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# SMALL COMPASS DIRECTOR

(GONIOMETRE BOUSSOLE DE BATTERIE)

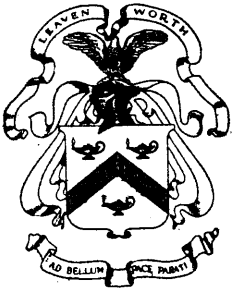
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WASHINGTON, D. C., *March* 22, 1918.

The following notes on "Small Compass Director" (Goniometre Boussole de Batterie) are published for the information of all concerned.

(062.1 A. G. O.)

By order of the Secretary of War:

PEYTON C. MARCH,
*Major General, Acting Chief of Staff.*

Official:

H. P. MCCAIN,
*The Adjutant General.*

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# GONIOMÈTRE BOUSSOLE DE BATTERIE

## (SMALL COMPASS DIRECTOR).

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The "Goniometre-boussole de batterie" is a very portable instrument destined for the usual topographical operations and for use as a director with batteries provided with sights graduated in mils (6.400 mils = 360 degrees.)

### DESCRIPTION. (Figs. 1 and 2.)

The instrument comprises a telescopic sight with a large field of view and a magnetic compass.

**The sight** is a small prism telescope having a magnification of about 4; its eye-piece is provided with focusing gear M (fig. 2). By means of screw U it can be elevated or depressed in a vertical plane approximately parallel to the axis of the needle in its zero position. It is fitted with a level V. As shown in fig. 3 the micrometer of the telescope comprises a vertical graticule for measurements in direction, a graduation in sight angle (— 100 to + 100 mils) and a telemetric scale. The optical axis corresponds with the point at which the vertical graticule is intersected by the zero graticule of the sight angle scale.

**Magnetic compass:** The needle can be clamped by lever D (fig. 2) [care should be taken to clamp needle before transportation]. By means of a small magnifying prism placed at the side of the eye-piece of the telescope the needle and its zero mark can be accurately observed. The zero mark on the north of the compass is only used for rough setting, the final adjustment being always effected by getting the south end of the needle in line with the zero mark beneath the reading prism.

**Movement in azimuth.**—The upper dial of the instrument carrying telescope and compass can be moved over a lower dial by turning milled head T of the tangent screw. For quick setting this tangent screw can be thrown out of action by pressing on pallet W. Before using slow motion see that screw has properly engaged, but do not attempt to force it home, turn milled head and screw will fall into gear.

Without upsetting relative positions of upper and lower dials the whole instrument can be rotated by means of lower milled head S. For rough setting first slacken clamp C.

**Verticality of the pivot.**—The pivot of the instrument is fixed to the tripod stand by means of a ball-and-socket joint. A spherical level H enables pivot to be set vertical.

**Tripod stand.**—Consists of three telescopic legs and a sliding vertical tube. By loosening clamp B the height of the instrument can be varied as desired between 0 m. 80 and 1 m. 80. In using the instrument for accurate topographical surveys employing the compass it is not advisable to raise the vertical tube more than necessary.

**Graduations.**—There are two graduations : (1) on the lower dial a continuous clockwise graduation from 0 to 6,400 mils, used in conjunction with black index on upper dial. Each division is worth 100 mils and intermediate values are read on the left-hand side of graduation of the tangent screw drum. Each division of the drum graduation is worth 1 mil and it is read in conjunction with the black index mark (the one engraved on smooth ground).

(2) A second graduation on upper dial, this, in conjunction with the right-hand side graduatuion on tangent screw drum, being intended for use specially with 75 mm. batteries when angles are measured in terms of "plateau" and "tambour" of the gun-sight. (See Annexe II.)

## INSTRUCTIONS FOR USE.

When employing the "Goniometre-boussole" as a topographical instrument the continuous clockwise graduation on lower dial, in conjunction with left-hand side graduation on tangent screw drum, is used exclusively.

(1) **To set up the instrument over a given station.**—Erect the stand so that pivot of instrument is vertically above given point; press each leg well into the ground so that the sliding tube is approximately vertical. Loosen the clamp of the ball and socket joint and adjust instrument until bubble is at the centre of the spherical level. Tighten clamp.

(2) **To "orient" an instrument occupying a known station** (i. e., to set it "correct in position" by observations of other known points). Let O be the known station occupied and A, B, C, . . . other known points visible from O and as far away as possible. First determine $\alpha, \beta, \gamma$ . . . the true Y azimuth (gisements)[1] of directions OA, OB, OC . . . This can be done either from map or plotting table (planchette de tir) by means of protractor, or by calculation. Erect the instrument over station O and set the angle $\alpha$ on continuous graduation. Loosen clamp C of general movement and direct telescope roughly on point A; tighten clamp C and turn milled-headed screw S of general movement until A coincides with vertical graticule. Then, without touching general movement, lay successively (and in clockwise direction) on A, B, and C, finishing up on A, thus completing one revolution. Let $\alpha', \beta', \gamma'$, be the reading. If these values agree within 1 mil with the theoretical bearing angles, $\alpha, \beta, \gamma$, the instrument is correctly oriented.

If the differences are considerable take the mean $\varepsilon$ of the differences $\alpha-\alpha', \beta-\beta', \gamma-\gamma'$, and by using the general slow motion, turn the instrument so as to increase all the readings by the angle $\varepsilon$. When this is done the instrument will be oriented as correctly as possible (i. e., its readings will be true Y azimuth).

(3) **To find the declination constant of the instrument occupying a known station.**—The instrument is first oriented by the method described above. This done, free the needle by pushing safety clamp D to the left. Disengage tangent screw and roughly set compass by turning upper dial; finally adjust by tangent screw until point of needle is exactly in line with its zero mark. Read

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[1] By "gisement" (hereafter referred to as the Y azimuth) of a direction OA is meant the angle which this direction makes with the positive (y) meridian rulings. It is measured by clockwise rotation in milliemes. (6,400 mils = 360 degrees.)

off the angle. Repeat this operation three or four times and take the mean of readings K, which is carefully noted on celluloid plate provided for this purpose. It should be observed that the value K thus found only holds good for that particular instrument and within a reasonable distance from the point at which it has been determined. In changing locality the constant will have to be determined anew.

**Important.**—The declination given by the map can only be used as a rough approximation. In reality the axis of the telescope is only approximately parrallel with the line joining index marks of compass—the difference between two instruments may be as much as 20 to 30 mils.

(4) **To orient an instrument whose declination constant has been determined.**—Set up the instrument and set on dial an angle equal to K, its known declination constant. Free the needle and bring it into coincidence with its index mark by using the general movement. The instrument is then correctly oriented.

(5) **To find the bearing angle of a direction AB.**—The instrument having been set up over station A and oriented as described above (4) disengage tangent screw and lay roughly on station B, using tangent screw for final adjustment. The reading on continuous graduation will then indicate the true Y azimuth of direction AB.

(6) **To measure a horizontal angle.**—Lay successively on two points as described above and subtract readings obtained of their respective Y azimuth (5). If it is desired to measure only one angle it will not be necessary first to orient the instrument, the operation being simplified as below:

Set the zero line of the continuous graduation in line with index mark by using relative movement. Lay on the left-hand point by using general movement, then lay on right-hand side point using relative movement. The angle required will then be given on continuous graduation.

(7) **To measure the sight angle of a given station.**—Set up the instrument, lay on the station getting its image to fall on the site

angle scale of the micrometer. Bring the bubble of the upper level in the centre of its run. Read site angle on micrometer taking note of sign.

(8) **To take a range by means of a 2 metres ranging rod.**—Place the rod vertically at the station, the range of which it is desired to measure. Lay the telescope on the rod so that its image falls on the telemetric scale of the micrometer. By turning milled head U of elevation movement, bring lower sighting mark on the infinity (oo) graticule, read the range as indicated by the image of the upper sighting mark.

For ranges under 25 meters use one of the fixed sighting marks and the bolt joining the two halves of the rod, this distance being one meter. In this case the reading observed must be halved.

To get accurate results it is essential that the rod should be absolutely vertical. Working with care the possible error is about 1 meter in 100 meters. This error increases very rapidly with the range and for this reason it should not be attempted to take ranges exceeding 150 meters.

## TOPOGRAPHICAL OPERATIONS USING THE "GONIOMETRE BOUSSOLE".

### Relievement ("Three-point Problem").

By this method the position of an unknown point is determined by observing from that point at least three other points whose position is marked on the map.

The "relevement" method can be used when the declination constant of the instrument is known either exactly or approximately. In both cases the telescope is first laid successively and in clockwise rotation on the known points, starting and finishing at a definite point. The difference between the "starting and finishing" readings on the same point should not exceed 1 or 2 mils.

Also the compass should be read both at start and finish. Thus a double check is obtained and a means is provided of ascertaining the declination constant of the instrument if this is not already known.

The position of the station occupied will generally be determined by graphical construction on the map or on the plotting table.

**Relevement by instrument whose declination constant is known.**—As previously explained the readings obtained in this case are the true Y azimuth. These can therefore be immediately plotted on the map by protractor. If one is sure of the declination constant and the known points are not far away, the centre of the triangle of error will be taken as the unknown. If, on the contrary, one is not absolutely certain of the constant the procedure will be as follows:

**Relevement by instrument whose declination constant has not been determined.**—The approximate (theoretical) declination is set on the instrument. In this case the reading obtained will differ from the true bearing angles by a small unknown $\epsilon$. Any of the following graphical constructions will, however, enable the deter-

mination of the unknown point, the constant $\varepsilon$ and consequently the correct declination constant K of the instrument.

**(1) Construction of "segment capables" by inverted triangles of error.**—Through each of the known points draw, by means of a protractor, a straight line in accordance with reading obtained. Mark this series of lines with the figure 1. Examination of the resulting triangle of error will indicate on which side the error lies. Starting from the known points draw a second set of lines forming with the first set an angle of a round number of mils (say 20 or 30 mils) in the desired direction (the same for all). Mark this second set of lines with the figure 2. By joining the point of intersection of two lines of the first set with the point of intersection of the corresponding lines of the second set one will get a segment capable (or more accurately its cord, which graphically can be considered as the arc). In this manner 3 or 4 segments are plotted and their point of intersection gives the position of the unknown station. Its position relative to the first set of lines gives the correction to be applied to the readings in order to convert them into true bearing angles.

NOTE No. 1.—This same correction $\varepsilon$ applied to the reading given by the compass needle gives the declination constant K of the instrument.

NOTE No. 2.—If one has not taken the precaution to set the approximate declination constant on the dial, the correction to be applied, instead of being small, would be a quantity which we will call C. In comparing the reading as given by the instrument with the bearing of the magnetic north (as indicated on the map) an approximate value of C can be obtained. Let $C_o$ be this approximate value (rounded off to the nearest 10 mils.) then:

$$C = C_o + \varepsilon$$

$\varepsilon$ being the unknown to be determined. The graphical construction will then be carried on, the position of the first set of lines being determined by the readings of the instrument increased by $C_o$.

(2) **Relevement by Italian method.**—Suppose readings $\alpha$, $\beta$, $\gamma$ of the known points have been obtained. Let *a*, *b*, *c* represent the corresponding points set out on the plotting table or the map. From *a* draw *a* line making an angle $\alpha$ (in clockwise rotation) with *ab*. Similarly from *b* draw line making an angle $\beta$ with *ba*. Let *y* be the point at which they intersect. Join *yc* and measure its bearing angle. Compare with reading $\gamma$ on C as given by instrument and deduce from it the Y azimuth of the zero position. Convert all the readings into true Y azimuths by adding this correction and complete graphical construction as in the case when the declination constant has been pre-determined.

(3) **Employment of tracing paper.**—This method can be used when the number of known points is at least four. Spread a sheet of tracing paper on the plotting table and lay out from any point O the directions O A, O B, O C, O D, etc., as determined. Then move the paper so that the lines representing these directions pass through the points *a*, *b*, *c*, *d* of the plotting table. Prick through the point O, which then coincides with the unknown point. This method is extremely simple and gives good results when carefully carried out.

## INTERSECTION AND RESECTION.

These operations can be performed by laying out either the angles, as measured by instrument whose declination constant is unknown, or the the true bearings as indicated by instrument of known declination. Plotting is done by protractor.

## CHEMINEMENT (TRAVERSING).

"Cheminement" consists in determining all the vertices of a polygon by determining successively the direction and length of each of its sides. The start is always made from a known point and the finish should be made on a known point other than the first. The directions are determined by means of an instrument whose declination constant is known and which will consequently indicate true bearing angles, or by measuring the angles of the polygon with an instrument whose declination constant is unknown.

The lengths are measured by using the telemetric scale (see fig. 3) or by means of a 20 meters chain if great accuracy is desired. In this case the number of sides of the polygon should be limited as far as possible while increasing their length—especially if one proceeds at the same time to determine the directions by measuring the angles of the polygon.

**"Cheminement" using instrument whose declination constant is known.**—Only every other vertex of the polygon is used as a station point and the instrument is oriented at every station by means of its compass. When using an instrument, whose declination constant is not exactly known, the same procedure can be adopted if it is possible to sight on two or three distant points whose position is accurately known. By laying on these auxiliary points the orientation of the "cheminement" can be rectified.

**"Cheminement" using instrument whose declination constant is unknown.**—All the vertices of the polygon must be used as station points and the angles of the polygon measured successively. Take care to set down in note-book **not** the angles measured but the **readings themselves** on the fore-point and the back-point. Make a sketch of the cheminement while on the spot. This method is used whenever local magnetic deviations are probable.

**To measure differences in altitude.**—Differences in altitude can be measured approximately as follows: Bring the adjustable red sighting mark of the ranging pole to the same height above the ground as the telescope of the instrument, the rod being placed vertically on the point at which it is desired to measure the altitude above the station point, lay on the rod and bring the telescope level to the centre of its run by turning milled head U. Read on the mils scale the site angle, say $n$ milliemes. If D is the range in metres of the rod, then the required altitude is

$$\frac{n\mathrm{D}}{1{,}000} \text{ meters.}$$

## TRANSPORTATION.

**To put the instrument and tripod back in their cases.**—After loosening clamp C remove instrument from its tripod. Put the

instrument in its case, telescope first, the pallet of slow motion turned towards the hinge of the case. Shut lid and fasten strap. Loosen clamps of telescopic legs of the stand and push them home. Tighten clamps again, taking care to turn the legs so that the clamps will not project outwards. Place tripod in its case, legs first. Shut lid and do up fastening strap.

## UP-KEEP.

Cleaning of internal parts and dismounting of the dials or telescope are strictly forbidden. If necessary the instrument should be returned for repairs to the "Service geographique de l'Armée". External parts only can be cleaned. In cleaning a lens, never rub it with a cloth or anything which might grease or scratch the glass ; breathe on the surface and dry immediately by rubbing gently with a piece of fine dry linen which is not fluffy. Repeat this until the vapor condenses regularly and evaporates concentrically. Frequently clean the sliding tubes of the tripod with an oily rag.

## ACCESSORIES.

These include cases for stand and instrument, made of reinforced waterproof cloth and leather; a battery box for illumination of the micrometer (see Annexe III).

# ANNEXE I

## USE OF THE GONIOMETRE BOUSSOLE AS A DIRECTOR.

### PREPARATORY OPERATIONS.

**To measure a site angle.**—Slacken clamp C and lay rough on direction; tighten clamp C and adjust accurately by means of milled head S; bring the bubble of level V in the centre of its run by turning milled head U; read off the site angle of target as indicated on the mils scale (see fig. 3).

**Clearing the crest.**—From the top of the crest or the base of the cover measure the site angle of the target. Add this angle to the angle of elevation corresponding to the range of the target from the crest or cover. Place the instrument at the height of the trunnions of the guns—this being approximately realized when the vertical tube of tripod is right down. Bring the bubble of the level to the centre of its run and read off the division of the site angle scale upon which the image of the crest falls. If the angle thus obtained does not exceed the sum of the site angle of the target and the angle of elevation, the emplacement can be occupied.

**To measure the horizontal angle between two points.**—Bring the instrument to zero by turning milled head T so that zero on the lower dial coincides with index mark X on upper dial and the zero of the tangent screw drum coincides with index mark Y. Lay the instrument on the left-hand side point and afterwards on the right-hand point. Subtract second reading from first and result is the angle required.

**To measure the deflection for a given target.**—Set the instrument to zero and lay on target, then lay on the aiming point by turning milled head T. Read off the deflection as indicated by instrument —this can be expressed either as the true angle as indicated by continuous graduation (0-6400 mils) or in terms of "plateau" and "tambour" (see Annexe II).

**To lay a gun parallel to a given direction (by "reciprocal" observations).**—(1) Using gun-sights with graduation divided into 4 quadrants and with "zero position" at 1000 mils (75 mm. and 65 mm. mountain batteries). Station instrument about 50 meters from gun and lay it in the given direction (target or expected direction of fire) by using clamp C and milled head S, the instrument being set to zero. Now lay instrument on gun sight pillar and read in terms of "plateau" and "tambour" the deflection which must be given to the gun (see Annexe II). Lay the gun with this deflection on the centre of the instrument (if the central sliding tube is vertical it will be convenient to lay on this tube).

(2) Using gun-sights with continuous graduation divided in 6400 mils with zero position at 0 mils. Station instrument about 50 meters from gun; set the instrument at 3200 mils and lay on the given direction by using clamp C and milled head S. Lay the instrument on gun-sight pillar using milled head T; read off the angle as indicated by continuous graduation. Lay the gun with this deflection on the centre of the instrument.

(3) Using gun-sights with graduation in two halves divided in 3200 mils in the same direction and with zero position at 1000 mils. Station instrument about 50 metres from gun; set the instrument at 4200 mils and lay on the given direction, using clamp C and milled head S. Lay the instrument on gun-sight pillar using milled head T; read off the angle as indicated by instrument. Subtract 3200 if the reading obtained is greater than or equal to 3200. Lay the gun with this deflection on the centre of the instrument.

**When two instruments are available.**—In this case it is possible to lay the gun parallel to the first instrument, occupying a station invisible from the battery. The second instrument is set up near the battery and both are oriented. The first instrument is then laid on the given direction and the second laid parallel to this direction (by giving it the same angle, as indicated by the first instrument). The gun is then laid parallel to the second instrument.

## DIRECTION AND CONTROL OF FIRE.

**To determine the height of burst.**—Make use of the site angle scale of the micrometer, divided every 5 mils.

**Correction of deflection.**—The instrument being laid in direction of target, bring the point of burst on the vertical graticule of micrometer by turning milled head T—the deflection of gun must be increased (or diminished) by the angle by which the instrument reading has increased (or diminished).

**Change of target.**—The instrument being laid on the first target, direct telescope on the new target by turning milled head T. The deflection of the gun must be increased (diminished) by the angle by which the instrument reading has diminished (increased).

# ANNEXE II

**To read deflection in terms of "plateau" and "tambour".**—When the goniometre boussole is used with 75 mm. batteries and set up close to the battery, by using the quadrant graduation on upper dial and the two indexes Y Z of the tangent screw drum, the commands can be given in terms of "plateau" and "tambour".

It should be noted that when the instrument is at zero, i. e., when, index X is in line with zero division of lower graduation, the reading in terms of plateau and tambour is "Plateau 0 tambour 100".

**To read in terms of "plateau".**—One quadrant of upper dial is divided into 8 sectors marked Pl-0, Pl-2, Pl-4. . . . Pl-14. As the optical axis of the telescope passes through the four quadrants of the "cercle fictif de pointage" (fig. 5) the quadrant on the upper dial passes successively over 4 arrow-shaped indexes which fall on the 0, 16, 32 and 48 marks of lower (continuous) graduation, whence the rule.

The "plateau" number is the number of the sector on which one of the indexes falls [1] (see example, fig. 5).

**To read in terms of "tambour".**—Each sector of the divided quadrant comprises a smooth and a rough portion. In reading in terms of "plateau" note in which of these two portions the index falls and read the tangent screw drum accordingly, i. e., use either reader Y on smooth ground or reader Z on rough ground. (See example, fig. 5.)

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[1] When laying a gun for direction by "reciprocal sightings" (Annexe I) the proximity of the gun renders the consideration of the quadrant useless; in this case it will be seen that the indexes of the gun-sight and the Goniometre boussole are necessarily brought into opposite quadrants.

# ANNEXE III

**The illuminating attachment** comprises a battery box containing battery, a rheostat, a switch, connecting cable and a small lamp in a mounting which can be fixed to the left telescope support. The light thus falls on the edge of the micrometer and illuminates the scale. By means of the rheostat the illumination can be varied. The lamp can also be used to facilitate the reading of angles and to illuminate the compass needle.

Spare batteries and lamps are supplied by the "Groupes de Canevas de Tir".

A pocket lamp can also be used to illuminate micrometer (by reflection) the needle and the graduations.

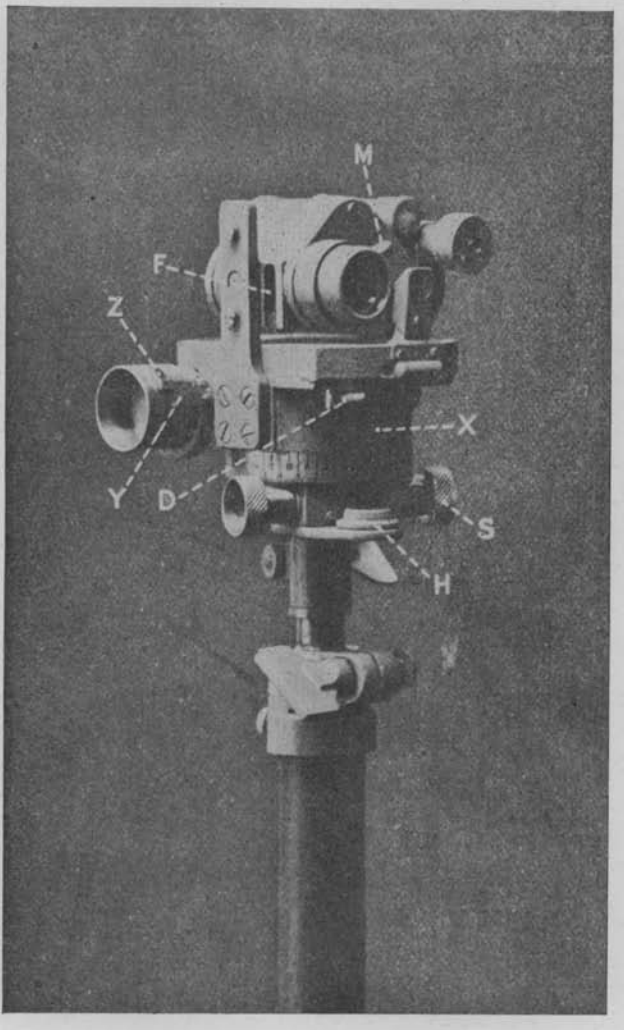



Figure 1.

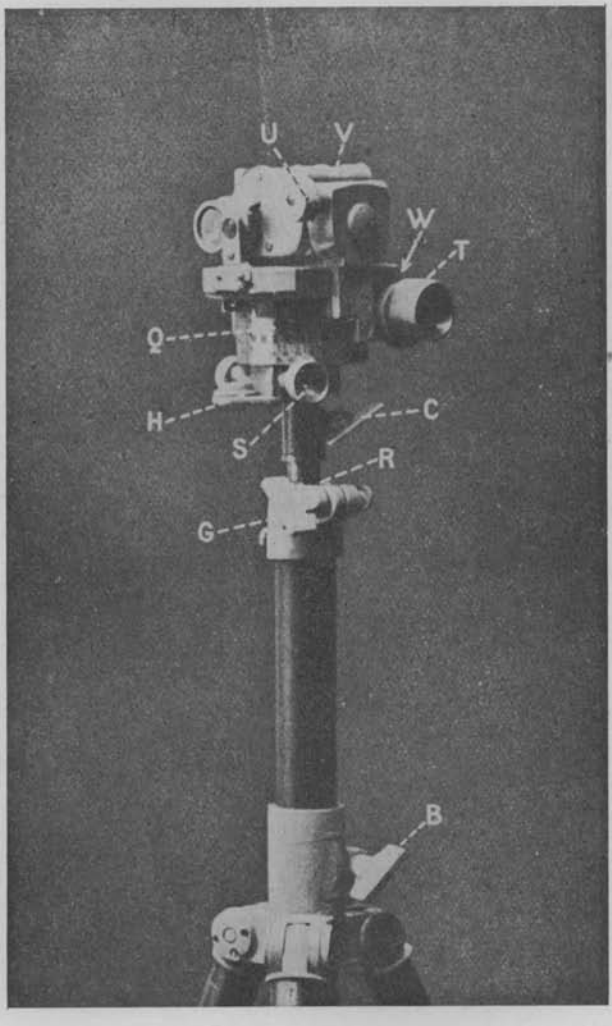



Figure 2.

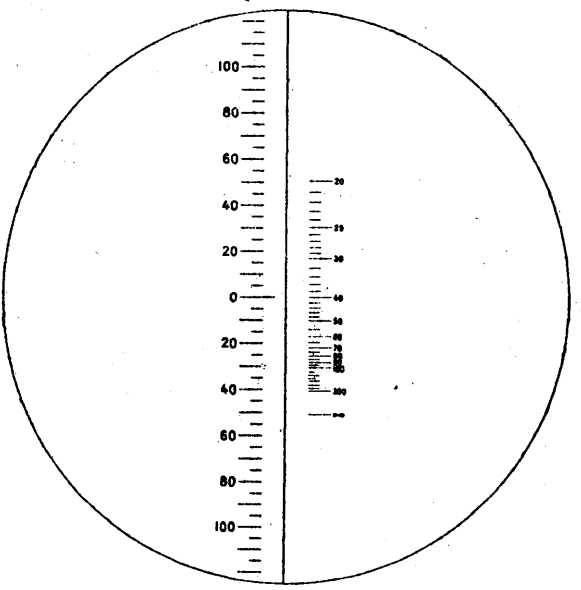



Figure 3.

MICROMETER

*The optical axis of the telescope corresponds with the point at which the vertical graticule is intersected by the zero graticule of the left-hand side scale.*

*The right-hand scale is used when measuring distances; it is graduated in meters.*

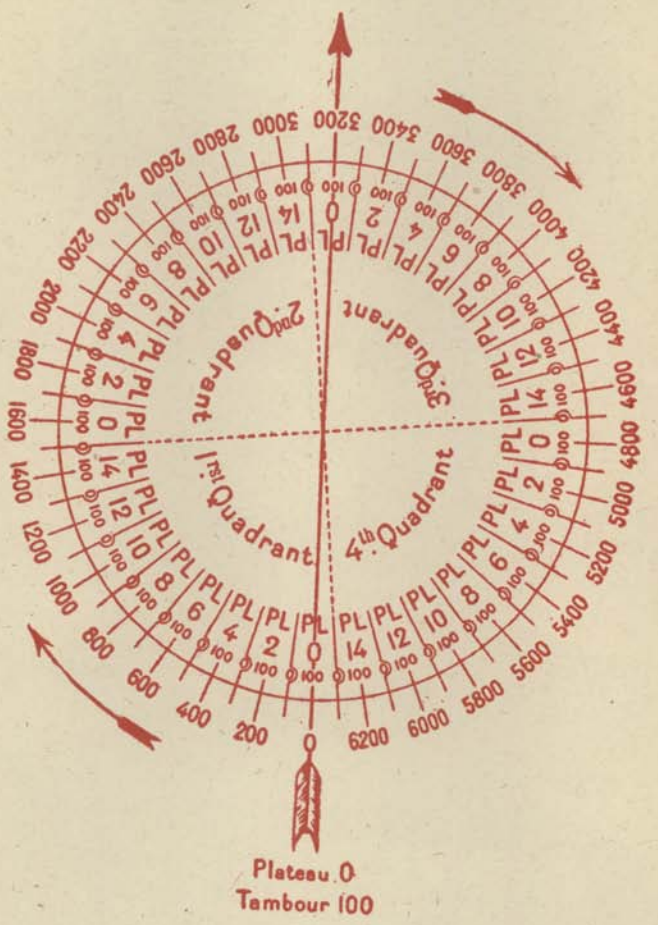



Figure 4.

## CERCLE FICTIF DE POINTAGE

(THEORETICAL SIGHT DIAL)

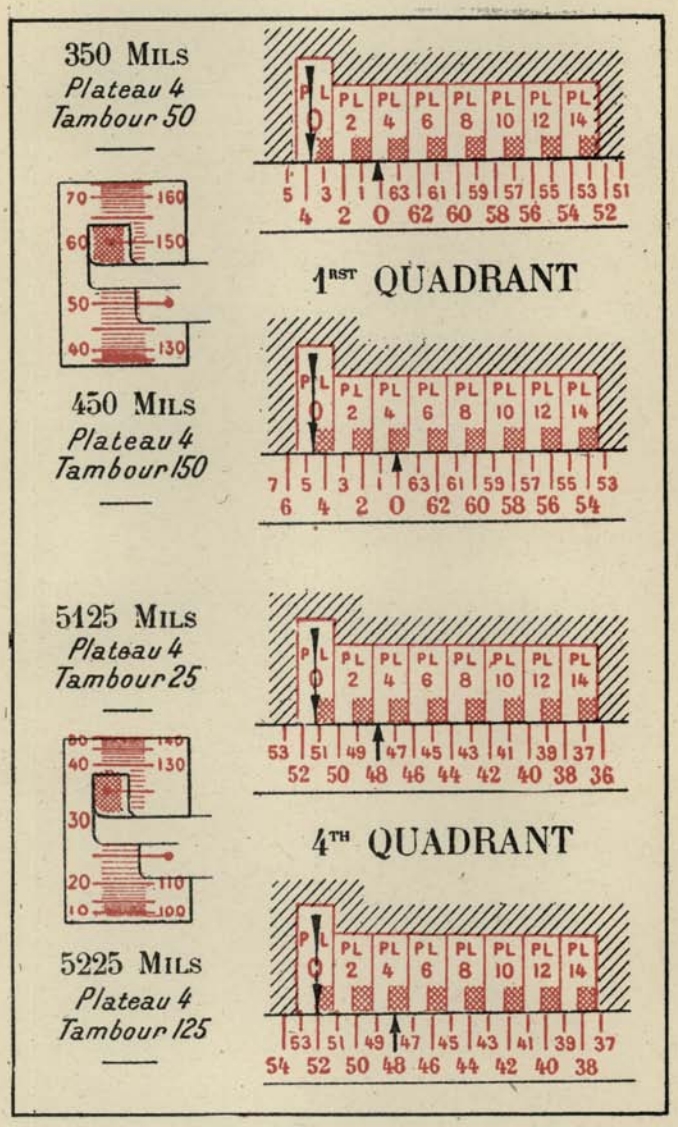

350 MILS
Plateau 4
Tambour 50
70
160
60
150
50
40
130
450 MILS
Plateau 4
Tambour 150
5125 MILS
Plateau 4
Tambour 25
40
130
30
20
110
10
100
5225 MILS
Plateau 4
Tambour 125
PL 0
PL 2
PL 4
PL 6
PL 8
PL 10
PL 12
PL 14
5 3 1 63 61 59 57 55 53 51
4 2 0 62 60 58 56 54 52
1RST QUADRANT
7 5 3 1 63 61 59 57 55 53
6 4 2 0 62 60 58 56 54
53 51 49 47 45 43 41 39 37
52 50 48 46 44 42 40 38 36
4TH QUADRANT
53 51 49 47 45 43 41 39 37
54 52 50 48 46 44 42 40 38

Figure 5.