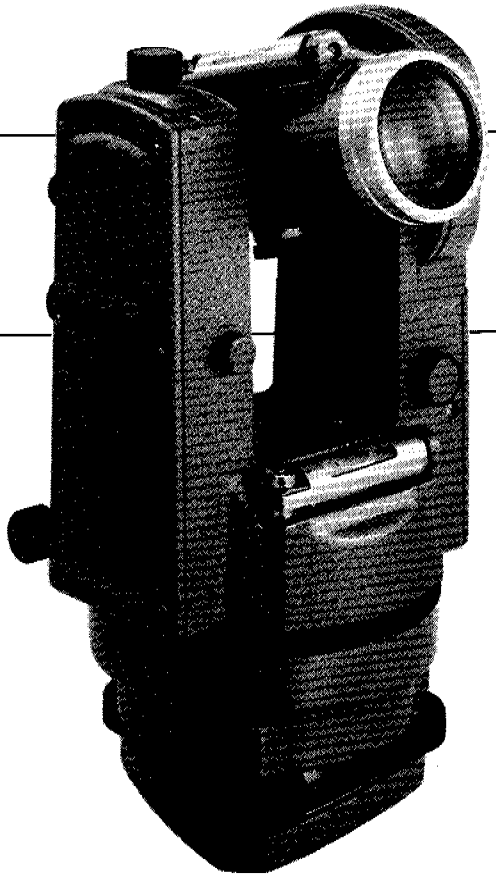
THEODOLITE



FX-1

INSTRUCTION BOOK

ASAHI PRECISION CO., LTD.

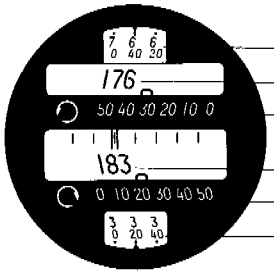
★ The telescope incorporates the annalactic optical system which assures a straight line of sight at all time.

★ The focussing marks on the focussing knob clearly show the rotating direction and distances. These marks facilitate focussing.

★ Simultaneous reciprocal clockwise and counter-clockwise reading of horizontal circle eliminates troublesome calculation and error.

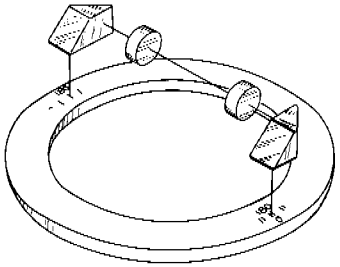
★ No more counting of horizontal graduation lines. Direct reading of horizontal circle in figures can be made down to 20 seconds. Estimation can be made down to 5 seconds.

★ Readings of horizontal circle can be made with the aid of microscope alongside the telescope without changing the posture of sighting an object through the telescope.



COUNTER-CLOCKWISE READING
Numbers for single minutes & full 20 seconds.
Number for full degrees.
Number for full 10 minutes.

CLOCKWISE READING
Number for full degrees.
Number for full 10 minutes.
Numbers for single minutes & full 20 seconds.



★ Optical system is designed so that the minutes and seconds obtained are the mean of the readings two diameteric sides of the circle to eliminate errors of circle eccentricity.

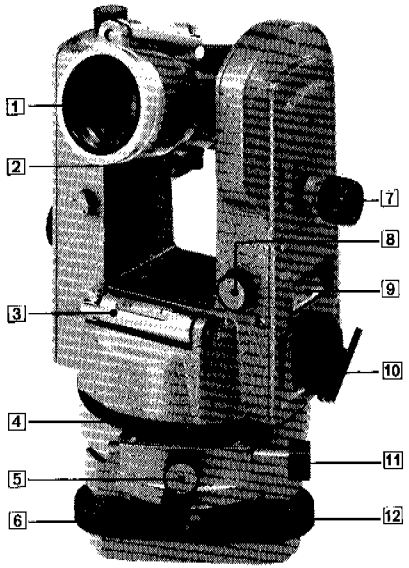
★ The combination of shifting mechanism for centering and optical plummet provides the fastest and most accurate means for setting up over a given point.

★ The vertical graduated circle is a 0—90° compass scale. When the line of sight of telescope is horizontal, the reading is 0. Direct vertical angle measurement without calculation.

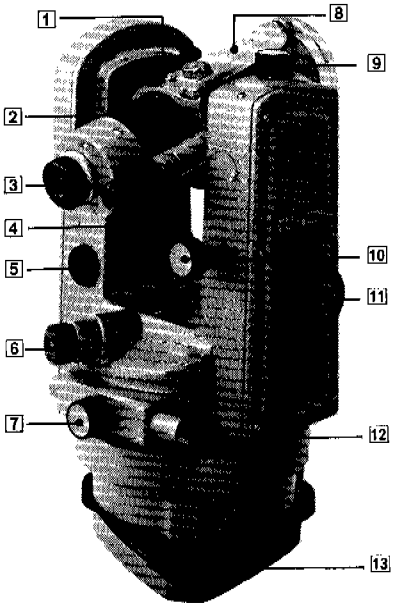
★ The collimator on telescope aids preliminary sighting of a point.

★ Since the vertical axis is an independent type double axis, high precision angle measurement by repetition is possible.

★ A lighting device, long elbow eyepiece and prism refconverter are available as optional accessories.



1. Objective lens
2. Reticle illumination knob
3. Plate level A
4. Horizontal circle rotation ring
5. Lower clamp screw
6. Centering clamp lever
7. Vertical circle reading magnifier
8. Compass clamp screw
9. Plate level B
10. Circle reflector
11. Lower tangent screw
12. Leveling screw



1. Collimator
2. Focussing knob
3. Telescope eyepiece
4. Horizontal circle reading magnifier
5. Compass
6. Optical plummet eyepiece
7. Upper clamp screw
8. Telescope spirit level
9. Telescope clamp screw
10. Telescope tangent screw
11. Optical micro-meter knob
12. Upper tangent screw
13. Bottom plate

SPECIFICATION

TELESCOPE

Type	Internal focussing anallactic optics Coated lenses are used
Image	Erect
Magnification power	28×
Effective aperture	40mm
Field of view	1° 20′
Minimum focus	1.5m
Stadia	Ratio 1 : 100; additional constant, 0

HORIZONTAL CIRCLE

Diameter	90mm
Graduation	1°
Graduation of microscale	20″

VERTICAL CIRCLE

Diameter	70mm
Graduation	30′
Vernier	Reads to 1′

SENSITIVITIES OF SPIRIT LEVELS

Telescope spirit level	60″ per 2mm
Plate level A	90″ per 2mm
Plate level B	60″ per 2mm

OPTICAL PLUMMET EYEPIECE

Image	Erect
Magnification power	2×
Field of view at height of 1.4m	150mm ϕ

CENTERING DEVICE

Type	Adjustment by loosening centering clamp lever
Range of shifting	16mm ϕ

COMPASS

Built-in bar type (N-indicating type)
Needle, 50mm

TRIPOD

2 × 35mm threads

DIMENSIONS

Instrument	262mm × 176mm × 168mm
Case	250mm × 236mm × 346mm

WEIGHT

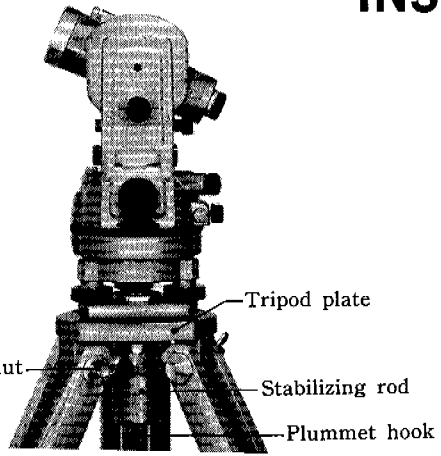
Instrument	4.5 kg.
Case	1.9 kg.

ACCESSORIES

Plastic case, objective lens cap, lens-hood, adjusting pins, screwdrivers, brush, plummet.

INSTRUCTIONS Preparation for Surveying

Fig. 1



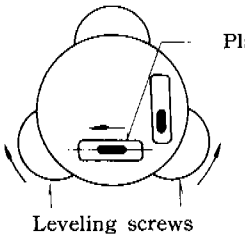


Fig. 2A

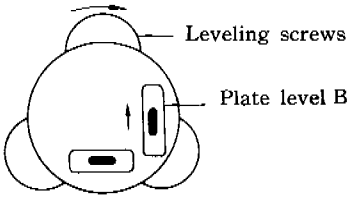


Fig. 2B

1. Installing Tripod

1. Use tripod for FM-1 & FG with tripod plate 2mm × 35mm threads.
2. Fasten all three legs of the tripod securely with the wing nuts.
3. First adjust the length of each leg and fasten the intermediate wing nuts tightly. Open out the tripod legs and stick them firmly into the ground. Make sure the tripod plate is as level as possible and that its center is directly over the station.

2. Attaching Theodolite

1. Set the theodolite on the tripod plate. Screw the stabilizing rod into the tripod screw on the theodolite and loosely tighten.
2. Pass the plummet hook through the center hole in the stabilizing rod and hook it over the loop on the bottom of the theodolite. Adjust the length of the string and suspend the plummet.
3. Move the theodolite by pushing the bottom plate with the fingertips. When the tip of the plummet coincides with the station, tighten the stabilizing rod securely.

3. Leveling

1. Place the plate level A parallel with a line joining any two of the leveling screws. Then, by adjusting the two screws, position the bubble in the center of the level. (see Fig. 2A).

   (Turn each of the two leveling screws in diffrent directions.)

Fig. 3

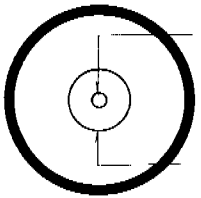
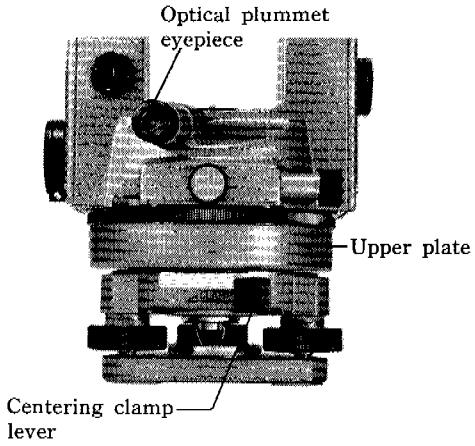


Fig. 4



2. Adjust the remaining leveling screw so that the other bubble comes to the center of the plate level B. (see Fig. 2B.)
3. Check that both bubbles are in the center of the plate levels. If they are not, re-adjust the leveling screws as explained in (1) and (2) above.
4. Rotate the theodolite 180° about its vertical axis and check that the bubbles do not move from the center. If the bubbles move from the center, the above adjustment of the plate levels is necessary.

4. Centering

1. First remove the plummet or wind the string around the tripod. Look through the optical plummet eyepiece and rotate the eyepiece knob until the center marks can be clearly seen.
2. Release the centering clamp lever by pushing it to the right. Look through the optical plummet eyepiece and push the upper plate with the fingertips until the center marks are aligned with the station.
3. Fasten the clamp lever by pushing it firmly to the left, so that it securely locks the centering system.
4. Check that the bubbles are in the center of the plate levels. If they are not, adjust with the leveling screws.

Note

* When instrument height is 1.4m, the size of the center mark large circle corresponds to 50mm ϕ and that of the small circle to 5mm ϕ.
* Even if the bubbles are found to have moved by one graduation in (4) above, this represents a deviation in centering of only 0.5mm at instrument height of 1.4m and has virtually no effect on actual observations.
* The optical plummet is designed so as to focus on the station

at the normal instrument height of 1.4m, but the depth of field makes focussing possible at instrument heights of from 0.9 to 3m.

* Before centering, first release the centering clamp lever and position the lower tangent screw so that it can easily be operated.

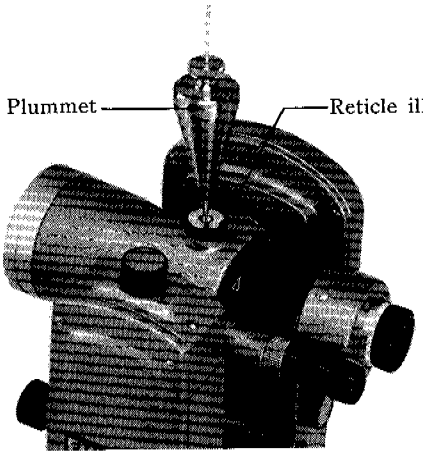
5. Centering on an Overhead Station

1. Suspend the plummet from the overhead station. Set up the tripod and theodolite beneath it and level the instrument.
2. Turn the telescope upside down and set the reading on the vertical circle to 0.
3. Release the centering clamp lever by pushing it to the right. Push the upper plate with the fingertips until the center mark on the reticle illumination knob coincides with the tip of the plummet.
4. Fasten the clamp lever by pushing it firmly to the left.
5. Check that the bubbles are in the center of the plate levels. If they are not, adjust with the leveling screws.

6. Leveling Adjustment

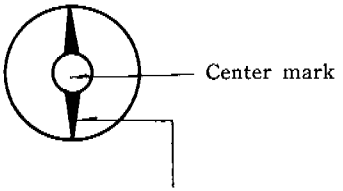
Where surveying of very high precision is required, adjust leveling of the instrument as follows after centering.

1. Place the plate level A parallel with a line joining any two of the leveling screws. Then by adjusting the two screws, position the bubble in the center of the level.
2. Rotate the instrument 90° about its vertical axis and adjust the remaining leveling screw so that the bubble comes to the center of the level again.
3. Again rotate the instrument 90° about its vertical axis and repeat 1 and 2 so that the bubble do not move from the center.



(A)

Fig. 5



(B)

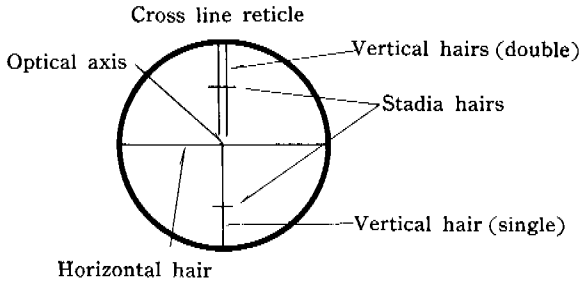


Fig. 6

1. Eyepiece Adjustment

1. Remove the telescope lens cap, and attach the lenshood, if necessary.
2. Point the telescope at a bright, unmarked surface or at the sky. Rotate the eyepiece knob to the left and temporarily pull out the eyepiece.
3. Look through the eyepiece and rotate the eyepiece knob to the right until the reticle appears at its maximum sharpness.

Note

* Unless the eyepiece is adjusted accurately for the observer's eyesight, and the objective is also accurately focussed, parallax may impair the accuracy of the work.

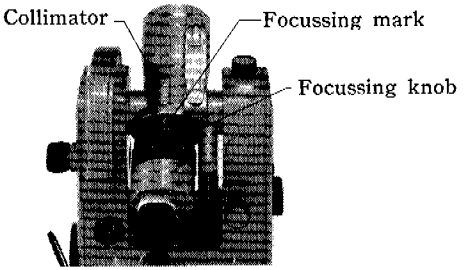


Fig. 7

2. Object Sighting

1. Point the telescope at the object using the collimator. Tighten all clamp screws.
2. Rotate the focussing knob and set the focussing mark corresponding to the object distance to the collimator.
3. Look through the eyepiece and finally adjust the focusing knob until the object is perfectly focussed. If focussing is correct, the object and the reticle should be clearly observed even when you move your eyes left and right when looking through the eyepiece. If they appear to move, adjust the focus by rotating the eyepiece focussing ring back and forth while making small adjustments with the objective focussing pinion until all apparent motion is eliminated.

4. Finally move the tangent screws and align the reticle with the object.

Note

* The focussing marks comprise an infinity mark and three triangular marks. The tip of each triangle shows the distance, smaller triangles indicating greater distance.

∞ △4m △2m △1.5m

* When focussing is made on an object with the tangent screw, always focus by rotating the screw clockwise. To correct unfocus due to overshooting the screw, once return the screw counter-clockwise to a larger extent and align the reticle with the object by turning the screw clockwise.

* Even when not focussing for reading the vertical circle, focus the object around the optical axis. For focussing a bigger object, align it between the double vertical hairs. (Fig. 6)

* The clamp and tangent screws for the operation 1 and 4, use the lower clamp and lower tangent screws for focussing of the first object, and use upper clamp and upper tangent screws for focussing of other objects than the first.

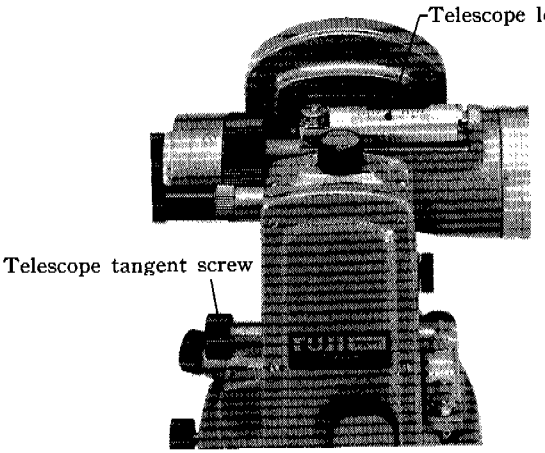


Fig. 8

3. Horizontal Sighting

When performing horizontal sighting in direct leveling and in setting up horizontal surfaces, first level the instrument, then center the telescope bubble with the telescope tangent screw.

* Whenever the telescope is rotated for sighting a new object, be sure that the bubble is in the center of the telescope level. If it is not in the center, center it with the telescope tangent screw.

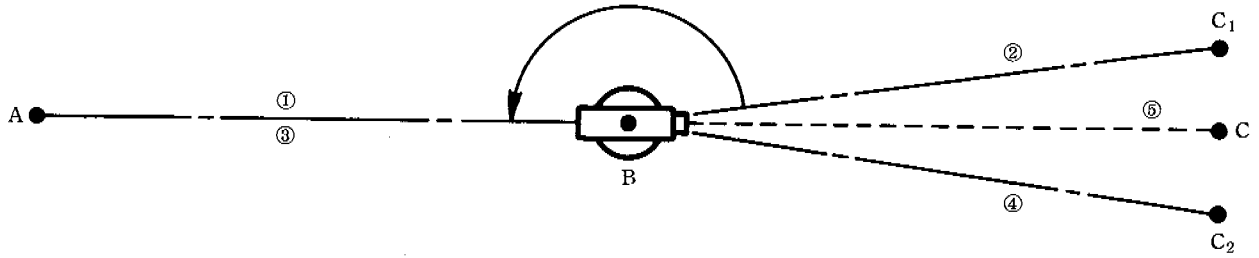


Fig. 9

4. Setting Up Straight Lines

A line joining points collimated to an object, near or distant, is a straight line. This fact is applied to setting up of straight lines. Setting up a point C on the straight line A and B is carried out as follows.

1. Set up the instrument at the point B on the straight line and level it. Then, collimate the point A.

2. Loosen the telescope clamp screw and reverse the telescope on its elevation axis. Set a point on the line of sight and call it point C_1. Tighten the telescope clamp screw.

3. Loosen the upper clamp screw and rotate the instrument about its vertical axis and sight the point A again. Tighten the upper clamp screw.

4. Loosen the telescope clamp screw and reverse the telescope on its elevation axis again. Set a point on the line of sight and call it point C_2.

5. Set the point C in the center of line C_1 and C_2. This is the requested point C that is on the straight line A and B.

* For the extension of the straight line for a long distance, separate distances AB and BC so as to be 100m each, and repeat the above instruction.

5. Setting Up Vertical Planes

When the instrument is leveled and the telescope rotated about its horizontal axis, the line of sight generates a vertical plane, and a vertical plane can thus be set up. Setting up the point B on the perpendicular at the point A is carried out as follows.

1. Set the instrument on the point P at a distance, same to or longer than AB. Level the instrument and collimate the point A.
2. Loosen the telescope clamp screw. Point the telescope upward at the same angle as point B and set a point on the line (Point B_1).
3. Move the instrument to the point P′ which is at right angle against the line AP and at the same distance to AP. Level the instrument and collimate the point A again.
4. Loosen the telescope clamp screw, and point the telescope upward at the same angle as point B and set a point on the line (Point B_2).
5. Set the point B at the crossed point of the extended lines of B_1 and B_2. This is the requested point B, and the line joining A and B is perpendicular.

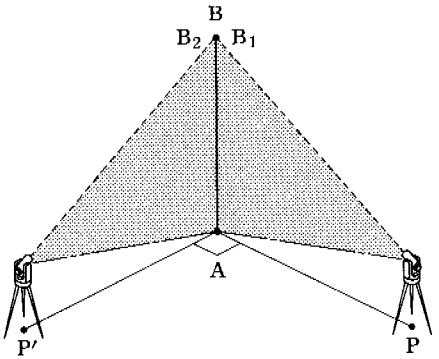
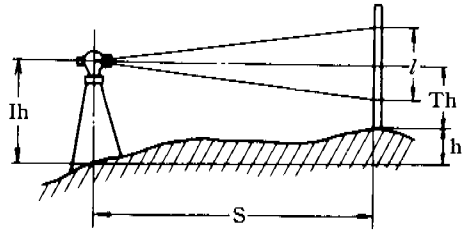


Fig. 10

* When collimating the point A in 1 and 3 above, be sure that the bubble is in the center of the plane level A. If it is out ot the center, collimate the point A after centering the bubble by adjusting with leveling screws.

  Where more precise result is required, repeat above 1, 2 and 3, 4 process respectively using the telescope in normal and reverse positions. And set B_1 and B_2 at the centers of points obtained by using the telescope in normal and reverse positions.

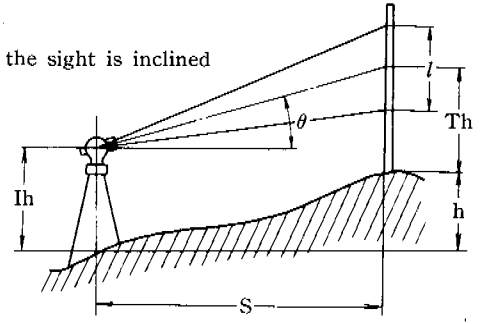
When the sight is horizontal



$S = 100l$
$h = Ih - Th$

Fig. 11

When the sight is inclined



(If Ih=Th)
$S = 100l \cos^2\theta$
$h = 50l \sin 2\theta$

Fig. 12

6. Stadia Surveying

Stadia provides a method of measuring distance and difference in elevation by merely sighting a rod.

* Calculations are straightforward since the stadia addition constant is 0.

S : Horizontal distance

h : Difference in elevation

l : Difference in top and bottom stadia hair readings

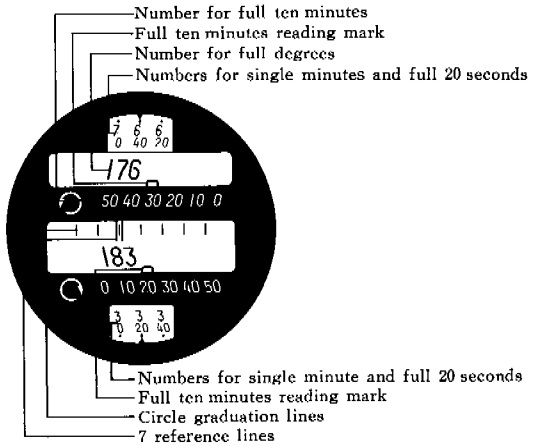
θ : Vertical angle

Ih : Instrument height

Th : Line of sight reading

ANGLE MEASUREMENT

Fig. 13



1. Reading Horizontal Circle

1. Open the circle reflector and look through the horizontal circle reading magnifier and adjust the position of the circle reflector so that circle graduations are most brightly seen.

2. Look through the circle reading magnifier and rotate its eyepiece knob so that circle graduations appear most clearly.

3. Turn the optical micro-meter knob until one of the 7 reference lines in the center of view comes to the center of two graduation lines. Now you simply read numbers.

NOTE: ※ Choose the nearest reference line either on the right or left of the graduation lines for the step 3.

※ Read the numbers for the step 3 as follows.

A. For counter-clockwise reading.

Read numbers in upper half part of the circle.

1. The number for the full degrees	176°
2. The number for the full ten minutes	30′
3. The number for the single minute	6′
4. The number for the full twenty seconds	40″
Circle reads	176° 36′ 40″

B. For clockwise reading.

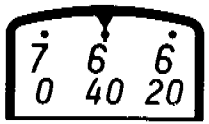
Read numbers in down half part of the circle.

1. The number for the full degrees	183°
2. The number for the full ten minutes	20′
3. The number for the single minute	3′
4. The number for the full twenty seconds	20″
Circle reads	183° 23′ 20″

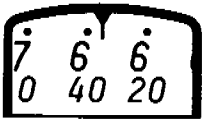
For the full ten minutes, read the number indicated by ∩ mark.

Optical system is designed to read two diametric sides of the circle. So, you may obtain the means of reading of the minutes and seconds of two sides at a time.

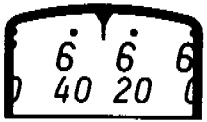
Fig. 14



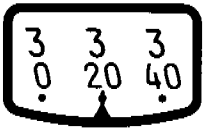
(6′ 40″)



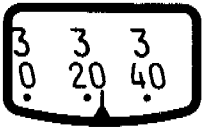
(6′ 40″ or 6′ 35″)



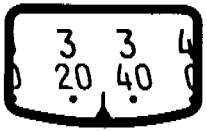
(6′ 30″)



(3′ 20″)



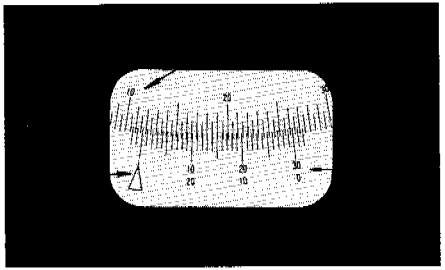
(3′ 20″ or 3′ 25″
by estimation)



(3′ 30″)

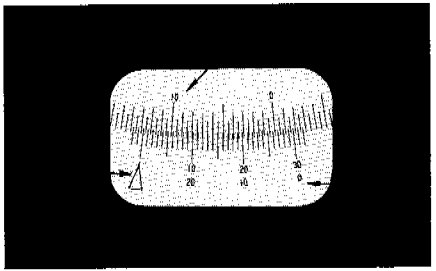
C. How to read the single minute and the full 20 seconds.

Fig. 15



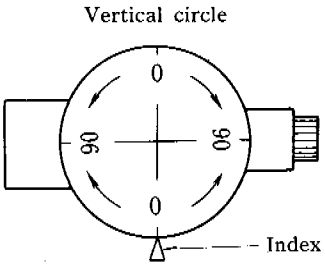
Vertical graduated circle
Regular scale reading 11° 30′
Vernier scale reading + 14′
11° 44′

Fig. 16



Vertical graduated circle
Regular scale reading 12° 30′
Vernier scale reading 16′
12° 46′

Fig. 17



2. Reading Vertical Circle

1. Read off in graduated units the reading on the regular scale indicated by the △ index on the vernier scale. (In Fig. 15, 11° 30′; in Fig. 16, 12° 30′.)
2. Read along the regular scale (in the direction of higher numbers) and read off the reading on the vernier scale which is most closely aligned with the regular scale. (In Fig. 15, 14′; in Fig. 16, 16′.)
3. Add the readings of the two scales together to obtain the final reading. (In Fig. 15, 11° 30′+14′=11° 44′; in Fig. 16, 12° 30′+16′=12° 46′.)

Note

* The vertical graduated circle is a 0 -90° -0 -90° -0 compass scale. When the line of sight of the telescope is horizontal, the reading is 0 (see Fig. 17)

	Left rotation	0	Right rotation
Telescope (normal)	Angle of elevation	Horizontal	Angle of depression
Telescope (reversed)	Angle of depression	Horizontal	Angle of elevation

3. Setting Horizontal Circle

1. Loosen the upper and lower clamp screws. Turn the circle rotating ring so that the circle number corresponding to the desired angle comes to the circle number setting slot.
2. Look through the reading magnifier and set the number for the desired full degrees, and tighten the upper clamp screw.
3. Turn the optical micro-meter knob and set the numbers of the desired single minutes and the full twenty seconds.
4. Turn the upper tangent screw and set the number of the full ten minutes to the ∩ mark.
5. Point the telescope at the first object and tighten the lower clamp screw. Collimate precisely to the object by turning the lower tangent screw.

   If the other objects are set with the upper clamp screw and upper tangent screw alone, angle measurement from the first object can be carried out.

Note

* Numbers on the circle rotation ring are in 10° units divided to 30°.

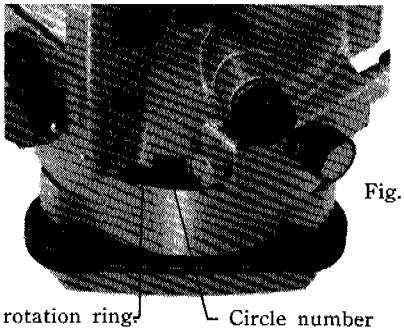


Fig. 18

4. Angle Measurement by Repetition

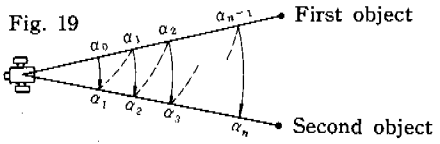
Since the vertical axis of this instrument is an independent type double axis, high precision angle measurement by repetition method is possible.

1. Point the telescope at the first object and set correctly with the lower clamp screw and lower tangent screw. Note down the reading on the horizontal circle.
2. Loosen the upper clamp screw and point the telescope at the second object. Set correctly with the upper clamp screw and upper tangent screw, and note down the reading on the horizontal graduated circle.
3. Loosen the lower clamp screw and repeat from (1).
4. Each time steps (1) and (2) are repeated constitutes one repetition. Determine angle α made by the first and second objects from the following formula:

$$\alpha = \frac{\alpha n - \alpha o}{n}$$

αo : First reading at step (1)
αn : Last reading at step (2)
n : No. of repetitions

Fig. 19



Note

* The number of repetitions is normally a multiple of 3.
* It is sufficient to record only the first αo and the last αn readings on the horizontal graduated circle, but recording each separate reading for step (2) makes checking for intermediate errors possible.

* If the repetition method is repeated with the telescope in the normal and reversed positions, results of very high precision can be obtained.

5. Setting Up Horizontal Angles

When setting up a fixed angle from a set point in civil engineering and other works, first set the horizontal circle at an arbitrary angle near 0° and then proceed as follows:

1. Point the telescope at the set point and set correctly with the lower clamp screw and lower tangent screw. Read off the horizontal graduated circle.
2. Determine the set angle for the horizontal circle by adding the fixed angle to the reading at the set point.
3. Loosen the upper clamp screw and rotate the support so that the circle number corresponding to the set angle comes to the horizontal circle reading magnifier.
4. Look through the reading magnifier and set the number for the full degrees for the set angle. Tighten the upper clamp screw.
5. Turn the optical micro-meter knob and set the numbers of single minutes and the full twenty seconds for the desired set angle.
6. Turn the upper tangent screw and set the number of the full ten minutes for the set angle to the ∩ mark.
7. Now look through the telescope. Make the point of focus and take it as the new set point.

6. Measuring Compass Angles

When the compass needle is set between the two lines in the compass indicator, the telescope is always set to magnetic north, and measurement or setting up of compass angles can be performed.

Compass angles are measured as follows:

1. Set the horizontal graduated circle at an arbitrary position near 0.
2. Rotate the magnetic needle clamp knob to free the needle.
3. Loosen the lower clamp screw and rotate the instrument about its vertical axis. Find the position where the needle comes to the compass indicator lines.
4. Tighten the lower clamp screw. Position the needle in the center of the two compass indicator lines with the lower tangent screw.

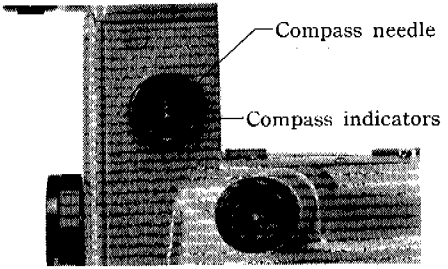


Fig. 20

5. Read off the horizontal circle. Take this reading as magnetic north.
6. Loosen the upper clamp screw and point the telescope at the object station. Set correctly by means of the upper clamp screw and upper tangent screw.
7. Read off the horizontal circle and find the difference from the reading obtained in (5). Take this as the compass angle of the object.

Note

* The magnetic needle clamp knob may be turned either to the left or right. The needle is locked and freed alternately at each click stop.
* When finding true north angles, local magnetic deviation must be corrected.
* After using the compass, always turn the needle clamp knob to lock the needle.

MAINTENANCE AND PACKING

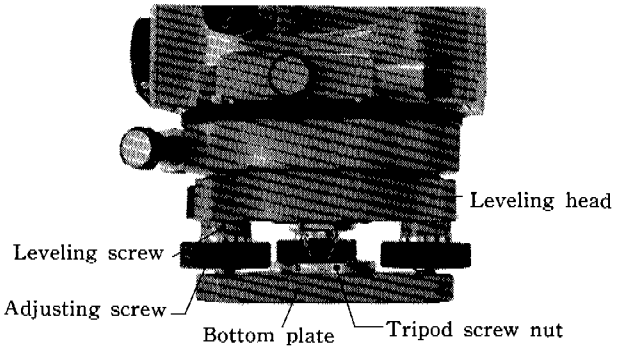


Fig. 21

1. Maintenance

1. After using the instrument, wipe off dust and moisture and store it in the case.

2. When cleaning exposed parts, first remove dust with the cleaning brush, then wipe with a soft cloth.

3. To clean the lens surfaces, first remove dust with the cleaning brush, then gently wipe with a clean cotton cloth to which a small amount of alcohol has been applied. Be sure the cloth used is not oily or sticky.

4. If the leveling screws are loose and leveling unstable, adjust by tightening with a screwdriver the two adjusting screws attached to each leveling screw.

5. If looseness arises between the leveling screws and the bottom plate, loosen the set screw for the tripod screw nut, and tighten the tripod screw nut as required with the adjusting pin. After adjustment, retighten the set screw.

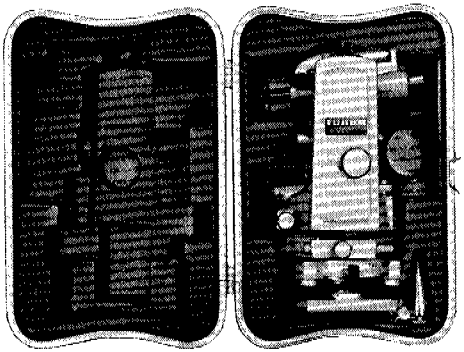


Fig. 22

2. Packing

Pack the instrument in the plastic case as follows.

1. Loosen all clamp screws and the centering clamp lever. Align the optical micro-meter knob, lower clamp screw and centering clamp lever, and place the telescope horizontally.

2. With lower clamp screw facing upwards, gently insert the instrument in correctly into the case. When the instrument correctly positioned in the case, tighten the clamp screws and lock the centering clamp lever.

3. Close the lid and lock the clamp.

PRECAUTIONS DURING USE

* For high precision surveying, shade the instrument and tripod from direct sunlight.
* Except when illuminating the cross hairs, always set the cross hair illumination knob indicator (see Fig. 5) parallel to the telescope.
* Be careful not to subject the instrument to shocks or vibration during carriage.
* Should dirt, etc., appear inside the lens, never attempt to disassemble the instrument yourself. Consult an expert.
* Should faults arise as result of dropping the instrument or other accidents, never force the parts or disassemble yourself. Have it repaired by an expert.
* Always make sure that there are no faults in the tripod.

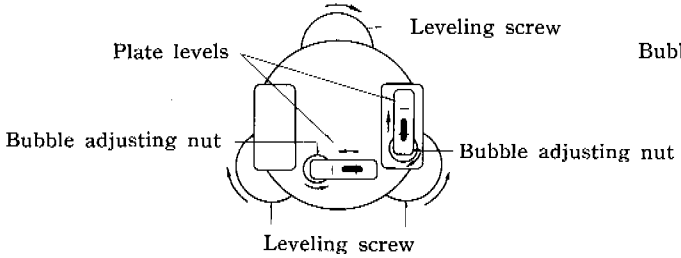


Fig. 23

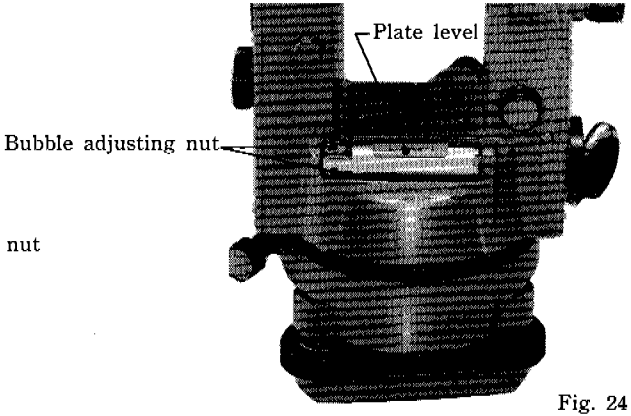


Fig. 24

1. Perpendicularity of Plate Levels to Vertical Axis

1. Attach the instrument to the tripod and aline the plate level A parallel with a line joining any two of the leveling screws. Then, by adjusting the two screws, center the bubble in the level.
2. Adjust the remaining leveling screw so that the other bubble comes to the center of the level B.
3. Repeat (1) and (2) until both bubbles are in the center of the plate levels.
4. Loosen the upper clamp screw and rotate the instrument 180° about its vertical axis.
5. If the bubbles move from the center of the plate levels, adjust as follows: bring them halfway back to the center by adjusting the leveling screws, then correct the remaining half by turning the bubble adjusting nuts with the adjusting pins.
6. Again turn the instrument 180° about its vertical axis and check that the bubbles do not move from the center. If they are found to have moved, repeat the adjustments in (5).

Note

* When adjustment for the plate level B is necessary, adjust after removing the vertical circle side support cover.

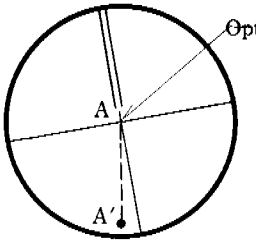


Fig. 25

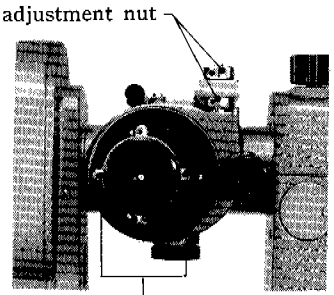


Fig. 26

2. Inclination of Telescope Reticle

1. Set object point A on the line of sight and tighten all clamp screws.
2. Move point A to the edge of the field of view with the telescope tangent screw (point A′).
3. If point A moves along the vertical hair of the reticle at this time, no adjustment is needed. If it moves away from the vertical hair, remove the eyepiece cover and adjust as follows.
4. Loosen the four eyepiece attachment screws with a screwdriver. Rotate the whole eyepiece around the line of sight and align the vertical hair of the reticle with point A′.
5. Tighten the eyepiece attachment screws. Repeat (1) and (2) and check that adjustment is correct.

3. Perpendicularity of Line of Sight to Horizontal Axis

1. Sight a well defined object point A 30—50m away from the instrument.
2. Loosen the telescope clamp screw and reverse the telescope on its elevation axis. Mark a point set on the line of sight at a similar distance to object point A, and call it point B.
3. Loosen the upper clamp screw and rotate the instrument about its vertical axis. Again sight on point A.
4. Loosen the telescope clamp screw and reverse the telescope on its elevation axis. Set a point on the line of sight and call it point C.
5. If point B and point C coincide, no adjustment is necessary. If they do not coincide, set up a point D located 1/4 of length of line BC from point C.
6. Rotate the two horizontal reticle adjusting screws (see Fig. 26) with the adjusting pin. Move the reticle so that point D is set on the line of sight.
7. Repeat from (1) and check that adjustment is correct.

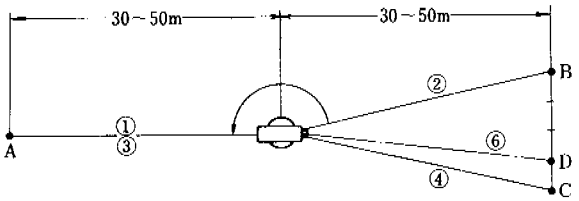


Fig. 27

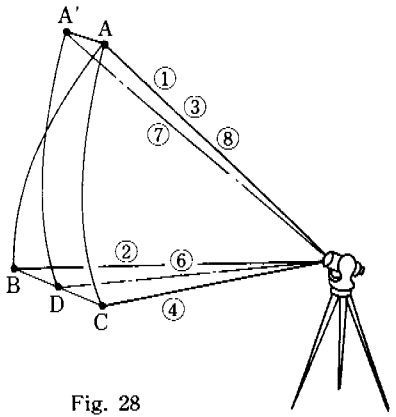


Fig. 28

4. The Elevation Axis

1. Sight on an elevated object point A (30—40°).
2. Loosen the telescope clamp screw and point the telescope horizontally. Set a point on the line of sight and call it point B.
3. Loosen the upper clamp screw and rotate the instrument 180° about its axis. Reverse the telescope and sight on point A once again.
4. Loosen the telescope clamp screw and point the telescope horizontally. Set a point on the line of sight and call it point C.

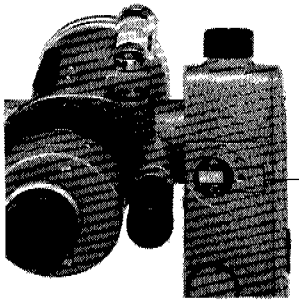


Fig. 29

5. If points B and C coincide, no adjustment is necessary. If they do not coincide, set up a point D midway between point B and point C.
6. Set point D on the line of sight with the upper tangent screw.
7. Loosen the telescope clamp screw. Point the telescope upwards at the same angle as point A and set a point on the line of sight (point A').
8. Remove the cover above the focussing knob. Rotate the horizontal axis adjusting nuts with the adjustment pin until point A is set on the line of sight.
9. Repeat from (2) and check that adjustment is correct.

Note

* In (8), the horizontal axis at point A is too high and must be corrected.

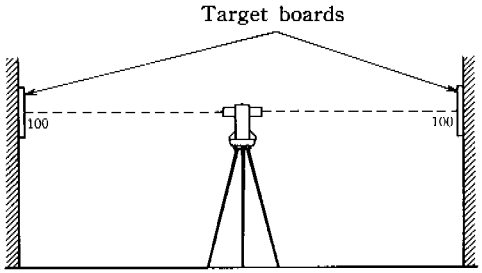


Fig. 30

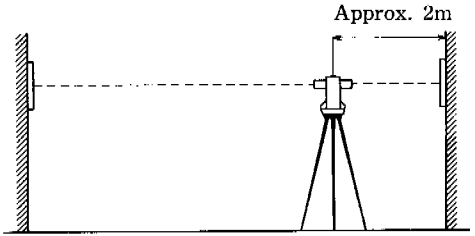


Fig. 31

5. The Telescope Level

To adjust the telescope level when the line of sight is horizontal, proceed as follows.

1. Set up the instrument on fairly level ground and in the center of two walls having a distance 50 — 100 meters. And level it with the leveling screws.
2. Center the bubble in the telescope level with the telescope tangent screw.
3. Set a target board on each wall so that reading on each target becomes at same level.
4. Move the instrument to a position having a distance of 2 meters from a wall, and level it with the leveling screws.
5. Center the bubble in the telescope level with the telescope tangent screw. Take a reading on each target.
6. If the readings are same, no adjustment is necessary. If they do not coincide, point the telescope to the target board in the longer distance.
7. Adjust the reading by rotating the telescope tangent screw so as to be the same reading to the target board in the shorter distance.
8. Rotate the bubble adjustment nut (Fig. 26) with the adjusting pin to center the bubble in the telescope level.
9. Repeat from (5) and check the adjustment is correct.

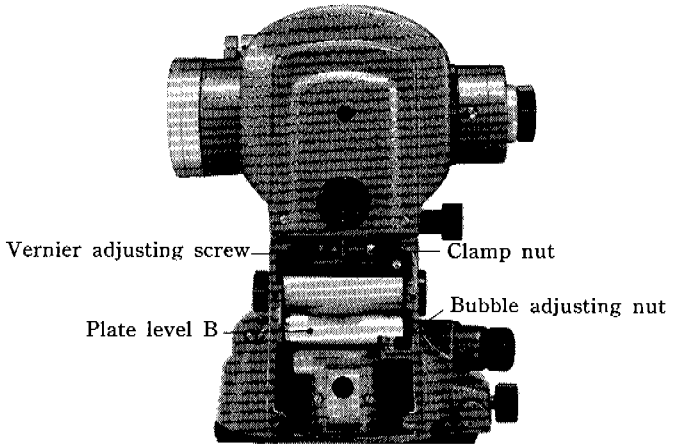


Fig. 32

6. Vertical Circle Reading

Before carrying out this test and adjustment, test and adjust afore-mentioned telescope level (5).

1. Check that the bubbles are in the center of the plate levels and telescope level.
2. Read off the vertical circle.
3. If the reading is 0, no adjustment is necessary. If it is not 0, remove the vertical circle side support cover.
4. Loosen the clamp nut with the adjusting pin, and rotate the vernier adjusting screw with the adjusting pin until the vertical circle reading is 0. Then re-tighten the clamp nut.

7. Optical Plummet

1. Attach the instrument to the tripod and place on the ground a sheet of white paper on which a cross has been drawn.
2. Look through the optical plummet eyepiece and adjust the position of the paper so that the intersection of the cross is roughly in the center of the field of view.
3. Align the center mark of the centering telescope with the intersection of the cross by adjusting the leveling screws.
4. Rotate the instrument about its vertical axis. Check at every 90° whether the center mark and intersection are aligned by looking through the optical plummet eyepiece.
5. If the center mark and the intersection coincide, no adjustment is necessary. If they do not coincide, first set the line of sight of the optical plummet at each 90° turn and mark the points on the sheet of paper. Call them points A, B, C and D.
6. Draw straight lines between the opposite points (i.e. AC and BD) and set up point 0 at their intersection.
7. Rotate the three optical plummet adjusting screws (see Fig. 33) with the adjusting pin until the center mark of the optical plummet coincides with point 0.
8. Repeat from (4) and check that adjustment is correct.

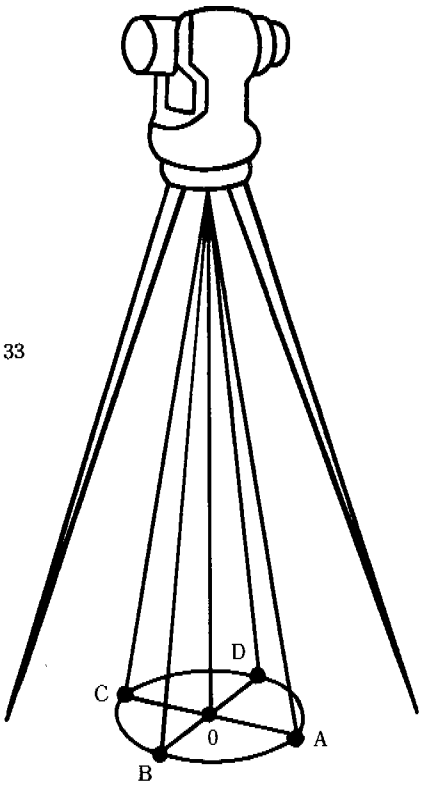


Fig. 33

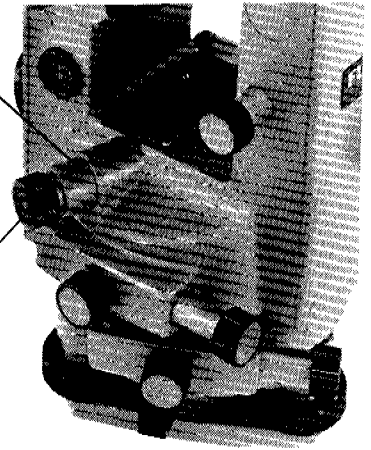


Fig. 34

8. Precaution during Tests and Adjustments

* When carrying out tests and adjustments, always follow the numbered operations in the correct sequence.

  If the correct sequence is not observed, previous tests and adjustments may be affected.

* In sections 4 and 7, the above warning does not apply, and the sequence of operations may be changed freely.

* After adjustment always test again and see that adjustment is correct.

MEMO

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Printed in Japan

7202-S