 8.

HANDBOOK

FOR THE

DEPRESSION RANGE-FINDER

FOR

ELEVATED BATTERIES.

LAND SERVICE.

1892.

LONDON:
PRINTED FOR HER MAJESTY'S STATIONERY OFFICE,
BY HARRISON AND SONS, ST. MARTIN'S LANE,
PRINTERS IN ORDINARY TO HER MAJESTY.

And to be purchased, either directly or through any Bookseller, from
EYRE & SPOTTISWOODE, East Harding Street, Fleet Street, E.C.; or
JOHN MENZIES & Co., 12, Hanover Street, Edinburgh, and
90, West Nile Street, Glasgow; or
HODGES, FIGGIS, & Co., Limited, 104, Grafton Street, Dublin.

Price Sixpence.

HANDBOOK

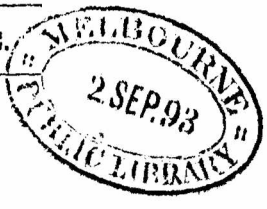
FOR THE

DEPRESSION RANGE-FINDER

FOR

ELEVATED BATTERIES.

LAND SERVICE.



1892.

LONDON:
PRINTED FOR HER MAJESTY'S STATIONERY OFFICE,
BY HARRISON AND SONS, ST. MARTIN'S LANE,
PRINTERS IN ORDINARY TO HER MAJESTY.

And to be purchased, either directly or through any Bookseller, from
EYRE & SPOTTISWOODE, East Harding Street, Fleet Street, E.C.; or
JOHN MENZIES & Co., 12, Hanover Street, Edinburgh, and
90, West Nile Street, Glasgow; or
HODGES, FIGGIS, & Co., Limited, 104, Grafton Street, Dublin.

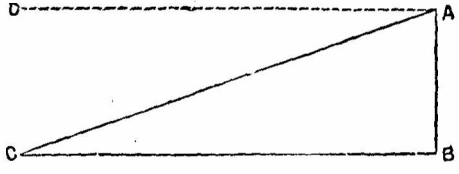
Price Sixpence.

(Wt. 8522 750 8 | 92—H & S 7765)

Depression Range-Finder for Elevated Batteries.

THE distance of an object on the sea level can always be ascertained from an elevated battery by means of the angle of depression, or the angle sub-tended by that object and the *true* horizon, thus:—

Fig. 1.



If C be an object situated on the surface CB of the water, A the Battery at a height AB. If DA be drawn parallel to CB, the angle DAC will represent the angle of depression, which will be equal to the angle ACB, and

$$\text{Sin ACB} = \frac{\text{AB}}{\text{AC}}$$

$$\therefore \text{AC} = \frac{\text{AB}}{\text{Sin ACB}} = \frac{\text{AB}}{\text{Sin DAC}};$$

that is, the

$$\text{* Range of C} = \frac{\text{Height of battery}}{\text{Sine of the angle of depression}}.$$

But as for all practical purposes the distance BC is equal to the distance AC, and the graduation of the range-finder is simplified by taking the range as equal to BC, the formula employed is

$$\text{Range} = \frac{\text{Height of battery} \times 1146}{\text{Tan. of the angle of depression}}.$$

As a table of Tans may not always be available, the following formula deduced from the above will often be found useful:—

$$\text{Range in yards} = \frac{\text{Height of battery in feet} \times 1146}{\text{Angle of depression in minutes}}.$$

But as any calculation, however simple, takes time, an instrument which only gives the angle of depression is of little value for taking the distance of moving objects. A range-finder, therefore should be capable of at once giving the distance without calculation.

* The curvature of the earth is not allowed for in these formulæ, but a correction for this is made in the graduation of the Range-Finder.

The depression Range-Finder is designed with the view of:—

1st. Giving the range without calculation.
2nd. The same instrument being available for different heights.
3rd. Easily being adjusted for rise and fall of tide.
4th. Being self-adjusting.

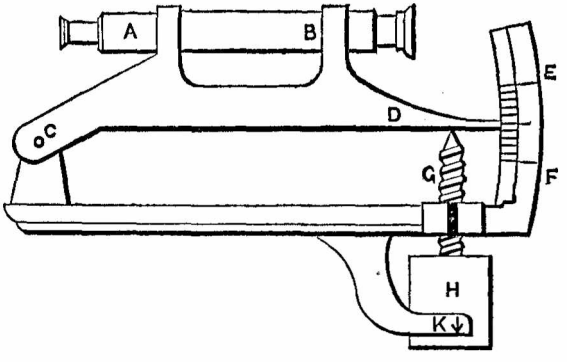
Theory of the Range-Finder.

The instrument may be divided into two parts, viz.:—

1st. The means employed for obtaining the range without calculation.
2nd. The device by which one range scale is made available for different heights.

The means employed for obtaining the Range without calculation.

Fig. 2.



If a telescope AB be fixed so that its axis is parallel to an arm CD pivoting at C, then the inclination of CD, when the telescope is laid on an object, would indicate the angle of depression. This angle might be read on a graduated plate EF as in the case of the Theodolite, but the motion being very small would require a Vernier. To avoid this inconvenience the arc through which CD moves is read by the number of revolutions of a screw G. To facilitate this reading a drum H is attached to the screw, having a continuous spiral traced on its surface. A fixed index K shows the number of revolutions through which H has been turned.

As each revolution will represent a definite angle through which it permits CD to move, the drum may be graduated in degrees and minutes. If we suppose such an instrument placed at some given height above the sea level, it is evident that every angle of depression will have its corresponding range, and the drum, instead of being marked in degrees and minutes, might be engraved with a scale of yards; and thus, whenever

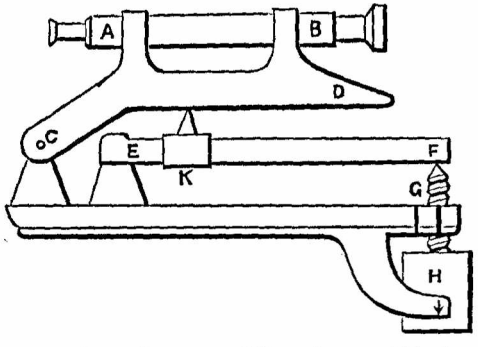
the telescope was pointed at an object by turning the drum, the range could be at once read opposite the index K.

The Device by which one Range Scale is made available for different heights.

An instrument such as has just been described would only be available for one fixed height, and for non-tidal waters; it is therefore necessary, still retaining the screw and drum as before, to have some means of altering the inclination of the telescope for any given position of the screw. Thus, for instance, supposing the height at which the instrument is fixed is 50 feet, and the drum unscrewed to the mark representing 1,000 yards, the inclination of the telescope would be (*a*) minutes. If the instrument be now taken to a height of 100 feet the inclination of the telescope would be, roughly speaking, (2*a*) minutes when viewing an object 1,000 yards distant.

The means employed for thus changing the inclination of the telescope is shown in the following figure:

Fig. 3.



In addition to the telescope AB and arm CD shown in Fig. 2, a second lever EF pivoting at E is employed, having a slider K capable of being moved into any position along it. The point of the screw G presses against the end of EF instead of CD, the arm CD resting on the raised point of K. EF being placed at any angle by unscrewing the drum, the inclination of CD and the telescope attached to it will vary according to the position of the slider K. And thus for one position of the drum, representing, say, 1,000 yards, the telescope can be brought to different angles of depression, representing that distance at different heights, by moving the slider K along the bar EF. This bar is accordingly graduated with marks indicating heights in feet.

Description of the Depression Range-Finder.

The range-finder consists essentially of a framework QK (*see* plate), capable of horizontal movement round a vertical axis KL, supported by three levelling screws, L.

Springing from the framework are two uprights, into which are pivoted two arms, EF, CD. A screw H, with drum attachment I, supports the end of the lever EF; the arm CD being held up by the steel point of the slider G.

This slider can be moved into any position along the bar EF, which is graduated to represent the various heights at which the instrument can be employed. A telescope AB, fitted with cross wires and a level M, rests in Y-shaped brackets, fixed to CD.

It follows from this arrangement that any movement of the screw H allows of the levers EF, CD, turning on their respective pivots and inclining the telescope; the amount of this inclination for any definite movement of the screw and the drum in connection with it will depend on the position of the slider G. The nearer this is to the pivot E the less the angle of depression, and *vice versâ*, and thus one scale of yards on the drum representing ranges from one height can be made available for other heights.

A horizontal plate O, engraved to degress of angle with a Vernier reading to $\frac{1}{4}$ degrees, is fixed to the lower portion of the main axis, and therefore revolves with the telescope.

This plate has been added with a view of indicating the target to the guns by means of the graduated arc and pointer. The sights of the gun and the cross wires of the telescope being brought on to some well-defined object, the Vernier index should be clamped so that the reading on the horizontal plate corresponds to that of the pointer on the graduated arc.

A screw S clamps the instrument, so that slow motion in a horizontal direction can be given by turning the screw P.

The instruments are graduated to suit different heights, and are distinguished as Mark I., Mark I. A, B, C, or D.

Mark I. are graduated from	80 ft. to 200 ft.,	for batteries	85 ft. to 190 ft.	in height.
Mark I. A	,,	50 ft. to 125 ft.,	,,	60 ft. to 110 ft.	,,
Mark I. B	,,	100 ft. to 250 ft.,	,,	110 ft. to 240 ft.	,,
Mark I. C	,,	240 ft. to 600 ft.,	,,	240 ft. to 590 ft.	,,
Mark I. D	,,	25 ft. to 50 ft.,	,,	25 ft. to 50 ft.	,,
Special	,,	for heights that do not come within the above.			

Instructions for Observing with the Depression Range-Finder.

1. The instrument should be conveyed in its box to the place of observation, together with the tripod belonging to it.

N.B.—The tripods are not always interchangeable, and are numbered to correspond with the instruments.

2. The tripod should be well opened out, and the legs placed in such a way that the top plate on which the instrument is to be placed is as nearly level as possible. A little care in effecting this properly will save time afterwards in adjusting the range-finder. The stand should then be firmly pressed into the ground to prevent any subsequent movement.

It is very desirable that the position chosen for observation should be to windward of the guns firing, and at such a distance as not to be affected by the concussion.

For permanent works it is advisable to demand base plates and covers (*see* par. 5514 L. of C.): these should be mounted by the Royal Engineers either on the parapet or on specially built concrete pillars. This arrangement secures greater steadiness, and has the additional advantage that instruments once levelled require but slight readjustment each time they are set up.

3. To allow of the levelling-screws dropping into the V slots of the tripod, the top plate should be moved sideways until the larger opening is over the V-shaped slots of the second plate.

4. Unlock the box and withdraw the wood slide on which the instrument is fixed. The turning of the wood buttons frees the range-finder, which should then be carefully lifted off with both hands grasping the framework QK, and the bottom of the levelling-screws inserted in the holes in the top plate of the tripod. Turning this top plate sideways locks the instrument into position.

5. See that the drum is screwed up to the zero mark, and turn the instrument until the drum lies over one of the levelling screws. Turn the levelling screw until the *bubble of the telescope* is brought into the centre of its run, then manipulate one or both of the other levelling-screws until the *small cross bubble* Q on the body of the instrument is levelled. If the telescope bubble has been disturbed by this adjustment it should be again levelled.

6. The range-finder should now be turned round until the drum is successively over each levelling-screw, and any displacement of the telescope bubble (which should be *very* slight) corrected. If these manipulations have been properly carried out, there should be no movement of the bubble attached to the telescope when the instrument is revolved on its vertical axis. The bubble on the body of the instrument parallel to the telescope should now correspond with the bubble of the telescope.

7. Remove the cap protecting the object glass of the telescope, and, if raining, put on the rain shade, then pull out the eyepiece until the cross-wires are distinctly seen. Turn the large milled-head screw in the centre of the telescope until the object viewed is brought into focus.

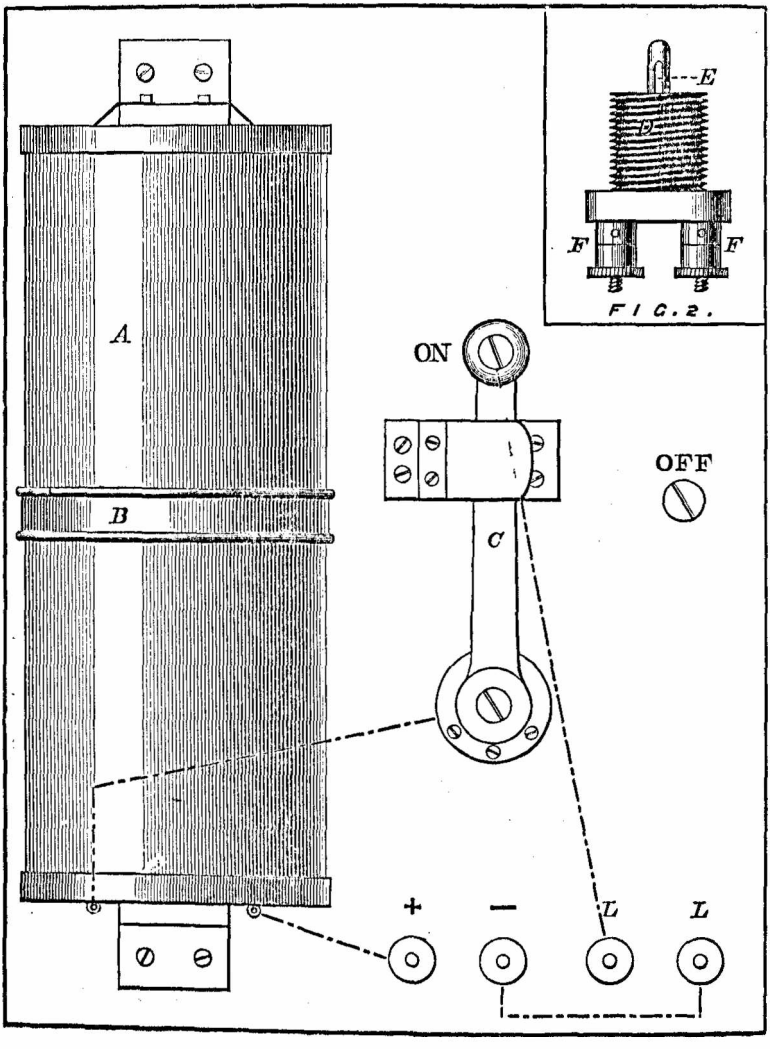
8. Turn the instrument in the direction of the datum point (a well-defined object in the water, the distance of which is exactly known). Place the drum to the figure corresponding to this distance, and move the slider G until the cross wires cut the water line. The height scale will then indicate the exact height of the telescope above the water level at that moment. In tidal waters the instrument should be frequently turned to the datum point to correct for rise or fall of tide; more especially is this necessary when the height of the battery is small.

9. The instrument is now ready for taking ranges. To take the range, bring the cross wires exactly on the water line of the object by turning the drum; the reading opposite the ⅄ will be the range. Should the object be a ship in motion, keep the cross wire on the water line by means of the slow movement screw P and the drum I.

10. At all stations the distance of two well-defined objects are recorded for setting the range-finder as described in para. 8, but should it be necessary to set it up in any other position, ranges may be obtained by placing the slider to the known height and proceeding as described in para. 9. But whenever it is possible, the method of adjusting the instrument described in para. 8 should be employed, as it ensures far greater accuracy.

11. In order to follow a vessel at night either with the range or position-finder, it is necessary to illuminate the cross wires of the telescope, and the following apparatus has been designed for this purpose:—§ 6062, L. of C.

As the illumination of the cross wires is only required when the object is lit up by the electric light, this apparatus will only be issued to stations having electric search lights.



A mahogany switch board has fixed upon it an ebonite cylinder, *A*, which is double wound with German silver wire, A ring, *B*, slides over this cylinder, touching the wire coils, and according to its position increases or decreases the brilliancy of the light, by altering the resistance in circuit with the lamp. A switch, *C*, puts the lamp in or out of battery circuit in accordance with indications near handle. Binding screws are marked for connecting wires to battery and lamp.

Fig. 2 represents the arrangement of the lamp for position-finder, and consists of an ebonite plug, which screws into a brass socket in the body of the telescope, near to the diaphragm carrying the cross wires. Fixed in this plug is a small 4-volt incandescent lamp, *E*, connected to binding-screws, *F*.

The arrangement for the depression range-finder is somewhat similar.

To use, screw the lamp into the telescope, fasten the switch-board in a convenient place on the wall of the observing station, and connect wires from terminals *L L* to the lamp.

Connect four large Leclanché cells to the binding screws +, —. *Before putting the switch handle over to the position* "*On*," be careful that the ring, *B*, is close to TOP of cylinder, *A*.

Should the lamp not be sufficiently bright, the light will be increased by moving the ring down.

Great care must be exercised to move the ring slowly down, and only so far as to give sufficient light.

With batteries in good condition, putting the ring close to the bottom of the coil would cause too much current to go through the lamp, and break the filament.

To prevent this, the Officer in charge of the instrument should carefully test the lamp AT NIGHT, and by coiling cord round the coil, prevent the ring being drawn down to a dangerous point. This test should be performed at night, or in a perfectly dark room.

The switch should only be kept "on," when actually observing, as the batteries soon lose their power.

12. Inconvenience having been experienced in using the depression range-finder in wet weather (and occasionally from the sun's rays shining into the telescope), a shade about 4 inches in length, to place over the object glass has been designed to obviate this, and a pattern has been sealed to govern supplies. (§ 6064 L. of C.)

13. Range-finders should be demanded to suit the heights of the batteries for which they are intended, but should they not be available any of the different marks may be used for other heights than those for which they are graduated.

Thus, should the height be *less* than that marked on the scale:—

(*a*) Place the drum at *double* the distance of the datum point, and move the slider until the cross wires are on the water level; proceed as in para. 9, but the reading opposite the ⅄ must be *divided by two* for the true range.

Should it be necessary to place the drum at *three* times the distance in order to bring the cross wires on the water level, the

reading opposite the ⅄ in taking a range must be divided by *three.*

(*b*) When no datum points are available, place the slider to double or treble the known height, the range readings being divided by two or three for the true distance.

Should the height be *more* than that marked on the scale:—

(*c*) Place the drum at *half* the distance of the datum point, and move the slider until the cross wires are on the water level; proceed as in para. 9, but the reading opposite the ⅄ must be *multiplied by two* for the true range.

Should it be necessary to place the drum at *a third* the distance, the reading opposite the ⅄ on taking a range must be *multiplied by three.*

(*d*) When no datum points are available, place the slider to *half* or *third* the known height, the range readings being *multiplied by two or three* for the true distance.

The above will not give perfectly true results owing to the correction for curvature.

Method of Adjusting the Instrument.

The instruments when issued for service are in perfect adjustment, and with moderate care should so continue for any length of time, but, nevertheless, it is advisable occasionally to test the different parts. It should, however, be distinctly understood that no corrections are to be made without a thorough knowledge of the principle on which the adjustment depends, and only when, after two or three observations, the existence of an error is distinctly indicated. Instruments that would otherwise be in perfect condition have been rendered useless by reckless and unnecessary movement of adjusting screws.

1st. *To test if the intersection of the cross wires is in the centre of the telescope*, commonly known as the test for *collimation*, lay the intersection of the cross wires on some well-defined object, turn the telescope half round in the Y-shaped brackets (that is until the bubble is over the telescope instead of under it), and note if the intersection is still on the object; if it is, the collimation is correct. If, however, the intersection is above or below the object, proceed as follows:—If the intersection appears *above*, unscrew the capstan-headed screw *a* (*see* plate), and screw up *b* to a similar extent (with the steel pin found in the side of the wood box) until the intersection of the wires is brought *half* way towards the object. Now revolve the telescope back into its normal position (bubble downwards), and repeat the process until the intersection is neither above nor below the object sighted. If the intersection appears *below*, first unscrew *b*, and then screw up *a*, and proceed as above. Any *slight* displacement of the *vertical* wire, *right* or *left* of the object, is of small importance, but it is as well to correct it in the same way.

2nd. *To adjust the level* M *truly parallel to the axis of the telescope.*—Clamp the instrument by means of the screw S, so that the drum lies over one of the levelling screws L, and by

means of this screw bring the bubble M to the centre of its run. Throw open the clip confining the telescope, and reverse it carefully end for end in the Y-shaped brackets; should the bubble not settle on the same point of the glass as before, it shows that the level is out of adjustment. The end to which the bubble recedes must then be noticed, and the bubble made to return one-half the distance by turning the adjusting screw L, and the other half by turning the capstan-headed screws at the end of the bubble tube. The telescope must now again be reversed, and the operation repeated until the bubble settles in the centre of its run in both positions of the instrument. The adjustment is then perfect, and the clips should be again made fast to confine the telescope in the Y-shaped brackets.

3rd. *To set the axis of the telescope at right angles to the vertical axis round which the telescope turns.*—Bring the bubble M into the centre of its run by the levelling screw L as before, the drum I being carefully screwed up to the zero mark. Unclamp the screw S, and turn the telescope half round, so that it points in the opposite direction; if the bubble does not settle at the same point as before, half the error must be corrected by the screw L, and the other half by the capstan-headed screw in the side of the Y-shaped brackets. The process must be repeated until the bubble remains stationary.

This adjustment would seldom be required.

The long spirit level in the body of the instrument should be made to correspond with the level M of the telescope.

Instructions for the Care and Preservation of Depression Range-Finders.

1. Depression range-finders, of the following descriptions, are allowed for coast batteries (armed with heavy guns) having an elevation of 25 feet and upwards above high-water mark:—

Mark I.	for batteries	85 to 190 feet.
Mark I. A	„	60 to 110 feet.
Mark I. B	„	110 to 240 feet.
Mark I. C	„	240 to 590 feet.
*Mark I. D	„	25 to 50 feet.
Special	„	at other heights.

2. The instruments will be taken on charge by the Officer Commanding Royal Artillery of the District, who will be held responsible for their condition.

3. The range-finders in works at home will be periodically inspected by the Inspector of Position-finding, or an Officer deputed by him when such inspection is recommended by the Instructor in D.R.F. at the various stations.

4. The instruments found defective will be sent to Woolwich for repairs on the recommendation of the local Instructor in D.R. Finding through the Senior Ordnance Store Officer of the District, to the Commissary-General of Ordnance, Woolwich,

* This instrument has a screw and drum arrangement different from that of other marks.

who will transmit them to the Inspector of Position-finding. The instruments will be returned through the same channel. The Inspector of Position-finding will communicate direct with Officers Commanding Royal Artillery concerned, as to when these instruments are to be sent for inspection. As far as possible the inspection should be carried out during the winter months.

5. A history sheet in duplicate will be prepared for each range-finder, and every transaction connected with the instrument will be entered on these sheets (*see* specimen page). One copy will accompany the instrument to which it relates on all occasions of inspection or return to store; the other will be retained by the Inspector of Position-finding.

6. When instruments in Ordnance Store charge require examination, the Inspector of Position-finding is to be communicated with as to time and place of inspection.

7. When an instrument is sent to the Commissary-General of Ordnance for repair or inspection, a report of the condition of the instruments will be sent with it, thus:—

(*a*) Condition of No. instrument.
(*b*) Is the instrument in good order, and does it give correct ranges?
(*c*) If not, explain reason.

8. If the instrument has been damaged, full particulars of how the damage occurred should be stated.

9. To pack the instrument for transport—

(*a*) Remove the telescope and place it in the special box in which it was sent to the station.
(*b*) Push the slide to the end of the bar furthest from the pivots.
(*c*) Screw up the drum to the zero position.
(*d*) Tie several turns of tape round the telescope arm and the body of the instrument so as to keep these parts from moving.

10. The boxes containing the instrument and telescope should be packed in a strong box with hay, and marked "Glass, with care;" the lid being screwed down, not nailed.

11. The range-finder, when not in use, should be kept in a dry place.

12. Instruments when taken out for instruction or practice should be in the immediate charge of a qualified Officer or non-commissioned officer, and before passing out of his charge should be carefully inspected.

13. On no account should an unqualified man attempt to set up or use the range-finder.

14. The steel parts of the instrument and the large screws should be occasionally oiled, but the oil must be wiped off again; an accumulation of oil is liable to cause particles of grit to adhere and damage the working parts.

15. The object glass and eye piece should be occasionally carefully cleaned with a *perfectly clean* soft piece of chamois leather, which should be used for no other purpose.

16. It is not advisable, unless absolutely necessary, to remove the object glass or eye piece.

17. Should it be necessary to remove the object glass, great care must be exercised that the two lenses are replaced correctly, the marked surfaces being placed together, also that the cell is carefully screwed up into exactly the same position, and the instrument tested for collimation again.

18. If the eye piece is removed, great care should be taken that the fine spider's web which will be then exposed is not damaged.

19. Care should be exercised in ascertaining that the distances of the datum points are correct, and it is very desirable that one of these points should be near the extreme right, the other near the extreme left training.

20. Should the instrument when set on one datum point not give the correct distance of the other datum point, the instrument should be examined to see if it is properly levelled, and in adjustment. If these are correct, the distance of the datum points should be verified from a map, or application be made to the Royal Engineers to measure the distances.

21. When it is considered advisable to use the instrument on permanent work, base plate and covers should be demanded through the War Office.

22. These, which are somewhat similar to the head of the range-finder tripod, are secured with cement on the work.

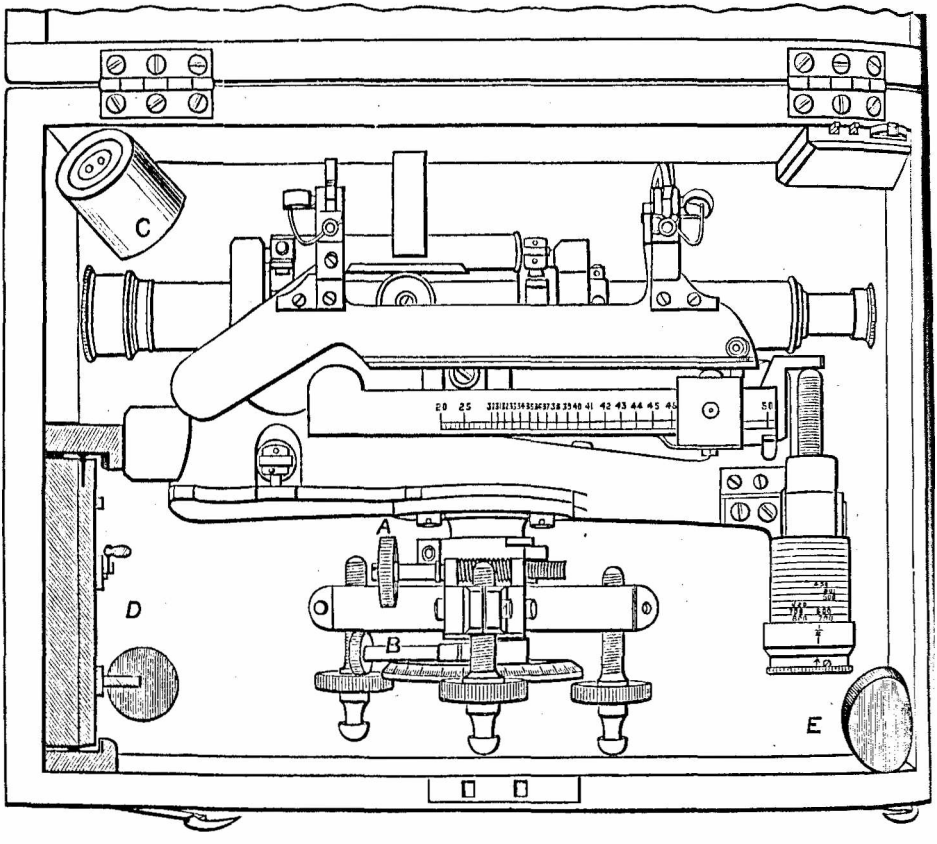
23. Instruments once levelled on to a base plate, if carefully taken off when returning to box, will require no adjustment when again set up for use.

24. Covers with padlock will be provided for use with the base plate to protect them from the weather. (*See* § 5514, L. of C.)

25. On no account should any attempt be made to repair the instruments locally. Should new cross-wires be required, the Instructor in D.R. Finding should be applied to.

26. The following diagram gives the method of packing the instruments in the new pattern case :—

METHOD OF PACKING THE DEPRESSION RANGE-FINDER IN ITS BOX.



Screw A. to be up. Clamping Screw B. to the left.
C., Electric Lamp. D., Resistance Coil and Switch.
E., Rain Shade.

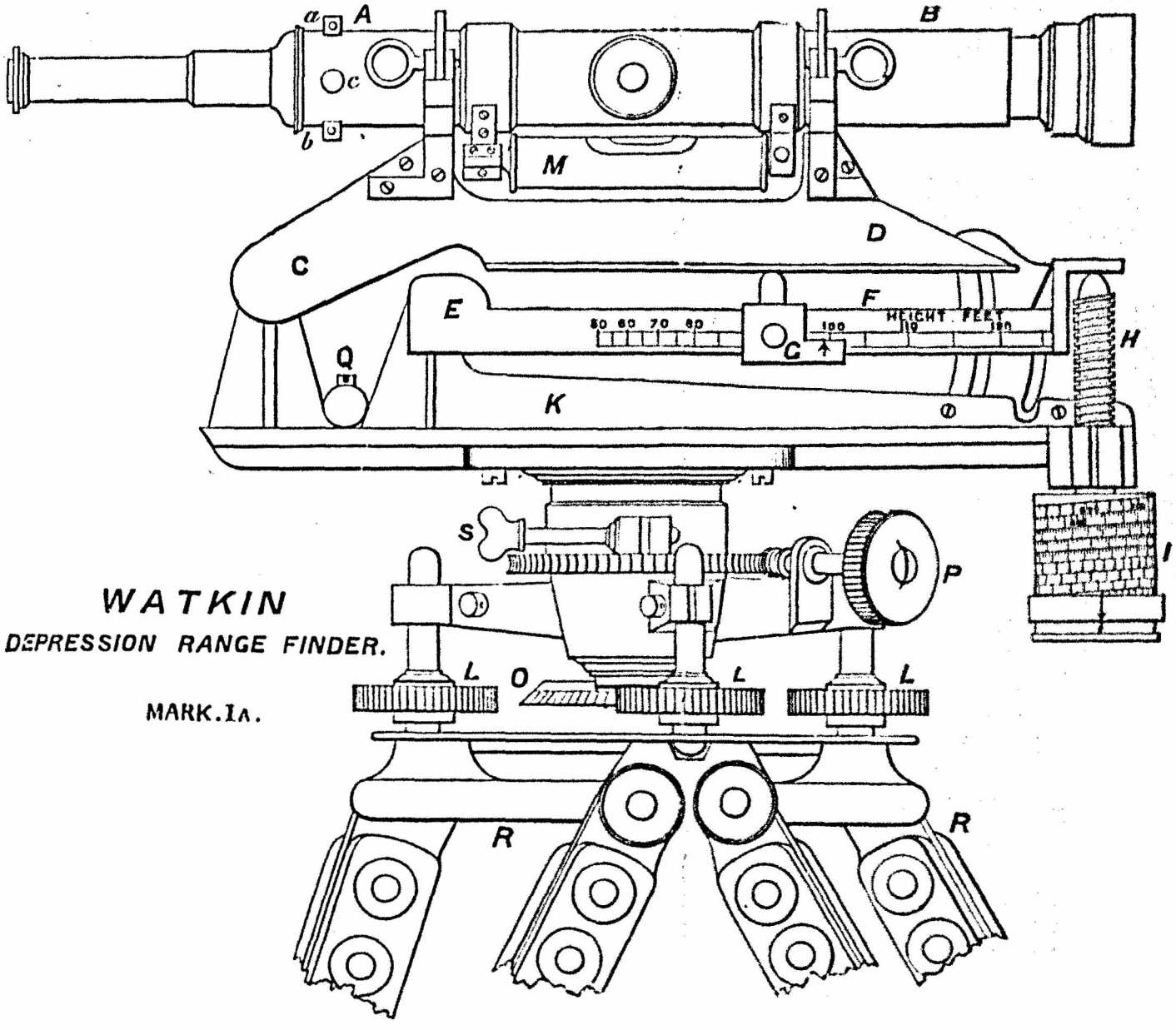
SPECIMEN FORM OF HISTORY SHEET.

Depression Range-finder. Mark Ia. *Number* 217 . *Manufacturer*, Smith & Co.

Inspected 20.1.88, by _____, Inspector of Position-finding.

Issue and Exchanges.				Signature of Officer making the entry.	Inspections.				Repairs.		Signature of Officer making the entry.
Date.	From	To	For		Date.	Occasion.	Remarks of Inspecting Officer.	Recommendations.	Date.	By.	
5.1.87	C.G.O.	C.R.A., Western District	Service								
20.11.87	C.R.A., Western District	C.G.O.	Inspection ...	...	4.12.87	Annual ...	Good order	Service	...	...	H.W.
10.12.87	C.G.O.	C.R.A., Western District	Service								
8.6.88	C.R.A., Western District	C.G.O.	Repair of cross wires	...	20.6.88	After repairs	Good order	Service	12·6	Smith	
&c.	&c.	&c.	&c.	...	&c.	&c.	&c.	&c.			
10.1.90	C.R.A., Western District	C.G.O.	Repair, blown down, placed too near gun	...	30.1.90	Inspection ...	Damaged beyond repair ...	Struck off charge ...	Authority	84 W	

(Wt. 8522 750 8 | 92—H & S 7765)



WATKIN

DEPRESSION RANGE FINDER.

MARK. 1A.