OFFICIAL COPY.

[Issued with Army Orders for August, 1922.

SIGNAL TRAINING.

VOLUME III.

Pamphlet No. 2.

HELIOGRAPH, 5-inch, Mark V.

1922.

LONDON:
PUBLISHED BY HIS MAJESTY'S STATIONERY OFFICE.

To be purchased through any Bookseller or directly from
H.M. STATIONERY OFFICE at the following addresses:
IMPERIAL HOUSE, KINGSWAY, LONDON, W.C. 2, and 28, ABINGDON STREET, LONDON, S.W. 1.
37, PETER STREET, MANCHESTER; 1, ST. ANDREW'S CRESCENT, CARDIFF;
or 23, FORTH STREET, EDINBURGH.

Price 2d. Net.

[*Issued with Army Orders for August*, 1922.

40
W.O.
8364

SIGNAL TRAINING.

VOLUME III.

Pamphlet No. 2.

HELIOGRAPH, 5-inch, Mark V.

1922.

LONDON:
PUBLISHED BY HIS MAJESTY'S STATIONERY OFFICE.

To be purchased through any Bookseller or directly from
H.M. STATIONERY OFFICE at the following addresses:
IMPERIAL HOUSE, KINGSWAY, LONDON, W.C. 2, and 28, ABINGDON STREET, LONDON, S.W. 1.
37, PETER STREET, MANCHESTER; 1, ST. ANDREW'S CRESCENT, CARDIFF;
or 23, FORTH STREET, EDINBURGH.

1922.

Price 2d. Net.

By Command of the Army Council,

THE WAR OFFICE,

August, 1922.

CONTENTS.

CHAPTER I.

THE INSTRUMENT.

CHAPTER II.

OPERATING.

CHAPTER III.

ADJUSTMENTS, REPLACEMENTS AND CARE OF INSTRUMENT.

HELIOGRAPH, 5-INCH, MARK V.

CHAPTER I.

THE INSTRUMENT.

1. *General description.*

The heliograph, 5-inch, Mark V, has an exposed mirror surface of 5 inches and weighs, in its case, 8 lbs. Its range in favourable atmosphere is 70 miles. Its use is very dependent on climatic conditions because for practical purposes it can only be used when the sun is shining. It has the great advantage of secrecy because its signals can only be read within a few yards of the station into which it is directed. Its chief advantages are portability, range, secrecy, rapidity of sending, and ease in opening communication owing to the flash being so readily noticeable. Its disadvantages are the need for continual training and practice to obtain good results, its dependence on the sun and the delicacy of some of its adjustments which make it liable to become unserviceable unless carefully handled.

2. *Detailed description.*
(*See diagrams.*)

A. Stand.
B. Anchoring hook.
C. Sight arm with clamping screws " C'."
D. Tangent box with lid below.
E. Tangent screw head.
F. Key.
G. Key spring.
H. Key bridge.
I. Key bearings.
J. Beat regulating screw.
K. Lock nut for ditto.
L. Swivel joint.
M. Collar.
N. Vertical socket.
O. Vertical steel rod.
P. Clamping screw for ditto.
Q. Nickel-silver ball attached to claw " Q'."
R. Adjusting screw for ditto.
S. Base plate.
T. U-arms, with detachable portion " T' " and screws adjusting.
U. Signalling mirror in frame.
V. Unsilvered spot at centre of signalling mirror.
W. Duplex mirror with frame in U-arms (T).
X. Sighting vane on ditto.
Y. Butterfly and pivoting screw.
Z. Sighting rods with movable vanes " Z'."

i. *The case.*—The heliograph is carried in a leather case provided with shoulder and waist straps, the latter should invariably be strapped round the waist when riding either horse or bicycle to prevent jolting. In addition to the parts enumerated below, two spare mirrors in a separate aluminium box, a small leather bag containing spare parts and an adjusting tool are carried in the case.

ii. *The stand* (A).—The stand consists of three mahogany legs joined at the top by a brass head provided with a screw for receiving

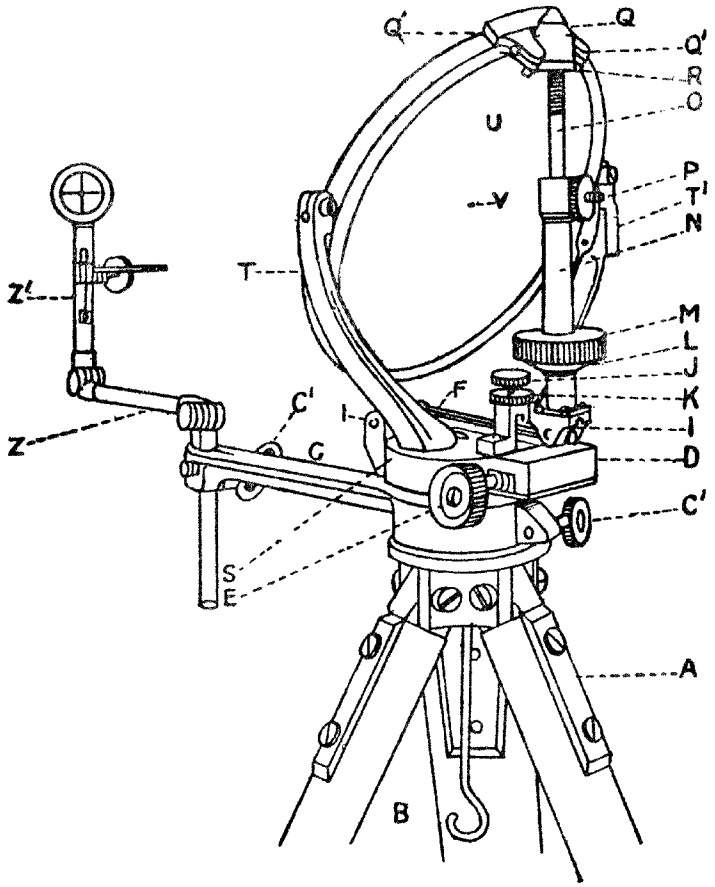


DIAGRAM 1.—HELIOGRAPH WITH JOINTED SIGHTING ROD.

the main socket of the heliograph. When the stand is not in use, the screw head is protected by a cap, attached to one of the legs by a chain. A leather sling is attached to one of the legs for carrying purposes. An anchoring hook and a strap or loop to fasten the legs together, when closed, are also provided. The stand weighs 4 lbs. The anchoring hook (B) is useful on hard or rocky ground where the legs cannot be driven in. Stability may be obtained in such a case by suspending from it a weight which should just touch the ground so that it cannot swing about. The hook may also be used to secure the stand to a tent-peg or stake either driven into, or buried in the ground immediately below it.

These expedients are only necessary in exceptional circumstances when proper stability cannot be obtained without them.

iii. *The body.*—The body, comprising the base plate, central pivot, U-arms, key bearing and tangent box, is made of gunmetal and cast in one piece. The body is attached to the main socket by the central pivot secured by a washer and main socket screw which must not be fastened too tightly or too loosely, but so that the tangent screw is able to give the necessary horizontal motion,

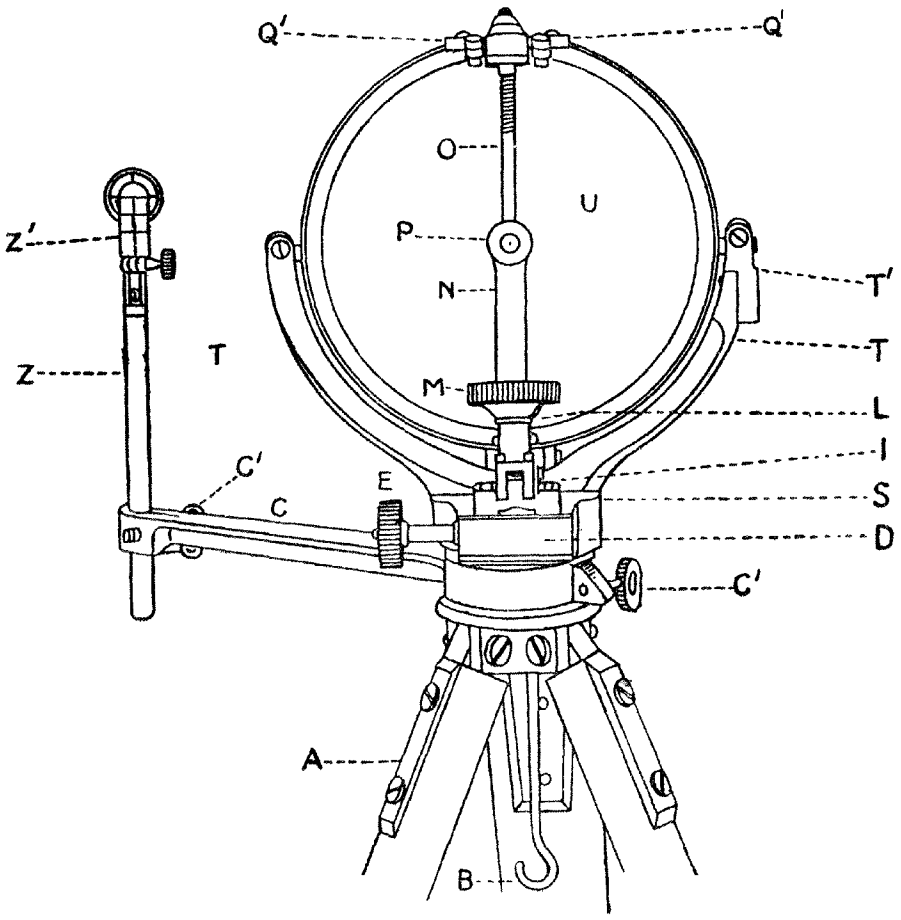


DIAGRAM 2.—HELIOGRAPH WITH STRAIGHT SIGHTING ROD.

and that there is no undue shaking. The main socket is threaded internally to screw on to the stand. Its upper portion is toothed externally, into which fits the thread of the tangent screw.

iv. *The signalling mirror.*—A plane glass circular mirror, the back of which is coated with hard paint to preserve the silvered portion from damp and injury, is used. It is mounted in a metal frame to show a surface 5-inch diameter. The mirror is kept pressed against the front rim by means of three nickel-silver springs screwed in the back of the frame. A paper washer rests over these springs to prevent them damaging the paint on the mirror. This frame is furnished with trunnions which rest in the bearings of the U-arms,

a portion of one of which is detachable. The centre of the mirror is left unsilvered, showing a circular spot $\frac{1}{8}$-inch in diameter.

v. *Horizontal motion.*—The tangent box carries the "Tangent screw"; the worm of this screw being made to engage the teeth on the main socket by a V-spring resting in the tangent box and bearing against the shank of the tangent screw, which passes through the end of the tangent box and is fitted with an ebonite milled head.

By turning this head the body (together with the mirror) is given a slow horizontal motion round the main socket.

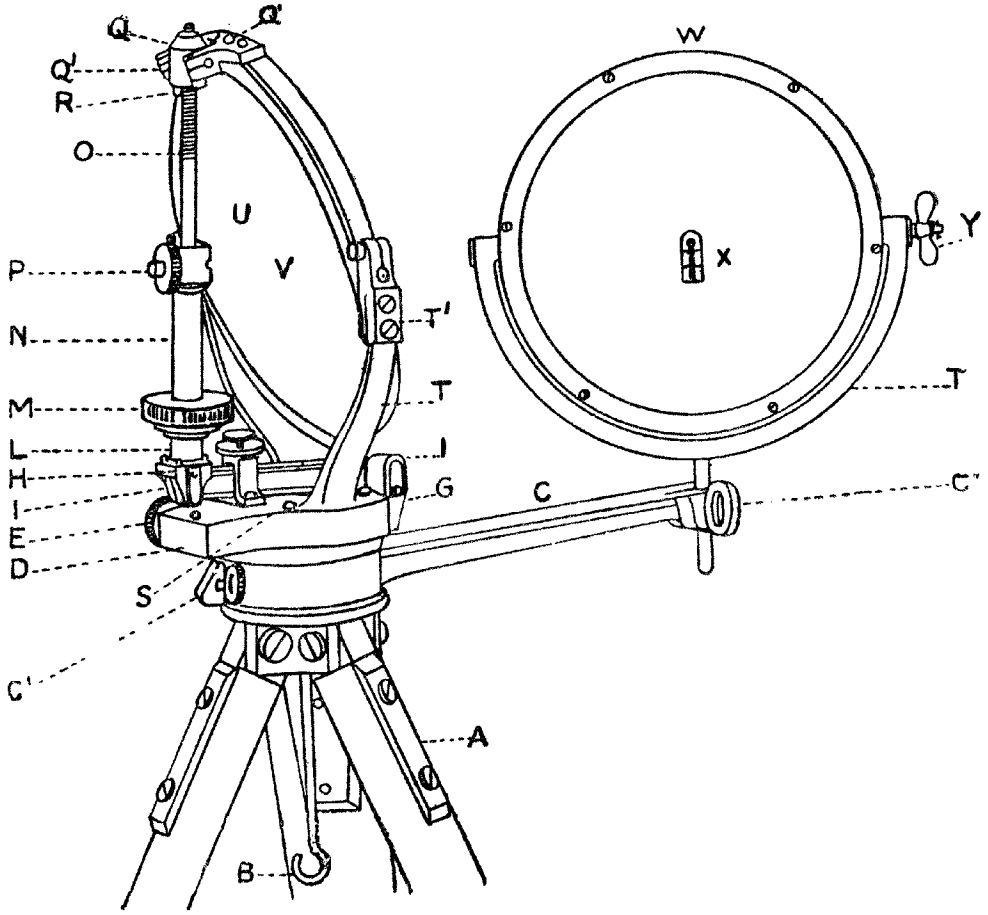


DIAGRAM 3.—HELIOGRAPH WITH DUPLEX MIRROR.

The U-arms are so placed that the centre of the mirror and the centre of the pivot are in a vertical plane, consequently no horizontal motion imparted to the mirror about the pivot will alter the position of the unsilvered spot at its centre.

vi. *Vertical motion.*—The mirror can turn vertically on its trunnions, resting in the bearings of the U-arms. Attached to the rim of the mirror frame are two cock pieces forming the "claw." The nickel-silver ball is provided with trunnions resting in bearings on the claw. The upper end of the vertical rod has a screw thread which engages the threads of the nickel-silver ball; the lower end is plain and can be clamped at any convenient height in the vertical

socket by means of the clamping screw. The socket is fitted with a swivel arrangement at the lower end, and is secured by a pin passing through the rear end of the key. The " collar " is rigidly secured to the socket, and on turning it the vertical rod is screwed through the nickel-silver ball which travels up or down it, and thereby causes the mirror to move vertically. If it should be necessary to give the mirror a considerable vertical motion, this may be done by moving the vertical rod in or out of the " socket," the clamping screw being first released. This means should always be used when not sending, in preference to turning the " collar " so as to preserve the threads of the vertical rod and nickel-silver ball as much as possible.

vii. *The swivel joint* (L).—The swivel joint consists of three parts, a saddle and socket, a steel rod with a collar, and a cap. The saddle fits over the rear end of the key; the shorter end of the steel rod fits into the socket; the cap fits over the longer end of the steel rod and rests on the collar. The cap is fastened by four screws to the top of the saddle. Through the longer end of the steel rod is a hole by means of which it is fastened to the lower end of the vertical socket by a pin, which is kept in position by the ebonite collar screwing over it.

viii. *The key* (F).—1. The rear end of the key is secured to the bottom of the vertical column by a tapered pin. The front end is secured to the " key-bearing " in a similar way. The " key-spring " is screwed down at one end to the upper surface of the base plate, the other end is free and bears against the under edge of the key, tending to force it, and with it the vertical column, upwards; by this means the mirror is kept in the " position of rest."

2. When it is desired to bring the light on to the distant station, the key is moved by pressing down the collar, thus inclining the mirror upwards; by the same action the key spring is compressed, but as soon as the pressure on the collar is removed, this spring comes into action and the mirror is brought back to the " position of rest."

ix. *The beat.*—The distance through which the key is moved when signalling is called the " beat." This can be regulated to suit the skill of the signaller, and the distance between the stations. The key passes under the bridge, which is secured to the base plate by two screws. The beat-regulating screw passes through the top of the bridge, and bears against the upper edge of the key. The amount of the beat is thus regulated by screwing or unscrewing the beat-regulating screw; as soon as it is satisfactory, it can be so kept by screwing down the milled lock nut until it is in contact with the top of the bridge.

x. *Sight arm* (C).—The " sight arm " serves the purpose of carrying the sighting rod or " duplex mirror." It is made T-shaped for strength and lightness, and can be fixed in any direction required

by means of the " clamping screw " which is at the rear end of the " sight arm," and fastens the " sight arm " to the " main socket." The " sight arm " must be removed when packing the instrument.

xi. *Sighting rods* (Z).—1. The " sighting rods " are of two patterns, one being straight with a circle of metal and cross wires at the top, and the other similar in construction with the exception that it has two joints which render it capable of being rapidly elevated or depressed without unclamping the screw which retains it in the " sight arm " ; also, if a lateral motion is necessary, this sighting rod can be moved horizontally without loosening the clamping screw of the " sight arm." The joints in the latter rod can be loosened or tightened by means of the " adjusting tool."

2. In aligning the heliograph with a sighting rod, it must be remembered that the point of bisection of the cross-wires is the " sighting mark," and so it is necessary to move the rod laterally and vertically until the distant station is cut by the intersection of them. There is an enamelled vane on the upper part of the sighting rod which must be turned down sufficiently far to admit of alignment, and when turned up, enables the signaller to see that his light is properly adjusted. The vane has a thin black line down its centre from the " spot," and three horizontal lines. This enables the signaller to judge the correct position for the " Shadow Spot " when the signalling mirror is in the position of rest. In order to prevent the enamelled surface of the vane from being chipped it should *never* be turned fully down, particularly when packing up.

xii. *The duplex mirror* (W).—In the " duplex mirror " there is a portion left unsilvered ; on this a paper vane is fixed (on the back of the mirror), which serves the double purpose of enabling the signaller to effect an alignment and to see that his light is properly adjusted. The vane is marked with lines in a similar manner to the vane on the sighting rod.

The frame of the duplex mirror has no trunnions, but the mirror is pivoted in the " U " arms by means of two screws which pass through the ends of the arms into the frame. A butterfly screw is provided to clamp the mirror at any required elevation. The stem on its " U " arms can be clamped in the socket at the end of the sight arm.

CHAPTER II.

OPERATING.

3. *Theoretical considerations.*

1. In order to reflect the rays of the sun on to a distant station by means of a mirror, the mirror must be placed at right angles to an imaginary line bisecting the angle between the distant station and the sun, and in order to keep the reflected rays on to the distant station it will obviously be necessary to move the mirror continually to counteract the continual apparent motion of the sun.

The heliograph is designed to do this, the mirror being mounted so that it can be given a gradual motion both vertically and horizontally by the operator while engaged in sending a message.

2. When the sun and the distant station are in opposite directions it becomes impossible to reflect the light from one mirror alone in the required direction and a second mirror, called the duplex, must be placed so that the light from the sun is reflected from the signalling mirror on to the duplex, and thence to the distant station. As the light striking the duplex does not come direct from the sun but from the signalling mirror which is moved as necessary in accordance with the apparent motion of the sun, it is not necessary to move the duplex mirror in order to keep the light on the distant station. The duplex mirror must always be used when the angle between the sun and the distant station is greater than 90°.

3. As it is impossible to see whether the reflected light is on the distant station, a sighting mark on a vane is brought into alignment with the centre of the mirror and the distant station. A small circle ($\frac{1}{8}$-inch diameter) is left unsilvered in the centre of the mirror, and this causes a small shadow to be thrown on the vane.

4. If the alignment be true, it is only necessary to see that when the mirror is in the signalling position, this shadow spot covers the sighting mark on the vane ; the reflected light will then be fully on the distant station. When using the duplex mirror, a paper vane is attached to the mirror itself, so that the sighting mark coincides with its centre. In aligning, the duplex is placed so that the reflection at its centre of the distant station will be visible from the centre of the signalling mirror. In other words, the duplex is placed so that the unsilvered spot at the centre of the signalling mirror hides the reflections of the sighting mark and distant station.

5. There are two positions of the signalling mirror, namely, the "position of rest" and "position of signalling." In the former, the light is thrown on the ground somewhat below or on the near side of the distant station. In the latter, the light is thrown fully on the distant station. The heliograph is aligned and the mirror placed in the signalling position so that the light is on the distant station. The mirror is next turned downwards through a small vertical angle and is thus brought to the "position of rest," in which it is kept by means of the key spring. The mirror is in connection with a key, and on working this similarly to the dummy key, the mirror is brought to and kept at the signalling position for short and long periods of time corresponding to the dots and dashes in the Morse alphabet and various signs.

4. *Setting up and aligning.*

1. It is important that the following method should be carefully taught and rigidly adhered to in order that certainty and speed of setting up and aligning may be attained.

Note.—The jointed sighting rod should always be used in the first instance when setting up and aligning. A change may be made to the straight sighting rod if the station is likely to remain in position for some time or if the jointed rod is found to be loose and gets out of adjustment.

2. Decide whether it will be necessary to use the duplex mirror by pointing one arm to the distant station and the other to the sun. If the angle thus formed is greater than 90° use the duplex mirror. When there is any doubt the signaller should consider whether the angle will be increased or decreased as the sun moves. In the former case use the duplex, in the latter the sighting rod and thus obviate changing from one to the other after work has commenced.

3. Grasp the stand with the right hand and unfasten the legs. Place the stand on the ground with the head level and the feet of the legs about 2 feet 6 inches from each other. As the stand will have to be moved again do not waste time at this stage in pressing the legs very firmly into the ground.

4. Sling the case round the legs, hinge of lid to the left, open the case and prop the lid open by inserting the end of the fastening strap in the hinge.

5. With the right hand remove the sight arm from the case, at the same time removing the signalling mirror by grasping it with the left hand, placing the 1st and 2nd fingers of the latter over the edge of the tangent box against the base plate, one on each side of the vertical column and the thumb on the main socket screw; draw the mirror gently from the case, holding it with the main socket upwards.

6. Moving the hands in front of the body, remove the thumb of the left hand from the main socket screw, place the sight arm over the main socket at right angles to the mirror (rib uppermost), and clamp the screw with the right hand. Replace the thumb, retaining hold of the heliograph with the left hand and sight arm with the right.

7. Turn the heliograph over, and place it on the screw head of the stand. Without releasing the grip of either hand turn the sight arm away from the body until a "click" is heard as the thread engages, taking care that the screw threads do not cross; then screw the heliograph firmly home by passing the sight arm from right hand to left hand in the opposite direction, *i.e.*, towards the body.

Note.—The heliograph should not be forced beyond the end of the screw or it will be damaged.

At this point the procedure is different according to whether the duplex mirror or sighting rod is used.

i. **When sighting rod is used.**

8. Withdraw the rod from the case with the right hand and place it in the end of the sight arm, clamping it till it moves stiffly. It

should be in prolongation of the sight arm with sighting vane vertical. Turn the vane halfway down only. Unclamp the screw on the vertical column, elevate the signalling mirror about halfway and reclamp.

9. Grasp the stand by the two legs furthest from the body and swivel it round on the third leg until the sight arm points towards the distant station. Place the two legs firmly so that the head of the stand is level and the feet of the legs about 2 feet 6 inches apart. Move round the stand, pressing each leg firmly into the ground, placing the right hand near the bottom of the leg, while steadying the stand with the left hand. Take care to keep the head of the stand level.

10. Stand just clear of the stand with the head between the sun and the mirror and look into the mirror. Move the head until the reflection of the distant station is hidden by the unsilvered spot in the centre of the mirror.

Keeping the head still, move the sighting rod until the bisection of the cross wires exactly coincides with the reflection of the distant station and the unsilvered spot, *i.e.*, so that the centre of the unsilvered spot, the bi-section of the cross wires and the distant station are in one line.

11. Turn up the right vane gently, being careful not to displace the alignment in doing so. By means of the tangent screw and the vertical motion adjust the shadow spot so that it coincides with the sighting mark.

12. Loosen the beat regulating screw (which should be screwed down when the helio is in the case so that there is no beat) until the shadow spot drops below the sighting mark to a distance of about $\frac{3}{8}$-inch. Clamp the screw in this position.

Note.—At short distances it will be found necessary to increase the beat to half an inch.

ii. When the duplex mirror is used.

8. Grasp the U-arm of the duplex mirror and withdraw it from the case with the right hand, place the standard in the socket at the end of the sight arm until the latter is within $\frac{1}{4}$ inch from the base of the U-arm. The duplex mirror should be parallel to and facing the signalling mirror, the standard should be clamped lightly so that it moves stiffly in the socket of the sight arm. Unclamp and elevate the signalling mirror slightly and reclamp.

9. Grasp the stand and turn it until the signalling mirror faces the sun. Move round the stand and press each leg firmly in the ground by placing the right hand near the bottom of the leg, keeping the left hand on the top of the stand to steady it, care being taken to keep the stand level. Then unclamp the large screw on the sight arm and move the sight arm and duplex mirror through an angle of

about 45° on that side nearest the station—*e.g.*, if the station is to the right rear, move the arm 45° to the right, see that both mirrors are kept parallel, then reclamp.

Note.—When the sun, helio, and distant station are all in the same straight line, place the sight arm on that side to which the sun is apparently moving.

10. Standing within easy reach of the instrument, with the back to the sun, and looking into the signalling mirror, move the head until the reflection of the sighting mark on the duplex mirror is hidden by the unsilvered spot in the centre of the signalling mirror.

Keeping the head still, hold the duplex mirror near the bottom with both hands, thumbs to the rear, first and second fingers to the front, the tips of the thumbs and fingers resting against the duplex. Turn the mirror horizontally and vertically until the reflection of the distant station as seen in the signalling mirror is exactly covered by the reflection of the sighting mark ; so that the unsilvered spot on the signalling mirror, the reflection of the distant station, and the sighting mark on the duplex mirror are in one straight line.

11. By means of the tangent screw and vertical motion adjust the shadow spot till it coincides with the sighting mark.

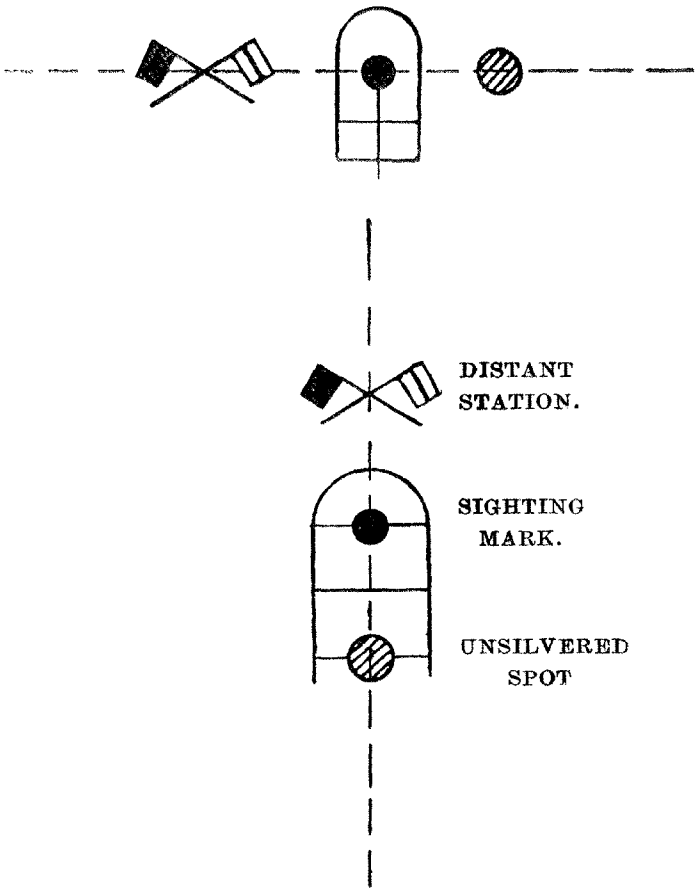
12. Loosen the beat regulating screw (which should be screwed down so that there is no beat when the helio is in the case) until the shadow spot drops below the sighting mark to a distance of $\frac{3}{8}$-inch. Clamp the screw in this position.

Note.—At short distances it will be found necessary to increase the beat to half an inch.

Note.—Experienced signallers have obtained greater rapidity in setting up and aligning the heliograph by using methods which differ slightly from that laid down above ; experience has, however, proved that the above method is the best for general use and it must be adhered to.

5. *Verifying the alignment.*

The alignment should always be verified. This may be done by standing back from the heliograph and by looking into the signalling mirror and getting the three points (the centre, the reflections of the sighting mark, and the distant station) covered as before ; then if on moving the head and eye slightly to one side, the three points appear to be in the same horizontal line, the elevation is correct ; similarly, if on moving the head slightly upwards, the three points appear to be in the same vertical line, the direction is correct. When using the sighting rod, the alignment should be verified *after* the vane has been turned up.



6. *Packing up the instrument.*

Speed and method in packing up are almost as important as in setting up and aligning. The following method will be carefully taught and adhered to on all occasions :—

i. Open the lid of the case and prop it open with the securing strap. Turn the collar until the vertical rod is flush with the top of the nickel-silver ball. Unclamp the screw on the vertical column, and bring the mirror flush with its U-arms, then reclamp. Unclamp the beat regulating screw and screw it down lightly till there is no beat, then reclamp.

ii. Unclamp and remove the sighting rod (or duplex mirror) and return it correctly to the case, taking care that the vane is turned upwards (and the duplex mirror with the glass towards the padded partition and the butterfly screw flush with the frame and uppermost).

iii. Grasp the sight arm with the right hand, palm upwards, holding the head of the stand with the left hand, then give a half-turn to the left with the right hand, which loosens the heliograph. Continue unscrewing the heliograph by passing the sight arm from hand to hand.

The sight arm should be held in the right hand when the heliograph is taken off the stand.

iv. Place the first and second fingers of the left hand one on each side of the vertical column and the thumb on the main socket screw, and turn over the heliograph so that the main socket is uppermost.

v. Unclamp the clamping screw and remove the sight arm from the main socket, momentarily removing the thumb for this purpose.

vi. Replace the signalling mirror gently in its case and the sight arm correctly in its pocket with the flat side to the right. The screws on the sight arm should be flush.

Note.—It is sometimes necessary to turn the large screw (which may protrude over the top of the case) at right angles in order that it will not bulge the lid when closed.

vii. Fasten the case and sling it over the shoulder.

viii. Replace the cap on the stand, and holding the chain clear fasten the legs together by the means provided. Then sling it over the shoulder.

7. *Calling for light.*

It is very important that a simple and rigid method of " calling for light " and acting on the call should be invariably used. It is only by this means that satisfactory results can be obtained, and the following method must therefore be strictly adhered to :—

i. *Calling for light.*

Reader (or answer reader) calls out " Bad light."
Writer (or caller) calls out " W."
Answerer (or sender) calls out " W, light open " (complying).
When the reader (or answer reader) has seen a good steady light **for three seconds** he calls out " Down."
Answerer (or sender) repeats the word " Down " as he promptly releases his key.

ii. *Answering a call for light.*

Answer reader (or reader) reads " W group, light open."
Caller (or writer) calls out " Open light and adjust."
Sender (or answerer) calls out " Adjusting," as he opens his light and carefully adjusts the shadow spot on to the mark. Having adjusted he holds the key down with normal pressure **while he counts ten out loud.**

If after counting ten the distant light is still open the caller will give the order " Re-align," and the sender will carefully re-align and repeat the words and actions given above.

The moment the distant light is dropped the reader will call out " Down " and the sender will drop his light and proceed with the work.

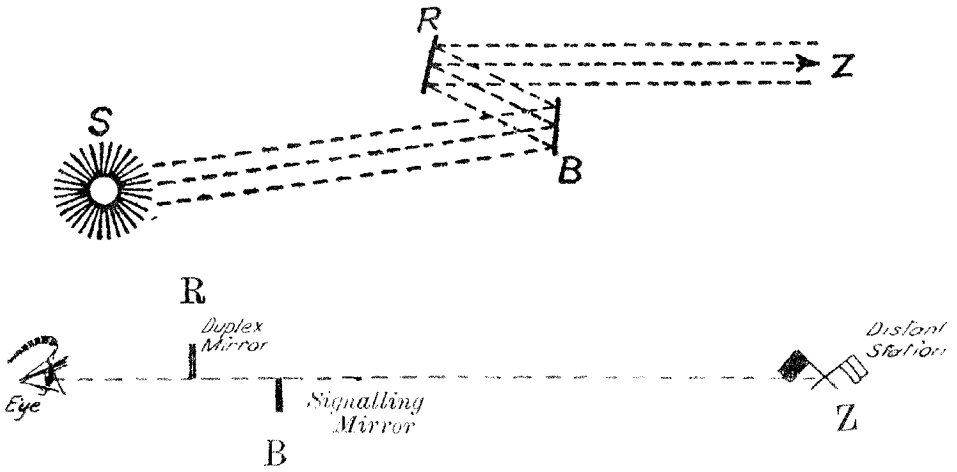
8. *Points to be borne in mind when using the instrument.*

1. The stand must be firm and rigid, as the efficiency of the heliograph greatly depends on having a firm base. The legs, where possible, should be securely fixed in the ground about as far apart as their length. Holding the stand at the head with the left hand to steady it, grasp each leg in turn with the right hand and press them firmly into the ground, keeping the head of the stand as level as possible and taking care that the pressure is applied along the direction of each leg, and not vertically so as to cause it to break.

2. On hard or rocky ground, where the legs cannot be driven in, stability may be obtained by suspending a weight from the anchoring hook under the head of the stand. The weight should just touch the ground so that it cannot swing.

3. The anchoring hook may also be used to secure the stand to a tent-peg or stake, either driven into or buried in the ground immediately below it.

4. When using the duplex mirror it may be taken as a rough guide that the sight arm should be placed at an angle of 45° to the signalling mirror. In order to get the maximum amount of light reflected to the distant station, the sight arm should be placed as near as possible to an imaginary line joining the sun and signalling mirror, but it must be placed sufficiently far to the side to prevent the duplex mirror R intercepting the sun's rays from the signalling mirror B, and to prevent the latter intercepting the light reflected from the duplex mirror to the distant station Z (*see* Diagrams below).



5. With sun, helio, and distant station in the same straight line, and when the sun is very low on the horizon, it may be necessary to depress the sight arm by moving the legs of the stand in order to prevent the duplex mirror interrupting the sun's rays falling on the signalling mirror. The same applies to some extent when signalling up or down steep hills.

6. If the standard of the jointed sighting rod or duplex mirror has become much worn and cannot, therefore, be clamped so that it moves stiffly, raise it slightly so that a less worn place is gripped by the sight arm when clamping.

7. When signalling hold the collar on the vertical socket with the first and second fingers, one on either side of the vertical column, the thumb on the side of the collar; the head of the tangent screw is to be held by the thumb and first finger of the other hand, at the same time constant attention must be paid to the sighting vane to see that every time the key is depressed the shadow spot just comes to its proper place, *i.e.*, covering the sighting mark. With this object, the tangent screw and the collar must be turned very slowly and continuously, without interrupting the sending.

The direction in which these slow motion screws should be turned depends on the locality and the time of day, but it should be remembered that, by means of them, the mirror must always be made to follow the apparent motion of the sun.

Great attention must be given to see that the signals are made sharply and distinctly. The importance of always depressing the key evenly and to its full extent can be impressed on learners, by causing them to align the heliograph and send on to a spot marked on a wall a short distance off. But above all, constant attention must be paid to the sighting vane, so that the shadow spot may not be allowed to wander, and for this reason the habit should be acquired of looking constantly at the vane and not at the distant station or mark representing it.

8. When using the duplex mirror in a high wind, it will be found difficult to read the signals owing to the vibration; to overcome this difficulty the duplex mirror may be removed and the signalling mirror of the second heliograph substituted for it, the latter being on its own stand, which should be placed close to the stand of the signalling heliograph. It will be necessary to affix a paper vane over the unsilvered spot of the second heliograph.

9. When searching for a station whose position has not been located but whose direction is roughly known, align the heliograph in the required direction and slowly traverse backwards and forwards, making a succession of dots. The traversing must be done very slowly or the station may be missed. If the direction of the unknown station is uncertain it is best to sweep the country with the flash from the duplex mirror held in the hands.

It must be remembered that in certain tactical situations this "searching" may not be allowable in some directions owing to the danger of giving the position away to the enemy, and no signaller should be allowed to "search" without proper authority and definite instructions as to over what area the light may be flashed.

CHAPTER III.

Adjustments, Replacements and Care of Instrument.

9. *Adjustments and replacements.*

1. *To replace a broken mirror.* It is unnecessary to remove the mirror frame from the body of the heliograph. Remove the detachable part of the rim by taking out the screws, take out the broken pieces of mirror and lay the new mirror on the paper washer covering the nickel-silver springs; replace the detachable part of the rim and screws. V-shaped marks are cut on the fixed and detachable portions of the rim to ensure correct replacement.

It happens occasionally that spare mirrors are not a perfect fit. In such cases the mirror must be packed, preferably with cork, or with paper if cork is not obtainable.

2. *To replace a broken or weak tangent spring.*—Remove the lid of the tangent box, clean out the recesses; insert the new spring and tangent screw simultaneously, seeing that the shank of the tangent screw works freely in the bearing on the spring. Replace the lid. At present no spare tangent spring is included in the spare parts pocket.

Should a tangent spring break whilst at work in the field the spring can be substituted by a wad of paper packed tightly behind the tangent screw. This will keep the threads engaged and will not damage the instrument. A new spring should be obtained from the R.A.O.C. at the first opportunity.

3. *To adjust the vertical rod screw or to replace the rod.*—Very slightly tighten the screw in the bottom of the nickel-silver ball, thus closing in the threads.

Loosen the clamping screw on the vertical socket, unscrew the threaded portion of the rod from the nickel-silver ball, and withdraw it from the socket, then replace in inverse order.

4. *To remove the key spring.*—Turn the mirror flush with the U-arms, remove the pin fastening the key to the front key bearings and draw back the key. The screw fastening the spring to the base plate is then easily accessible.

10. *Care of the instrument.*

1. If riding or cycling, always carry the heliograph slung across the shoulders and not attached to the saddle or cycle.

2. Avoid holding the instrument by the U-arms or mirror frame, and never touch the surface of the mirror with the hands.

3. If the helio gets wet, thoroughly dry mirror and metal portions after which metal work should be rubbed over with a slightly oiled rag before putting in case, or at first opportunity. Instruments which are known to have been wet should not be put into store and left after being treated as above ; but should be examined daily for about a week.

4. Always keep the heliograph clean and free from rust and dust. Grit and dust in the tangent box, or on the vertical rod and nickel-silver ball, will soon destroy the best instrument.

5. Occasionally oil the working parts (main socket and body, tangent, screw, bearings, &c.), but never leave superfluous oil on any part, as it collects dust. Never allow oil to drop on the mirror.

6. When making adjustments be careful not to damage or burr the heads of screws, and see that the threads are not crossed.

7. Before commencing any minor repairs, consider by which means the fewest screws and parts need be removed. Avoid stripping the heliograph on ground where the parts would be easily lost, such as long grass, &c. If possible spread a blanket on which to work.

Printed under the authority of HIS MAJESTY'S STATIONERY OFFICE
by Harrison & Sons, Ltd., 44–47, St. Martin's Lane, W.C. 2.

(B 28/30) Wt. 8055/4966—377 12M 9/22 H & S, Ltd. G. 28 G.S.290B