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FIRE CONTROL EQUIPMENT

DEFLECTION CONVERTER, MARK I AND MARK I, MOD. 1

GENERAL DESCRIPTION

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TABLE OF CONTENTS

Subject	Page	Illustrations	
		Figure	Plate
Purpose.....	3		
Mounting.....	3		
Method of use.....	3		
Mechanism of instrument.....	3		
Installation.....	5		
Adjustment.....	6		
Zero setting.....	6		
Range dial adjustment.....	6		
Spot dial adjustment.....	6		
Deflection drum adjustment.....	6		
Calibration.....	6		
Care of instrument.....	7		
Differences between Mark I and Mark I, Mod. 1.....	7		
Illustrations			
- Deflection converter assembled on range keeper.....	3		I
Schematic diagram of deflection converter.....	5		II
Deflection converter casing and mechanism.....	6		III
Deflection converter mechanism.....	7		IV

DECEMBER, 1922

(1)

FIRE-CONTROL EQUIPMENT

DEFLECTION CONVERTER MARK I AND MARK I, MOD. 1

GENERAL DESCRIPTION

PURPOSE

1. The deflection converter changes the relative deflection in knots which is generated by the Ford range keeper, Mark II, Mod. 3, into the angular deflection through which the guns must be displaced from the line of sight to allow for the distances which the ships will move at right angles to the line of sight during the time taken by the projectile to pass from the firing ship to the target ship. It also corrects this deflection automatically for drift of shell and provides a means of applying spotting corrections. The resultant deflection is indicated on a dial calibrated to read in mils, 1 mil deflection being equal to 1 yard deflection at a range of 1,000 yards.

MOUNTING

2. On the Ford range keeper, Mark II, Mod. 3, with which the deflection converter is designed to be used, there is a correction ring which surrounds the deflection dial and is normally operated by a knob on the case. When the deflection converter is applied, the correction ring is replaced by a follow-the-pointer ring, and in place of the deflection knob there is a crown gear which engages a similar gear on the outside of the converter. These gears form the only operating connection between the two instruments. The converter is attached to range

keeper in the position shown in Plate 1 by four screws. Details of the mounting are given under heading "Installation."

METHOD OF USE

3. As shown in Plate 2, the deflection converter has a range drum and a knob for setting it, a deflection drum and deflection knob, and a spot knob which operates a spot drum directly under the deflection drum. In operation, the range drum is set to correspond to the range shown on the range keeper, the deflection knob is adjusted to keep the white arrow on the follow-the-pointer ring of the range keeper matched with the triangular-shaped pointer of the range keeper deflection dial, and the spotting correction is applied by turning the "spot knob." *The angular deflection in mils at which the gun should be set will then be indicated on the deflection scale of the converter.*

MECHANISM OF INSTRUMENT

4. As previously stated, the deflection converter receives the relative deflection in knots between the firing ship and the target ship from the range keeper and converts it into the deflection in mils through which the guns must be displaced to allow for the speeds of the two ships, the range, the speed of the projectile, and the drift, provision also being made to apply

spot correction. A schematic diagram showing the mechanism by which this is accomplished is shown in Plate 2. Since the arrow representing zero on the follow-the-pointer scale is kept matched with the zero point of the deflection dial by turning the deflection knob, the position of this scale and of the deflection rack represents the deflection in knots. This rack contains a pin which operates in slot of the arm and controls the movement of the arm about the pivot. Operating in the slot is another pin attached to a slide mounted on the range bar along which it moves. The position of this bar and the vertical position of the slide and pin are determined by the range racks actuated by pinions connected through bevel gears to the range knob and to the range drum. The graduations on this drum represent time of flight of projectile divided by the corresponding range. Hence the drum is calibrated for the particular gun with which the instrument is to be used. The figures on the drum read ranges in thousands of yards.

5. Now, the function of the elements thus far described is to convert the deflection in knots as received from the range keeper and as represented by the position of deflection rack into deflection in mils which is represented by the position of the slide on the range bar. The next step is to correct this value for drift. This is done by mounting a cam plate on the drift rack and having the pin in slide operate in the slot of the cam plate. This slot is shaped to correspond to the drift curve of the gun, which is plotted with ranges as ordinates and drift in mils as abscissas. The action of the pin in moving along the slot is to select different abscissas or drift values corresponding to different range values as represented by the position of the range bar.

6. It is evident, then, that the displacement of the drift rack equals the algebraic sum of the displacement of slide and the drift. Thus the drift correction is applied and the displacement of drift rack represents the deflection in mils corrected for drift.

7. The final operation is to provide for applying spot corrections to this deflection. This is done by differential, in which one gear is turned through a gear train by drift rack and one gear by the spot knob. The spider member which is connected to the deflection drum will be turned to a position representing the algebraic difference between the positions of the two gears. Hence the deflection dial will indicate deflection in mils corrected for drift and with spot corrections applied.

8. The deflection drum is graduated from 0 to 20, 20 representing 200 mils. Zero deflection is normally 100 mils and is represented by 10 on the drum. The spot drum has 10 triangular-shaped pointers, five indicating up and five down. The first four spots—both up and down—represent 10 mils each and the fifth 8 mils each, so that the maximum spot correction that can be applied is 48 mils.

9. On the range drum the figures represent the range in thousands of yards.

10. A flat coiled spring on the spider shaft of the differential tends to draw all movable parts, such as gears and shafts, in one direction and thus take up any backlash or lost motion between gear teeth. For a similar purpose there are two coiled wire springs attached between the range slides and the frame.

11. It remains to explain in more detail how knots deflection are converted into mils deflection. Referring to Plate 2, figure 2:

ab=Displacement of deflection rack and represents knots deflection **K** as received from range keeper.

ac=Vertical length between ab and pivot c. This remains constant.

dc=Vertical distance between pivot c and slide pin.

The range drum is so calibrated that dc equals

$$\frac{\text{Time of flight} \times C}{\text{Range}}$$

Where C=a constant which takes care of the machine dimensions and of the conversion of knots into yards per second.

By similar triangles—

$$\frac{df}{ab} = \frac{dc}{ac} \quad \text{and} \quad df = \frac{dc \times ab}{ac}$$

That is —

$$df = \frac{C}{ac} \times \frac{\text{Time of flight}}{\text{Range}} \times \text{knot deflection}$$

which equals deflection in mils when the constant $\frac{C}{ac}$ is given the proper value.

INSTALLATION

12. The range keeper, Mark II, Mod. 2, is provided with a spot correction ring which surrounds the deflection dial. Before the converter is installed the range keeper has been returned to the factory (Ford Instrument Co.) and this ring and the crown gear to which it is attached is removed. Then the old graduations on the ring are replaced by a single arrow to make a follow-the-pointer ring, and the crown gear is cut around the complete circumference and follow-the-pointer arrow is placed on the deflection dial. The knob and shaft used for applying the spot corrections on the range keeper is then removed, the rebuilt ring and the recut crown gear are put back in place, and a new bushing and shaft are installed. The new shaft has a pinion at the inner end which meshes with the ring crown gear. At the outer end of the shaft is a crown gear which is to mesh with a crown gear on the outside of the converter. The training crank is removed when the converter is installed, also the shaft and its worm to which the training crank is attached are removed.

13. As these converters attached to the range keepers are used in connection or attached to a director, they are trained by gears attached to the training post extending from the base of the range keeper. As the director is trained these gears unwind or work the opposite to the director train, so that the proper relation is kept between the "O. S." (Own Ship) and "T" (Target) dials of the range keeper.

14. The open sight and its standard are removed from the case of the range keeper, and a plate for supporting the converter is put in its place. If a Mark I converter is being installed, the plate is attached at once to the seat from which the sight standard was removed, but for the Mark I, Mod. 1, instrument, the seat and a part of the case flange of the range keeper must be milled down, and the deflection knob opening must be reamed out. In putting on the plate the screws are left so that the bracket can be moved slightly for adjustment.

15. Before putting on the converter the follow-the-pointer ring on the range keeper is set so that the arrow comes directly under lubber line of the deflection dial, the deflection scale of the converter is set at 10, and the spot dial is set so that the triangular-shaped pointer representing its mid-position comes under number 10 on the deflection dial. The range is set for 1,000 yards.

16. The converter is then screwed to the bracket by four cap screws, its position being fixed by two dowels. Next the meshing of the crown gears is adjusted by shifting the position of the bracket, and when the proper position is obtained the converter is removed, the bracket is tightened to the case, and the position fixed by drilling and inserting dowels. This done, the converter is again screwed to the bracket, and the installation is complete.

17. The Mark II, Mod. 2, range keeper when the above changes are made in it and when the deflection converter is attached then becomes the Mark II, Mod. 3, range keeper. The Mark II, Mod. 2, range keeper may be modified to a Mod. 3 by removing the "spot correction ring" and the "crown gear" to which it is attached and the deflection dial and then returning them to the factory. The crown gear will then be cut in its entire circumference and the "follow-the-pointer" arrow placed on the "spot ring" and deflection dial. Upon the return of these from the factory the other changes given above may be made and the deflection converter attached. [CAUTION.—This work should not be undertaken except by an expert on the Mark II range keepers.]

ADJUSTMENTS

18. When the deflection converter leaves the factory, all drums are correctly set with relation to the instrument mechanism, and no adjustment will be necessary unless this initial setting is changed. To check the setting, obtain the drift and arbitrary deflection curve sheet for the gun, and, for different range settings, check the deflection drum readings with the deflection values shown on the curve sheet. The check should be made with several different knots deflection values.

Zero setting

19. The correct initial setting of the instrument can be made in the following manner: Remove the instrument case and bring the arm to a vertical position. A small hole in the cam plate will then line up with the slot in the arm. Then turn the range shaft until the lower pin is against the lower end of the slot in the arm. In this position of the mechanism the range drum should read 1, the deflection drum 10, and

the triangular-shaped spot mark should be directly under the 10 of the deflection drum. The stop block on the shaft turned by the deflection knob and stop block on the spot shaft should be in the mid-positions of their travel or within a fraction of a turn of this position.

Range drum adjustment

20. The range drum can be adjusted simply by slipping the drum with respect to its gear. This is possible since there is only a friction connection between the gear and drum, pressure being maintained by a cup-spring construction on the side of the drum which is compressed against the gear during assembly.

Spot drum adjustment

21. The spot drum is mounted in a similar way except that a cup spring is compressed between the drum and its gear, and adjustments can be made by slipping the drum, as in the case of making the range drum adjustments.

Deflection drum adjustment

22. It would seem that the deflection drum could be adjusted by turning the spot shaft until the reading of 10 appears and then slipping the spot drum to its mid-position. However, since this procedure leaves the stop block on the spot shaft out of its mid-position, it is evident that the deflection drum has been adjusted by bringing the spot shaft out of position. This method should therefore be used only for very slight adjustments.

Calibration

23. The range drum and the drift cam of the deflection converter are made for a gun and projectile for which the time of flight and drift are known. Should either or both of these quantities be changed, the converter must be

supplied with a new range drum and new drift cam, properly calibrated for the new conditions.

CARE OF INSTRUMENT

24. After the deflection converter has been properly installed it requires no operating attention except the oiling of the slides. This should be done at the same time that the range keeper is oiled. A high-grade light mineral oil should be used for the purpose. The light mineral oil used in the Waterbury gear has the proper qualities.

25. The Mark I, Mod. 1, deflection converter differs from the Mark I in that the range drum is graduated for use with 6-inch 53-caliber guns and also in details of the casing. The inner or side of the casing next to the range keeper is milled off. This allows the instrument to set closer in against the range keeper. The bezel and side of the range keeper has also been milled off, forming a new seat for the deflection converter. This method of mounting the two instruments together decreased the over-all dimension by about $1\frac{1}{2}$ inches. This saving in over-all dimension was required in the mounting on the directors. Care should be taken to see that the deflection converter is used only for the caliber guns for which it is designed. This information is given on a name plate secured to the outer side of the casing.

26. The deflection drum on the converter is graduated in 200 equal divisions, every 10 divisions being stamped from 1 to 20, the position of zero or no deflection being either 5 or 10, depending on whether the guns have their middle deflection position at 50 or 100.

27. The converter Mark I, Mod. 1, is the same as the Mark I, except that it is graduated for use with 6-inch guns on the scout cruisers.

28. If it is ever found necessary to change the middle deflection point of the deflection

drum of the converter from 100 to 50, proceed very carefully as follows:

(1) Set range to 1,000 yards, deflection to 100, and spot ring to position of "No spot." Remove converter from the range keeper by taking out the four securing bolts.

(2) Remove the cover, held by 12 machine screws, taking care not to injure the rubber gasket. It is advisable to take a measurement from the 100 deflection mark to the right-hand end of the brass frame for convenience in setting the drum after the cover has been taken off. This measurement is approximately 1.65 inches.

(3) Remove two screws at the back of the casing, turn the spot knob so that the pin which engages a slot in the detent disk is below the spot knob shaft, and the entire mechanism may be lifted out of the casing.

(4) Set the deflection drum back to 100 deflection (by using the measurement above mentioned) and turn the spot knob shaft so the spot ring is in position of "No spot." Holding the deflection drum in this position against the action of a spring (which will tend to rotate it as soon as the two screws mentioned below are released) turn the entire mechanism bottom side up.

(5) Release the two headless set screws in the hub of the large brass gear, turn the mechanism right side up and slip the deflection drum to the right with the fingers pushing on its surface until 50 is in alignment with the vertical arrow head on the spot ring; it should also check up with the measurement (1.65-inches) to the right-hand end of the brass frame. Tighten the two headless set screws in the hub of the large brass gear. The spot ring is held by friction and may be turned on its shaft independently of the spot knob if necessary for accurate setting.

(6) Turn the spot knob so the pin is in its lowest position [as explained in paragraph (3)] and replace the mechanism in its casing.

(7) Care should be taken to have the correction circle on the range keeper in the position of no deflection when the converter is bolted back on the range keeper; it is adjusted by turning the crown gear just outside the range keeper casing. The converter deflection

should read 50, the range drum should read 1,000 yards, and the spot ring should be in the position of "No spot" before replacing the converter on the range keeper.

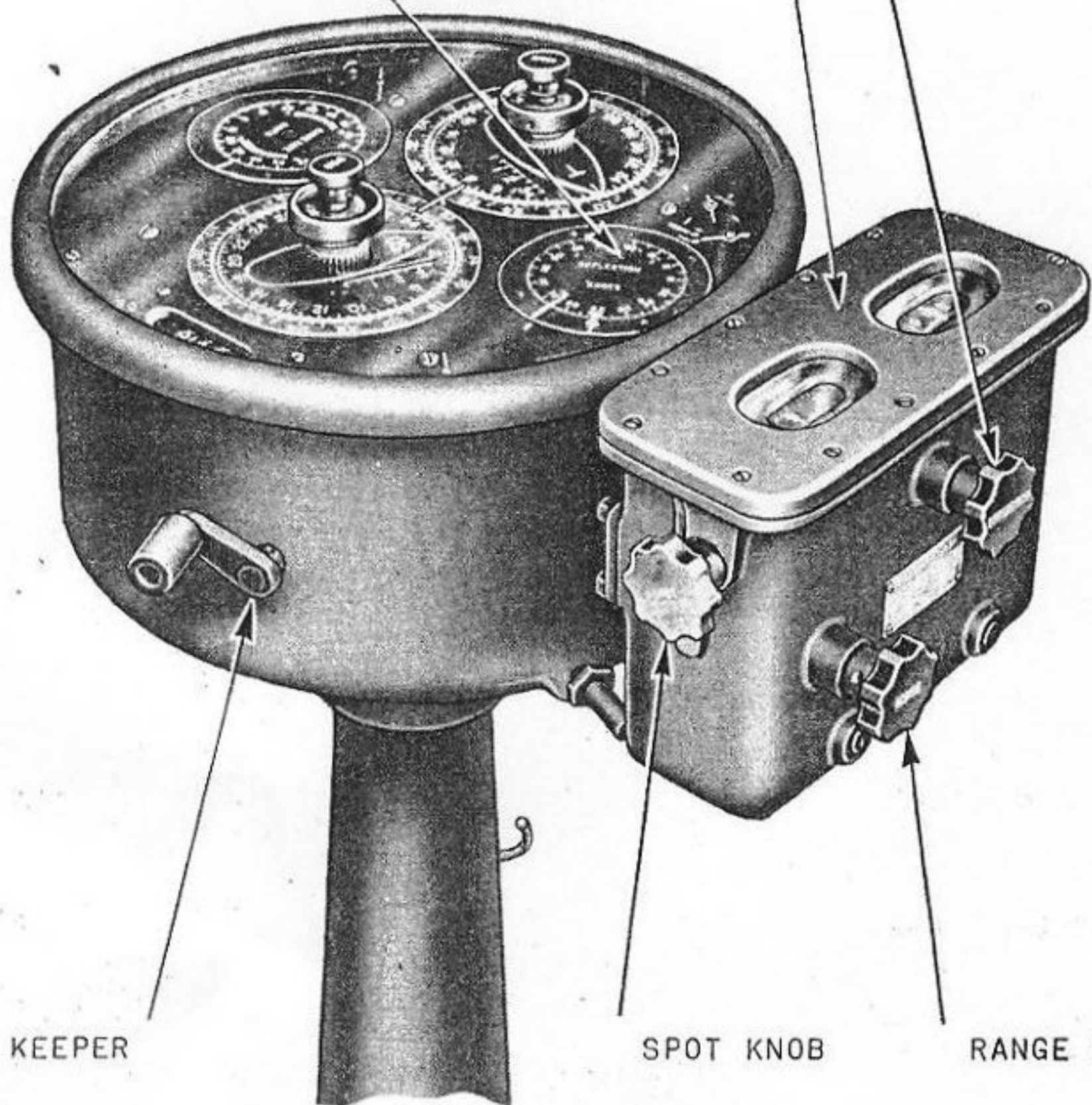
CHAS. B. McVAY,
Chief of Bureau

NAVY DEPARTMENT,
BUREAU OF ORDNANCE,
December, 1922

DEFLECTION DIAL

DEFLECTION CONVERTER

DEFLECTION KNOB

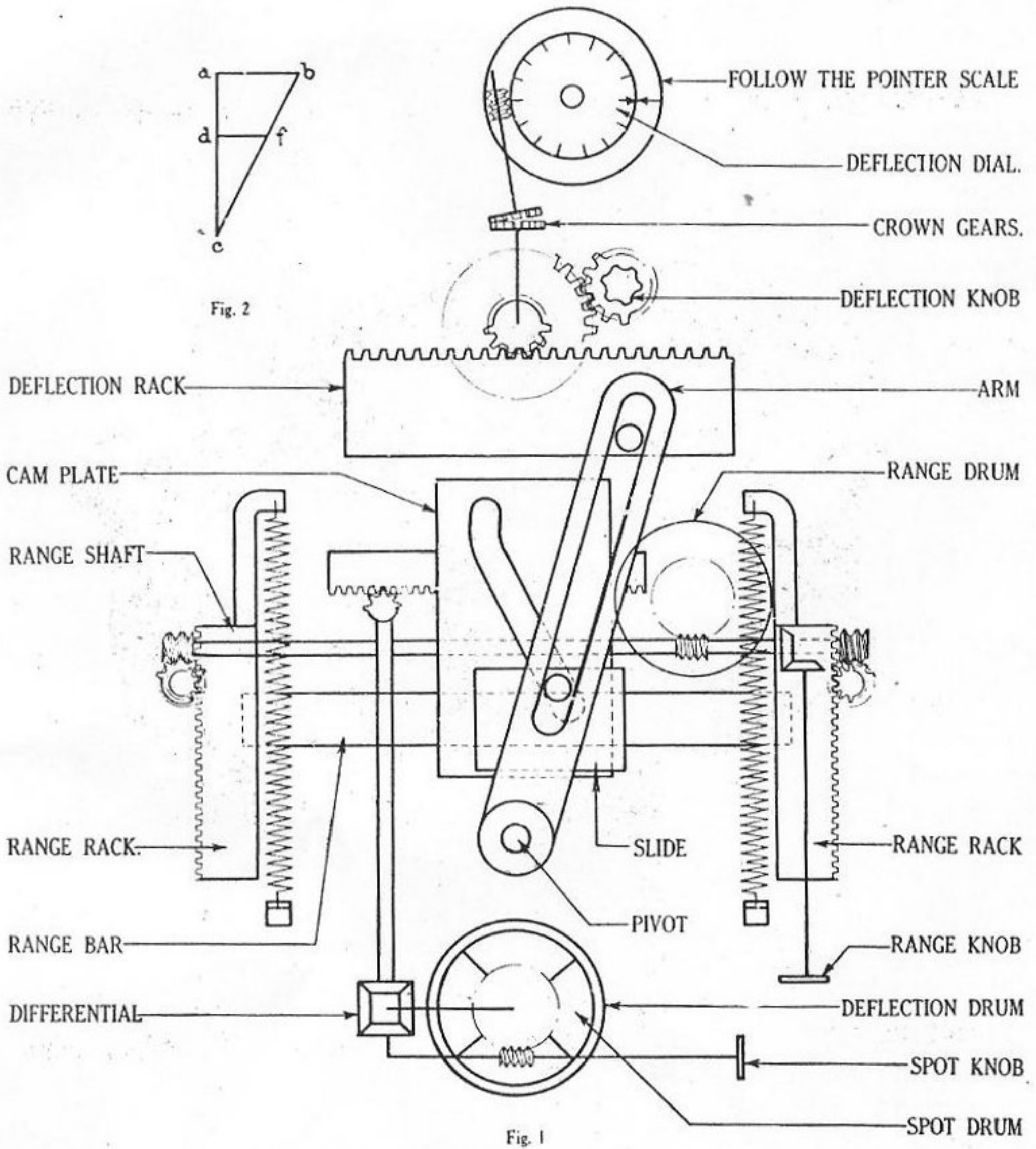


RANGE KEEPER

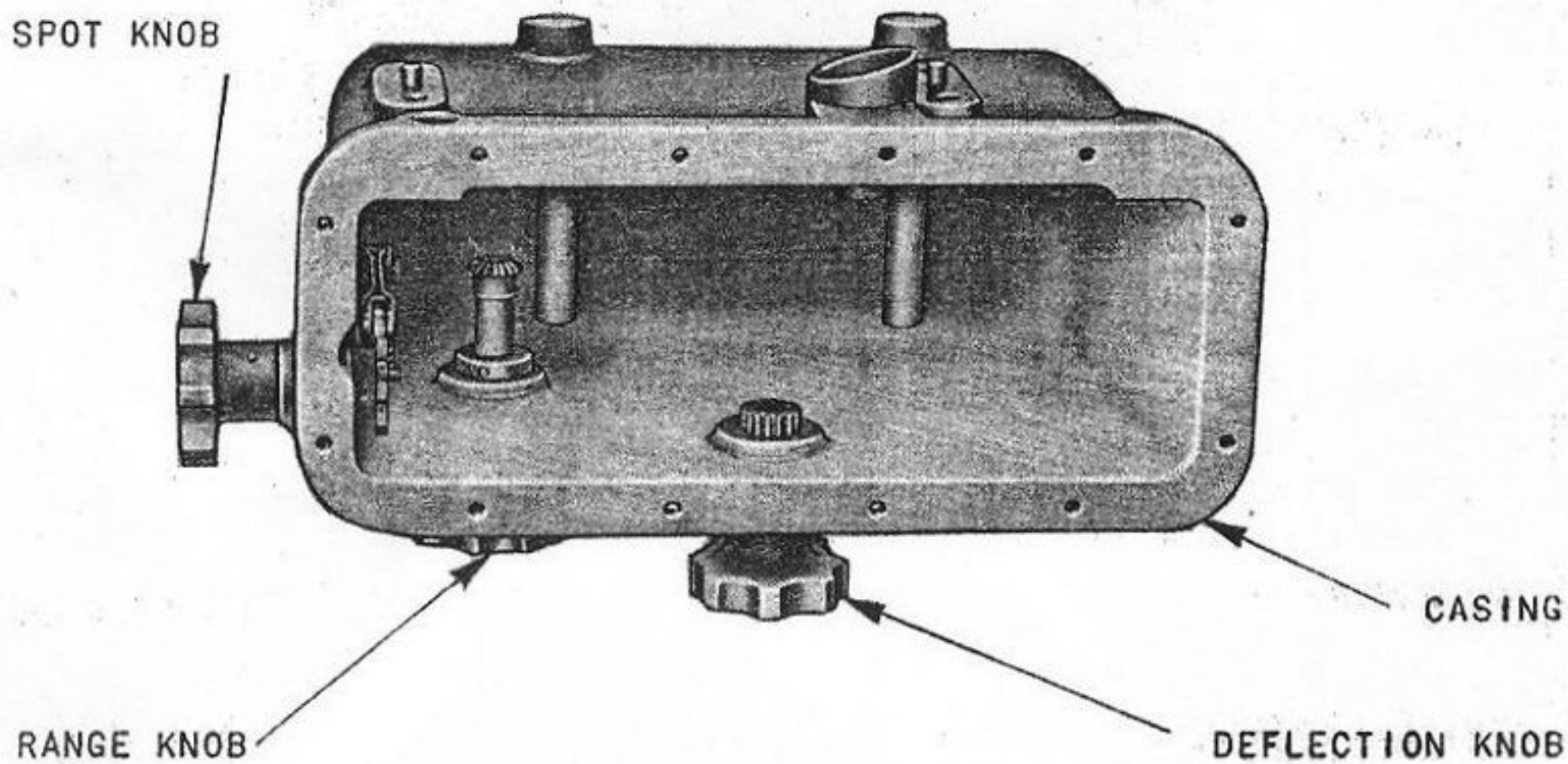
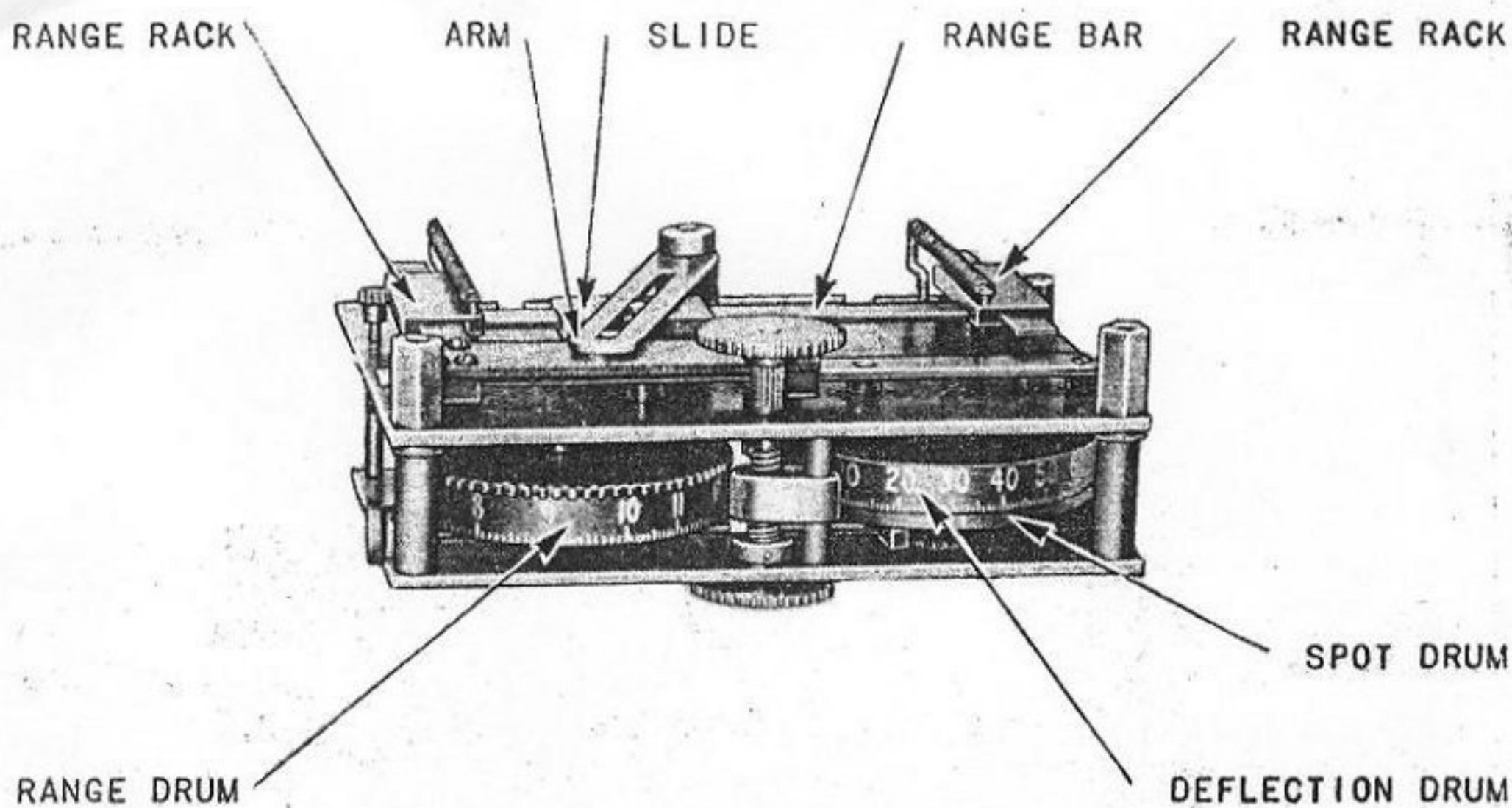
SPOT KNOB

RANGE KNOB

DEFLECTION CONVERTER, MARK I



Schematic Diagram, Deflection Converter Mk. I.



DEFLECTION CONVERTER, MARK I

CAM RACK

DEFLECTION RACK

RANGE BAR

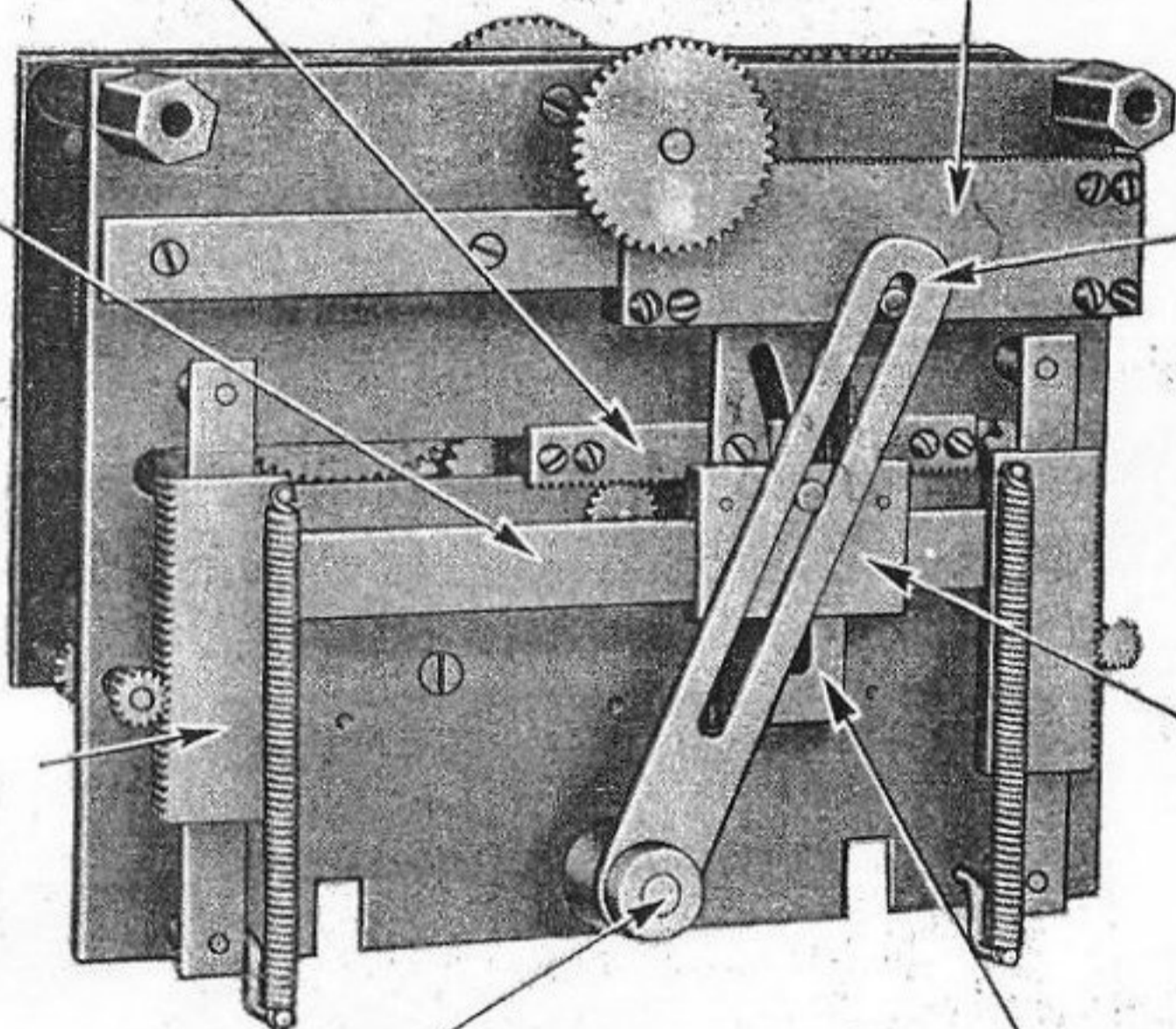
ARM

RANGE RACK

SLIDE

ARM PIVOT

CAM PLATE



DEFLECTION CONVERTER, MARK I

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