

OCTOBER, 1917

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WASHINGTON : GOVERNMENT PRINTING OFFICE : 1917

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In reply refer to No.

32817(I-1)12/30
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NAVY DEPARTMENT
BUREAU OF ORDNANCE
WASHINGTON, D. C.

DEC 10 1917

To: The Commanding Officers, All Ships of the Navy.
Troop Ships.
Prospective Commanding Officers, All Destroyers Building.
The Superintendent, U.S. Naval Academy
The Naval Inspector of Ordnance, Sperry Gyroscope Co.,
Brooklyn, N.Y.
Chief of Naval Operations.

Subject: Ordnance Pamphlet #460 - "Ford Range Keeper, Mark II"

Enclosure-separate cover: (A) Ordnance pamphlet #460.

1. There has been forwarded this date, under separate cover, the Ordnance pamphlet mentioned above.

2. Please acknowledge receipt of enclosure by return of attached card.

N. Ord. 17.

NAVY DEPARTMENT,
BUREAU OF ORDNANCE,

December 8, 1917

1 Enclosure for--
(No.)

The Commanding Officer, USS HENRY R. MALLORY

To accompany {letter / endorsement} of

File No. 32817(I-1)12/30

4—3431

N. Ord. 17.

NAVY DEPARTMENT,

BUREAU OF ORDNANCE.

Register

Dec. 15, 1919.

1 Enclosure for—
(No.)

Commanding Officer, U.S.S. ALDEN.

This slip to be retained by the Commanding Officer.

To accompany {letter} of

File No. 32817/3938(I-3)1/10

4—3434

FORD RANGE KEEPER, MARK II.

DESCRIPTION.

The Ford range keeper, Mark II, is a mechanical device actuated by clockwork which combines the functions of the rate of change of range projector and the range clock. Its purpose in fire control is to mechanically solve the problem of range and deflection as influenced by the motion of the ship and the motion of the target.

The instrument is a mechanism contained in a casing, about 14 inches in diameter and 8 inches deep, which is actuated by a mainspring, necessitating winding in a manner similar to an ordinary clock. For convenience in use, the instrument is mounted on a pedestal stand. It can be trained in azimuth while mounted on the pedestal by means of a small training wheel projecting from one side of the casing containing the mechanism. To this casing there is also attached a vertical arm, at the top of which is fitted an open sight. In operating the instrument this sight is kept trained on the target, thereby introducing the relative bearing of the target. The course and speed of "Own ship" and the course and speed of the target are set by hand. From this data, with the bearing of the target as determined by the open sight, the range rate and deflection are automatically solved and recorded by the instrument.

On the face of the instrument there are four dials, one window through which the range is read, and a small pointer known as the "regulator." To protect the face of the instrument there is a water-tight glass cover.

The dials of the instrument are:

(*a*) Range rate in knots.
(*b*) Deflection in knots.
(*c*) Target.
(*d*) Own ship.

RANGE RATE DIAL.

The "Range rate" dial is about 2½ inches in diameter and shows at any time the rate of change of range in knots. It is graduated from "zero" to "72" around to the right for "Increasing" rate, and from "zero" to "72" around to the left to show "Decreasing" rate. This dial is entirely automatic, the rate being read as the number indicated by the index line—1 knot being equal to 2,026.6 yards per hour.

DEFLECTION DIAL.

The "Deflection" dial is of the same size as the "Range rate" dial. It is graduated in deflection (knots) from "−22," clockwise, through "0" around to "122"—"50" being the point of zero deflection. This dial automatically gives the deflection, due to the motion and bearing

of the target. The deflection is read as indicated by the index marked "Zero," which is on a circle marked "Correction" surrounding the "Deflection" dial. This "Correction" circle may be moved around the "Deflection" dial by a knob that projects from the casing. The purpose of moving this "Correction" circle is to be able to apply deflection spots. On the sides of the "Correction" circle there are arrows marked "Left" and "Right" to indicate which way to move the "Correction" circle in applying spots. The amount of movement of the "Correction" circle is read from an index line on the face of the instrument.

TARGET DIAL.

The "Target" dial is about 3½ inches in diameter, and on it there is drawn an outline to represent a target ship, the heading of which is marked "zero." The periphery is graduated from starboard around to port in degrees from "zero" to "360." On the starboard side of the ship outline there is a speed scale graduated from "zero" to "36" knots. Mounted over the center and projecting through the glass cover of the instrument there are two knobs, one within the other. By pressing down on the inner knob, which is marked "Speed," a speed index can be set to the proper graduation to indicate the speed of the target. By pressing down the outer knob, which is marked "Set course," and turning, the "Target" dial may be revolved for the purpose of setting the target outline on the proper course relative to that of the "Own ship." Surrounding the "Target" dial there is a graduated circle, which automatically follows the motion of a similar circle that surrounds the "Own ship" dial. This circle surrounding the "Target" dial indicates the compass course of the target as read at the graduation on the circle corresponding to the bow of the target outline marked "zero."

OWN SHIP DIAL.

The "Own ship" dial is also about 3½ inches in diameter, and on it there is also drawn the outline of a ship, the heading of which is marked "zero." The range keeper should be installed so that this outline is parallel to the fore-and-aft line of the vessel. The inner periphery is graduated from starboard around to port in degrees, from "zero" to "360." These graduations indicate the relative bearing of the target from the vessel on which the instrument is installed. On the starboard side of the "Own ship" outline there is a speed scale graduated from "zero" to "36" knots. Mounted over the center of the dial and projecting through the cover of the instrument, there are two knobs, one within the other, similar to those mounted over the "Target" dial. By pressing down on the inner one, which is marked "Speed," the speed index may be set at the graduation to indicate the speed at which the vessel is steaming. By pressing down on the outer knob, which is marked "Set course," an outer circle graduated from "zero" to "360" is revolved about the "Own ship" dial. This outer circle corresponds to the ship's compass, and should be set for the course of "Own ship" by turning until the head of the "Own ship" outline marked "zero" corresponds to the graduation on the outer circle indicating the compass course.

In setting the outer circle of the "Own ship" dial, the motion is automatically transmitted to the circle surrounding the "Target" dial, which causes the graduations of the two outer circles to be at all times in the same relative position to each other.

The operation of course setting and the movement of the dials may be analyzed by setting them on "zero" course, setting the "Speed" scales of both to the same speed, and training the instrument so that the bearing of the target is "zero," i. e., the target is directly ahead of the "Own ship" on the same course and making the same speed. With this setting of the two ship dials, the "Deflection" and "Range rate" dials will read "zero." For example, with "Own ship's" course set for "45°" and target's course "zero," it will be noted that the line of fire is "315°." Now, placing the sight on target, the target course remains "zero," and is seen to be broad off the port bow of "Own ship"—line of fire "315°," and courses diverging "45°." This set-up represents the same picture to the eye as to the spotter aloft.

REGULATOR.

The regulator is a small pointer like the second hand of a watch. It indicates when the mechanism is running and can be started or stopped by turning a knob on the rear of the case marked "Start-Stop." When the clockwork is properly regulated, the pointer makes one complete revolution in 20 seconds or three revolutions per minute. Alongside of the "Start-Stop" knob there is an adjusting screw which may be turned by a screw driver to make the clock run slow or fast—an arrow marked "F" indicating which way to turn the screw to speed up the clock. The mechanism is wound by means of a crank on the rear of the case. Alongside the regulator there is a telltale to indicate that the spring has run down and should be rewound.

BEARING OF TARGET.

Near the center of the instrument between the "Own ship" dial and "Target" dial there is a double ended pointer. This pointer is at all times parallel to the open sight mounted at the side of the instrument.

When operating, the open sight is kept on the target by means of a handwheel which rotates the entire case containing the mechanism. When the sight is on the target, the double ended pointer indicates the bearing of the target which may be read on the outer circle of the "Own ship" dial. By reading the bearing on the inner circle of the "Own ship" dial, the relative bearing is known. This double ended pointer lies in the direction of the line of fire as viewed by an operator located at the center of the ship.

RANGE COUNTER.

The range counter is seen through the opening in the face of the mechanism. It may be operated by a crank on the exterior of the case. When the clock is operating, it is automatically driven at a speed corresponding to the rate of change of rate as shown on the "Range rate" dial. The range counter is set for the initial range by turning the crank until the range as indicated is the sight-bar range desired. The clock mechanism will change the reading of the range counter in accordance with the rate of change, as determined by the instrument. Spots are applied by turning the range-counter crank, which is so geared that one complete revolution of the crank makes a change of 200 yards.

OPERATION.

Wind the instrument by turning the crank slowly, being careful when nearing the "Stop" position. When fully wound, the instrument will run 30 minutes, but when in use it should not be allowed to run down. Rewinding while the mechanism is running does not introduce error. It is *preferable* to wind every *20* minutes. By comparison with an accurate timepiece, regulate the mechanism by the adjusting screw until the regulator pointer makes three revolutions in one minute. The running should be checked daily by a 5-minute test.

This test should not only be a test of the regulator but should include the counter mechanism. Train the instrument and set the speeds so that there is a high rate of change, for example, 30 knots equal to 1,013.3 yards per minute; check the range counter and see that it is recording accurately.

Set the "Own ship" dial for course and speed of ship and keep this setting correct at all times.

Until the enemy is sighted, keep the "Target" dial set for the same course and speed of "Own ship."

Keep the range counter set for the probable opening range.

When the target is sighted, change the setting of the "Target" dial for the relative course and speed of the target as obtained from the best information available. Train the instrument on the target by turning the training wheel until the open sight is on the point of aim and keep it on continually.

Set the range counter for the proper sight-bar range as determined from the best information available and *start the clock*, if it has not already been started.

Read the range and deflection from the instrument; send to guns; and open fire.

Apply spots in range by turning the range-counter handle and in deflection by the "Deflection" knob, being careful to apply them properly. The first shots will determine the sight-bar range, and it is not advisable to change the target's course and speed setting before a straddle is obtained, unless a change of course has been observed. When the target has been straddled, if the setting is correct, the range keeper will continually show the correct range and deflection. If the shots do not continue to straddle, the course and speed of the target as set on the "Target" dial are incorrect, and the operator must change the setting to meet the conditions.

When the enemy's course is approximately at right angles to the line of fire, spots in range indicate a change of course. When the enemy's course is in the line of fire, spots in range indicate a change of speed. In intermediate cases, either or both may change, and the instrument must be set according to the conditions of the particular problem.

In doing this, the instrument is excellent, for the operator has the two ships represented before him in their proper relation to each other, and to the line of fire. If the ship or target changes course or speed, change the corresponding dial setting accordingly as quickly as possible.

To predict the range for an interval, as necessary when there is a high rate of change, the sight-bar range may be corrected by applying the rate as determined from the "Range rate" dial, remembering that one knot equals practically 33 yards per minute; for example, if the range counter reads "5,000" and the "Range rate" dial shows "Decreasing 6," the range is decreasing at a rate of practically 200 yards per minute, or the prediction is 50 yards for 15 seconds, and "4,950" should be sent to the guns if a 15-second interval is used.

NOTES AND SUGGESTIONS.

The instrument depends upon a spring motor for its power, so, in order that it may be ready for instant use, this spring motor should be kept wound. When it is probable that the instrument will not be used for some time, it should be allowed to run down in order to relieve the tension on the spring.

The accuracy of the information obtained by the range keeper depends upon the accuracy with which the "Own ship" and "Target" dials are set. The "Own ship" data is accurately known, and if, at any time, a change of course or speed is made, the operator must receive the information at once and properly set the "Own ship" dial.

The target data is the unknown factor, and every means possible should be developed in order that the course and speed of the target may be set properly. The spotter, operator, and lookouts should continually train themselves in estimating courses and speeds of ships. Primarily, the spotter's estimates of the enemy's course and speed will be used, and, secondly, the operator, from his knowledge of fire control and consideration of the spotter's corrections, should be able to make corrections in the course and speed setting so as to keep the shots on. The target must be closely observed by the captain, the spotter, and, if possible, by the operator, in order that any evident change may be quickly applied to the range keeper. The person training the instrument must keep it on the target continually, as slight errors in train will cause slight errors in the record of the instrument.

The deflection, as determined by the "Deflection" dial, is in knots, and is accurate for all calibers. It will be found that with an initial correction for windage, the shots will fall on a line with the target or so close that by an occasional spot the spotter can keep on in deflection. The importance of deflection must not be overlooked, especially in fighting a submarine where the danger arc is limited and accurate deflection setting is necessary.

On ships using arbitrary scale, the operator must be able to quickly convert deflection in knots to arbitrary deflection.

On ships fitted for director firing, where the follow-the-pointer system is not installed, the so-called director correction should be applied as a spot, equal to the number of yards corresponding to that correction.

It is evident that the range keeper, Mark II, is of especial value on ships not equipped with range finders or where the conditions are such that a complete fire control organization can not be obtained. The personnel of destroyers, raider chasers, scout ships, cruisers, auxiliaries and turrets firing with independent control will particularly appreciate the need for the instrument.

In maneuvering by the zigzag method to avoid submarines continuous firing is not interrupted by the many changes of course, provided the instrument is properly set at the time each change is made.

The data taken from the range keeper, especially after gunfire has demonstrated that the setting is correct, will be very convenient for setting the torpedo director in case it is desired to fire a torpedo.

A highly efficient fire-control system can be obtained with two men and two officers, if—

(1) The chief operator is experienced in fire control and accurately applies spots and keeps target data applied. (Officer.)

(2) The spotter is trained in estimating enemy's course and speed and is familiar with the effect of his spots on the instrument. (Officer.)

(3) The instrument is continually set for the correct "own ship" data. (Enlisted man.)

(4) If the range keeper trainer is trained to follow the target. (Enlisted man.)

Drills with fire control problems involving various battle conditions and training at sea in observations of friendly vessels are recommended.

INSTALLATION.

A location should be selected for the range keeper which will give the operator the best position possible for observation. It should be possible to train the instrument so as to cover the entire horizon. To do this, it may be necessary to have more than one pedestal. The instrument should be firmly secured to the deck, and vibration avoided as much as possible. The instrument and operator should be protected from blast and shock of gunfire. Cast-iron pedestals are provided with the instrument. Where it is necessary to place the range keeper near the magnetic compass, a bronze pedestal should be requested.

TO MOUNT THE INSTRUMENT.

(*a*) Secure the pedestal to the deck. If the deck is too thin to prevent vibration, a wooden base may be put underneath the pedestal.

(*b*) Set the open sight at "zero," bringing the double ended pointer to read "zero" on the inside circle of the "Own ship" dial by means of the training wheel.

(*c*) Loosen the three set screws at the top of the pedestal so that the instrument can be turned without turning the training wheel.

(*d*) Line up the instrument so that the open sight, the double ended pointer and the "Own ship" dial are parallel to the fore and aft line of the ship. To do this it will be necessary to have fore and aft marks at the same distance from the center line as the position at which the instrument is to be located.

(*e*) Set up the set screws so that the range keeper will be secured in a fore and aft position.

Certain destroyers or other types of vessels may be so designed that it will be difficult to find a satisfactory location for the instrument which will afford it proper protection from blast, shock of gunfire, and exposure in bad weather. On such ships it may be an advantage to locate the instrument in the chart house or other compartment and transmit the bearing by voice tube from an observer located outside to the man operating the instrument, or by installing an extension to the open sight so that the bearing can be transmitted to the instrument from a distance. When the instrument is to be mounted in the open and likely to become wet or damaged, it should be removed from the pedestal and stowed in some secure place when it is not necessary to have it ready for use.

CARE AND MAINTENANCE.

During freezing weather the range keeper should be mounted in the pilot house or other heated compartment to prevent ice forming on the instrument, or the low temperature causing it to run unsatisfactorily.

The instrument is more rugged and, undoubtedly, will stand more abuse than an ordinary clock, but, as far as care and maintenance are concerned, it should be treated in the same manner as though it were a chronometer, and should be protected from weather and temperature.

It is equipped with ball bearings and is lubricated in such a manner that it should seldom require attention. If it should fail to function properly, the works may be removed from the casing for examination without disassembling. No one should be allowed to attempt to repair the instrument except a person who is familiar with clockwork mechanism, or an experienced machinist.

TO REMOVE THE WORKS.

First remove the bezel ring and glass cover; then remove four screws at the periphery of the face. This will allow the works to be lifted out by means of two lifting handles, which are provided for that purpose. The graduations on the dials are covered with luminous material, which is easily rubbed off, and care should be exercised not to touch any of the graduations. If, at any time, the glass cover is broken, care should be taken not to allow any of the fragments to get into the interior of the instrument. The glass cover should be renewed as soon as possible.

The mechanism may be oiled from time to time, but should not be disassembled for this purpose unless absolutely necessary. If the adjustment of the instrument causes considerable trouble and can not be easily repaired, the range keeper expert should be notified, or, if necessary it should be sent to the factory for overhaul. The box in which the instrument is received should be preserved, in order that it may be packed therein for transportation from one ship to another, if desired.

TO ASSEMBLE WORKS.

To assemble, take care that the vertical shaft carrying the training pinion is directly over its lower bearing, and lower the mechanism vertically downward into its proper position. Bring the four screw holes into alignment with the lugs on the casing. See that the "Start-Stop" knob is in its "Stop" position before removing or replacing the mechanism. Before tightening the screws, which fasten the mechanism in place, move the range crank, the "Deflection" knob and the training wheel slightly to make certain that all gears are in mesh and see that the faceplate is completely down in its position on the lugs. In replacing the glass cover, care must be taken to bring the knobs at the exact centers of their respective dials. The main spindle may be oiled from the outside by using an oil cup which is provided for that purpose.

RALPH EARLE,
Chief of Bureau.

NAVY DEPARTMENT,
BUREAU OF ORDNANCE,
October, 1917.

FIGURE I.

(A) Winding crank.
(B) Pedestal.
(C) Start-Stop knob.
(D) Deflection knob.
(E) Own ship speed knob.
(F) Own ship set course knob.
(G) Target speed knob.
(H) Target set course knob.
(I) Sight bar clamp.
(J) Training wheel.
(K) Open sight bracket.
(L) Open sight peep.
(M) Open sight cross wires.
(N) Range counter crank.
(O) Adjusting knob.

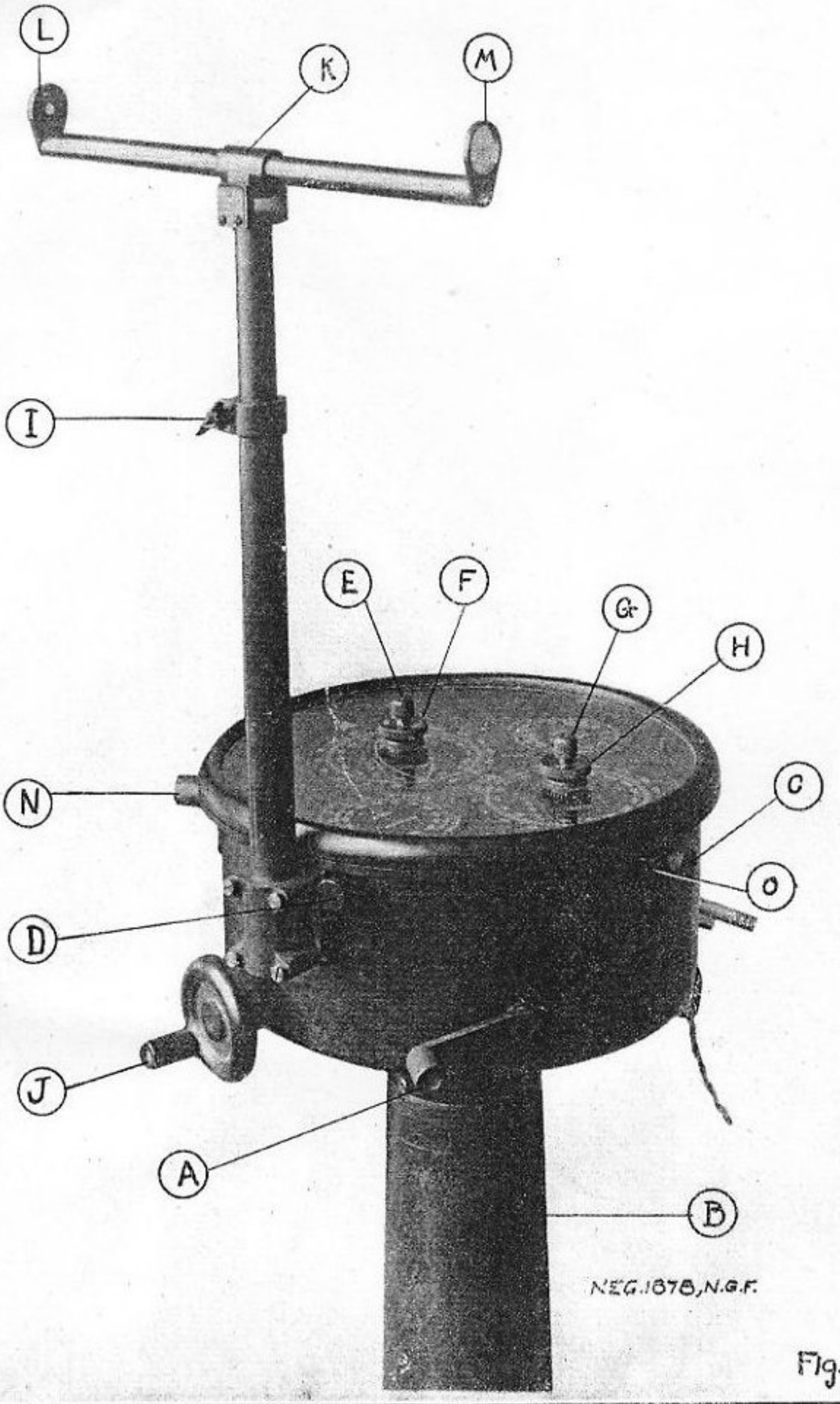

Fig. I

FORD RANGE KEEPER

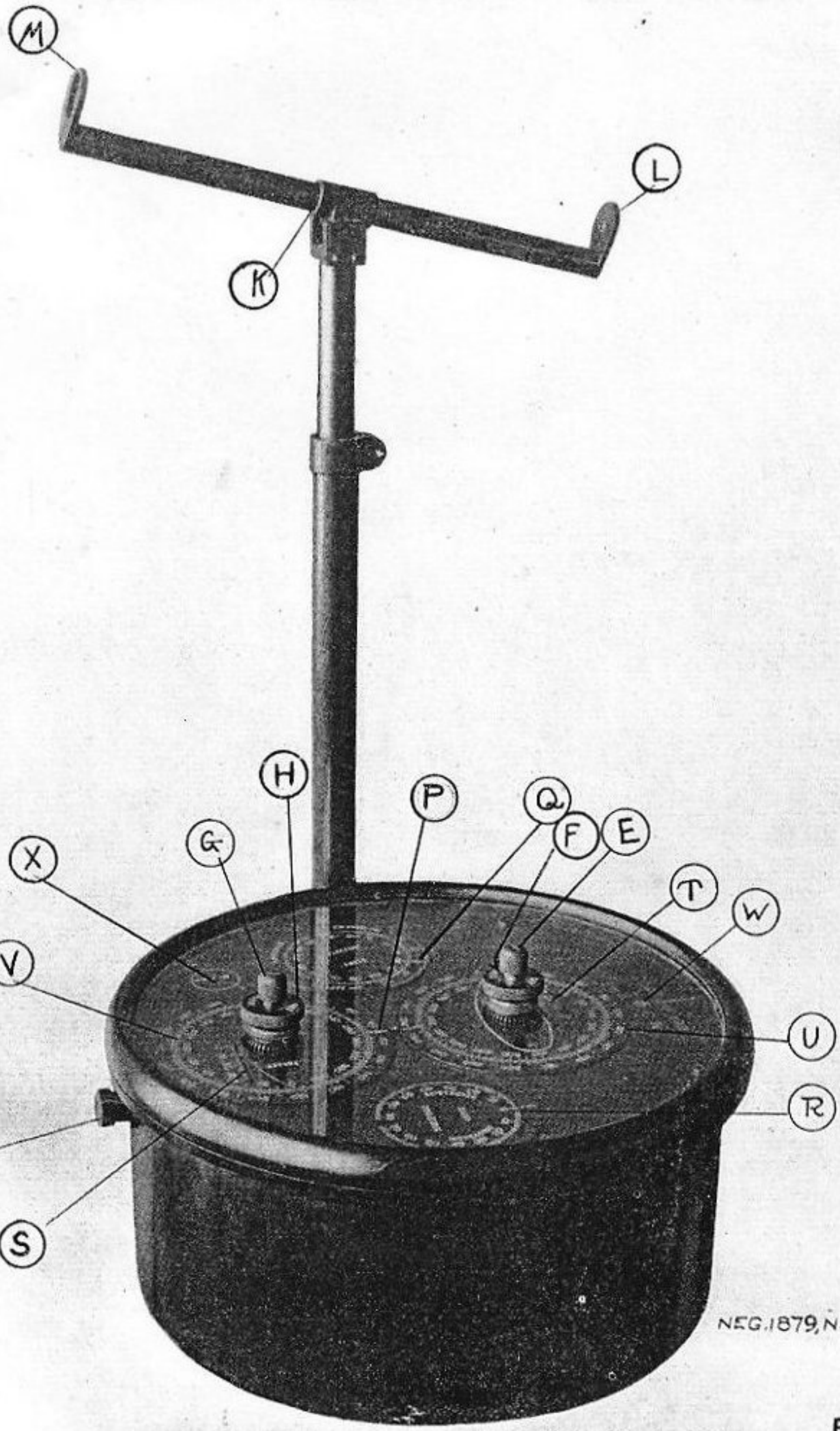

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Fig. II.

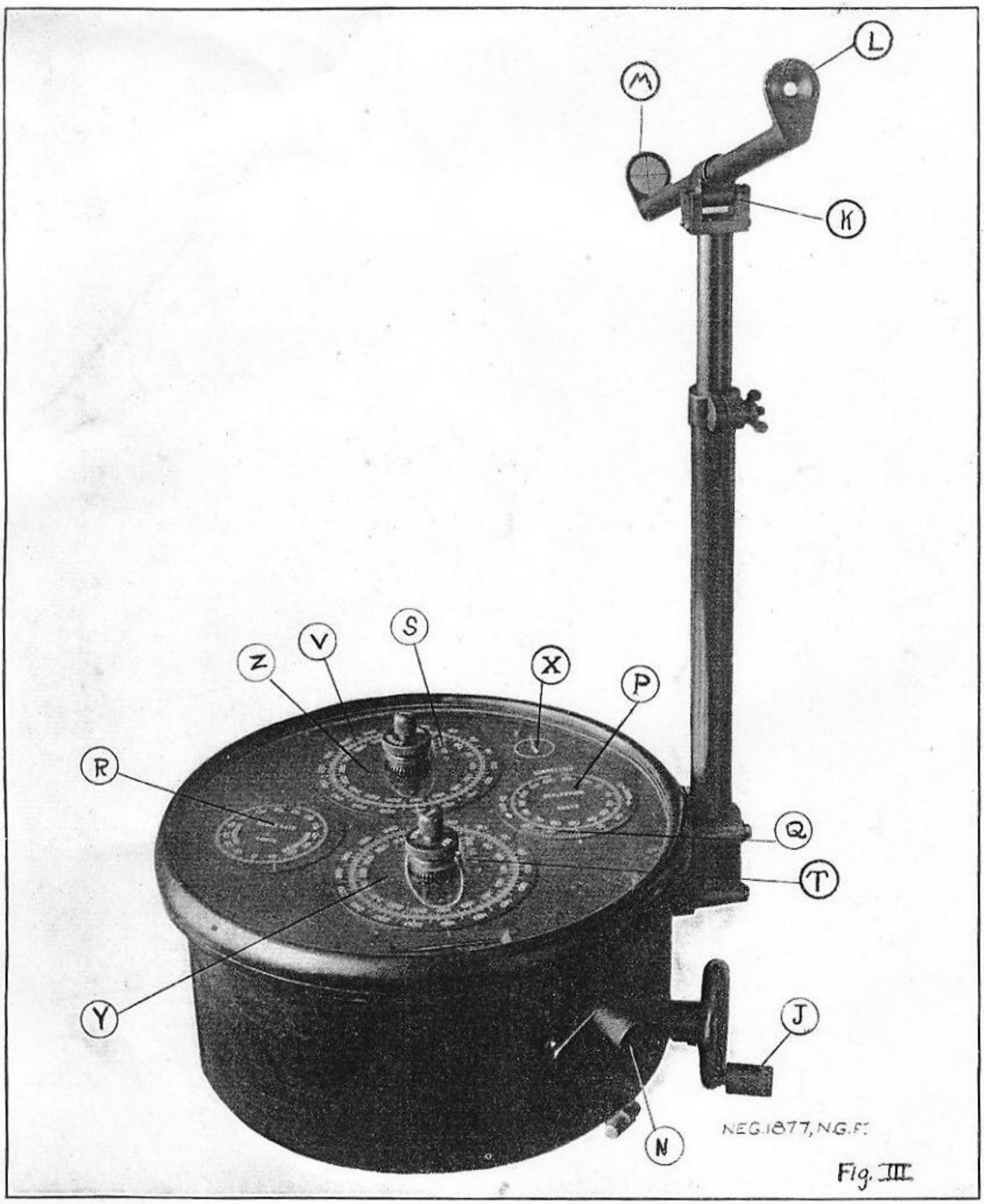
FORD RANGE KEEPER.

FIGURE II.

(C) Start-Stop knob.
(E) Own ship speed knob.
(F) Own ship set course knob.
(G) Target speed knob.
(H) Target set course knob.
(K) Open sight bracket.
(L) Open sight peep.
(M) Open sight cross wires.
(P) Double ended pointer.
(Q) Deflection correction circle.
(R) Range rate dial.
(S) Target speed scale.
(T) Own ship speed scale.
(U) Target bearing circle.
(V) Graduated circle surrounding target dial.
(W) Range counter.
(X) Regulator dial.

FIGURE III.

(J) Training wheel.
(K) Open sight bracket.
(L) Open sight peep.
(M) Open sight cross wires.
(N) Range counter crank.
(P) Deflection dial.
(Q) Deflection correction circle.
(R) Range rate dial.
(S) Target speed scale.
(T) Own ship speed scale.
(V) Graduated circle surrounding target dial.
(X) Regulator dial.
(Y) Own ship dial.
(Z) Target dial.



FORD RANGE KEEPER.