PENTAX®

ONE SECONDE THEODOLITE

TH-01W

INSTRUCTION MANUAL

1. Notes on Care of Pentax Theodolites

To prevent accidental damage to your equipment, please adhere to the following notes which have been constructed to help you in maintaining your instrument in a precise functioning condition.

1. Unpacking
When unpacking the instrument and accessories from their container, please remember how they are positioned so that repacking may be performed correctly. The instrument should always be held with two hands after being removed from its container, and held firmly with one hand when mounting on a tripod. Refer to page 20 for the correct operation of packing the instrument.

2. Setting up
When installing or removing the instrument on or from the tripod, the instrument should be held firmly at all times. The instrument should never be left on the tripod without being fixed securely by the center screw located on the tripod. To ensure correct compatibility with the instrument, always use a Pentax tripod.

3. Checking
Before using the instrument to take measurements, it should be examined by following the procedure outlined in section 9 of this manual. If there are any adjustments necessary, these should be carried out immediately or the equipment returned to your dealers for servicing where applicable. This procedure is always necessary regardless of the equipment age. Regular servicing of precision instruments is always advisable. Please consult your dealers for this information.

4. Transportation
Make sure that instruments are firmly secured in position when in transit so that they cannot be damaged by movement in the trunk of a car or rear of a van. The instrument should be separated from other equipment by using materials to prevent damage from impact or shock. It is recommended that an experienced person should be used to pack the instrument for long journeys. Insurance coverage should be considered when tranporting precision instruments over a great distance.

5. Storage

Your Pentax instrument should be stored in a dry and dust-free room which is not subject to large variations in temperature. Remember to remove the instrument from its container occasionally so that air may be allowed to circulate freely around the instrument thus preventing corrosion.

Contents

9. Inspection and Adjustment

1. Specifications

Telescope

Type	Internal focussing annalactic optics with coated lenses
Image	Erect (Prism erect image)
Magnification	30×
Effective aperture	40mm
Resolving power	2.5″
Field of view	1°20′ (2.3m at 100m)
Minimum focus	1.6m
Stadia ratio	1:100
Stadia constant	0

Horizontal Circole

180° diametrical scale, Graduation of micro scale

Diameter	100mm
Graduation	1° or 1G
Graduation of microscale	1″ or 1CC

Vertical Circle

180° diametrical scale, Graduation of micro scale

Diameter	80mm
Graduation	1° or 1G
Graduation of microscale	1″ or 1CC

Sensitivity of Sprit Levels

Telescope sprit level	30″/2mm
Plate sprit level	20″/2mm
Circular sprit level	8′/2mm

Vertical Compensation

Bubble coincidence	
Compensation range	±5′

Optical Plummet

Image	Erect
Magnification	2×
Field of view (at 1.4m high)	150mm∅

Tripod attaching screw

Diameter	5/8 inch
Pitch	11 threads per inch

Dimension and weight

Instrument	285×183×166mm
	5.5kg
Carrying case	380×240×210mm
	2.5kg

2. Description of Parts

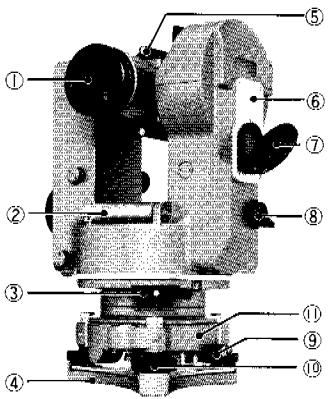

Fig. 1

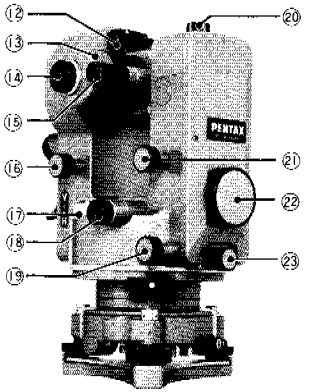

Fig. 2

1. Objective lens
2. Plate vial
3. Circle rotating knob
4. Base plate
5. Aiming collimator
6. Illumination holder
7. Reflecting mirror
8. Circle reading switching lever
9. Clamp lever
10. Leveling screw
11. Tribrach
12. Vertical compensation prism
13. Focusing knob
14. Eyepiece
15. Angle reading eyepiece
16. Vertical adjusting screw
17. Circular level
18. Optical plummet eyepiece
19. Horizontal tangent screw
20. Telescope clamp screw
21. Telescope tangent screw
22. Micro knob
23. Horizontal clamp screw

3. Standard Equipment and Optional Accessories

3-1 Standard equipment

Instrument	1
Carrying case	1
Plumb bob	1
Sunshade	1
Objective cap	1
Tool kit	1

3-2 Optional accessories

Wooden extension tripod	TS-2
Illumination device	E-1
Traverse set	PT-2
Diagonal eyepiece	SB-2
Eyepiece sunglass	SE-1
Tribrach	PW-1 (w/o O.P.)
	PW-2 (w/O.P.)

4. Preparation for Surveying

4-1 Setting up the instrument and the tripod

Adjust the tripod legs so that a height suitable for surveying is obtained when the instrument is set on the tripod.

Hang the plumb bob on the tripod, and carry out coarse centering with the station on the ground. At this time, set the tripod and fix the metal shoe firmly into the ground so that the tripod head is as level as possible, the center screw is at the center of its moving range, and the plumb bob coincides with the station on the ground.

If the tripod head is disturbed by the action of fixing the metal shoe into the ground, correct the level by extending or retracting each leg of the tripod.

After above are completed, center correctly in the following manner using optical plummet.

First remove the plumb bob. Look through the optical plummet eyepiece, and rotate the eyepiece knob until the center mark can be seen clearly. Then, rotate the focusing knob of the optical plummet and adjust the focus to the station on the ground.

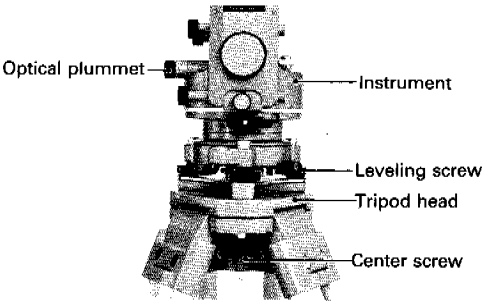

Fig. 3

4-2 Leveling with the plate vial

1. Place the plate vial in parallel with a line joining any two of the leveling screws. Adjust the two screws, and position the bubble in the center of the level (A of Fig. 4). (To adjust the screws at the same time, turn in opposite directions.)
2. Rotate the plate vial through 90° around the vertical axis. Adjust the remaining leveling screw so that the bubble comes to the center of the plate vial (see Fig. 4 (B)).
3. Repeat 1 and 2 by rotating the plate vial through 90° so that the bubble is positioned in the center when the plate vial is moved in any direction.

- See arrows in Fig. 4 (A) and (B) for the relation between the direction of leveling screw rotation and the bubble shifting direction.
- If the bubble is not positioned stably in the center in 3 even after repeating 1 and 2, "Adjustment of the plate vial" is necessary (see Page 24, 9-2).

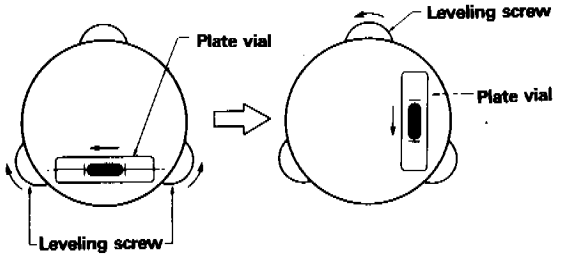

Fig. 4

4-3 Centering to an overhead station

Method 1

The instrument can be centered to an overhead station by adjusting the center of the collimator sight to the tip of the plumb bob suspended from an overhead station on a roof or ceiling.

1. Suspend the plumb bob from the overhead station. Set the tripod so that the center of the tripod head is placed right under the station.
2. Mount the instrument on the center of the tripod head, and level the instrument.
3. Set the vertical circle to 0° or 180°.

Method 2

Suspend the plumb bob from overhead station. Mark the ground where tip of plumb bob reaches. Then, set the instruments following procedures 4-1 and 4-2.

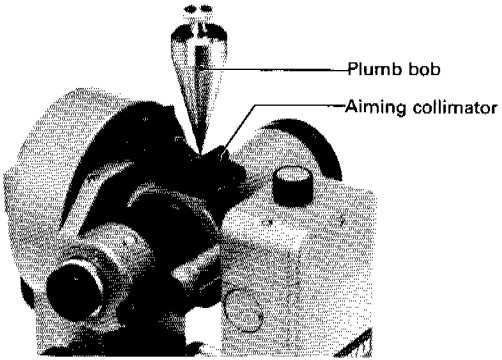

Fig. 5

4-4 Attachment and Detachment of Tribrach

The tribrach is detachable from the instrument if required: when replacing the instrument with a target for traversing or exchanging with an electronic distance meter for example.

A Detachment
First loosen the recessed screw with a screwdriver. Then rotate the locking knob until the arrow points upward, and lift the instrument up.

B Attachment
Mount the instrument on the tribrach with the guide marks coinciding, and rotate the locking knob until the arrow points downward.

- When the tribrach does not need to be attached or detached or the instrument is to be transported, tighten the recessed screw with a screwdriver to fix the locking knob.

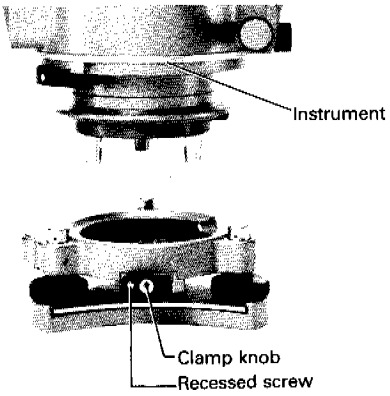

Fig. 6

5. Surveying

5-1 Focusing and sighting

5-1-1 Reticle pattern

1. Remove the telescope lens cap, and attach the lens hood, if necessary
2. Point the telescope at a bright object, and rotate the eyepiece ring fully counterclockwise.
3. Look through the eyepiece, and rotate the eyepiece ring clockwise until the reticle appears as its maximum sharpness.

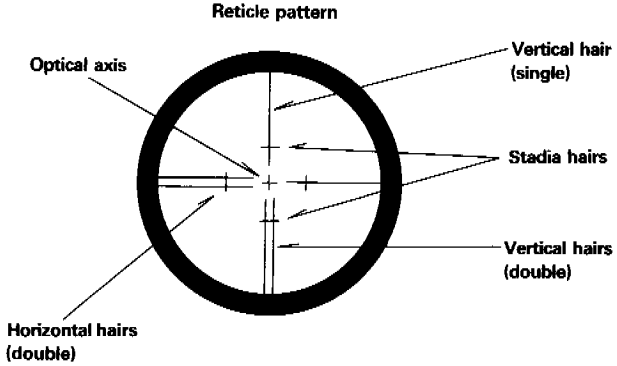

Fig. 7

5-1-2 Focusing

Loosing horizontal clamp and telescope clamp screws, aim telescope at the objective with aiming collimator. Then, tighten both screws. Rotate focusing knob until the object comes into sight through telescope eyepiece.

Rotating horizontal and telescope tangent screws, coincide cross hair with the objective. Focus the objective extremely sharp and check there is no parallax.

Focusing knob has three each ∞ and triangle marks. A tip of triangle mark shows remoter distance and you can focus on farther distance as triangle mark becomes smaller.

Smallest triangle mark shows focus at 4m, medium one about 2m and the largest one 1.6m.

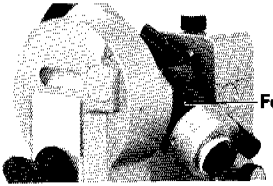

Fig. 8

5-1-3 Sighting

Sight the objective correctly by rotating horizontal and telescope tangent screw.

Use either single vertical or double vertical hairs according to width of the objective. (See Fig. 7)

When you stop turning tangent screws, make sure that they should be stopped by turning clockwise.

For the work at dark places, attach illumination device to illumination holder and light cross hairs with it by adjusting light volume.

5-2 Circle reading

For the work in daytime, use reflecting mirror adjusting its openness and direction to get proper light volume for reading circle.

For the work in night time or at dark places, use illumination device.

Both vertical and hirizontal circles can be read through circle reading eyepiece located at the side of telescope eyepiece.

When reading horizontal angle, turn the switch lever downward (H). When reading vertical angle, turn it upward (V). Adjust circle reading eyepiece by turning its knob so that the image sees clearly. Circle images appear as follows,

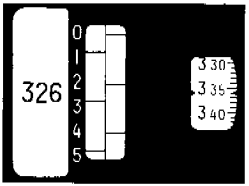

Fig. 9

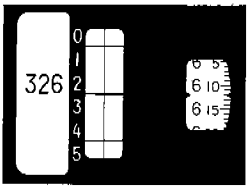

Fig. 10

Circle reading is attainable by aligning two lines by turning micrometer knob, which move in opposit direction each other. Pay careful attention to aligning two lines.

Fig. 9 shows that two lines do not align each other, which means that circle reading is impossible. Then, turn the micrometer knob to align two lines as shown in Fig. 10. In this instance, angle can be read 326° 26'12".

5-3 Setting the horizontal circle

Following is the procedure to set the horizontal angle when sighting the first target.

1. Set micro scale at around 5'00" and then sight the first target.
2. Pull the circle rotating knob cover and turn the circle rotating knob. (Fig. 11)
3. Set the desired circle graduation at the side of 0 of 10" unit.
4. Turning the micrometer knob and read horizontal angle as described in 5-2.

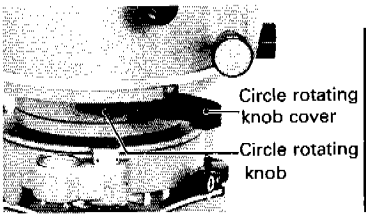

Fig. 11

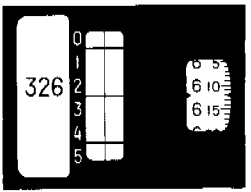

Fig. 12

5-4 Setting specified angle

When setting up a specified angle from a set point in civil engineering and other works, following procedures are required.

1. Sighting a set point, add specified angle to the reading at the set point. For instance, summed reading is 326°26'12" when specified angle, 326°20', is added to reading at the set point, 6'12".
   Turn the micrometer knob to set the reading at 6'12". Then, loosing the horizontal clamp screw, rotate the standard clockwise so that circle graduation of 326° is set at the side of figure 2 and fix it.
2. Turn the horizontal tangent screw to two lines exactly.
3. The point aimed through the telescope is the one which is set at a specified angle point from a set point.

6. Angle Measurement

6-1 Horizontal angle measurement

6-1-1 Angle measurement by single method

1. Set the instrument over the point, level it and read the horizontal circle.
2. Sight the first object accurately.
3. Point the telescope to the second object accurately.
4. Read the horizontal angle (a_1) and obtain the difference with the reading (a_0) of 3. Then, the angle (a) made by the first and second objects can be obtained.

- If the above method is repeated with the telescope in the normal and reversed positions to obtain the average of the two measurements, a more accurate result can be obtained.

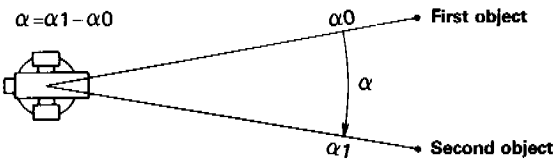

Fig. 13

6-1-2 Angle measurement by the direction method

1. Set the instrument over the angle measurement base, level it and set the horizontal circle in the neighborhood of 0°.
2. Place the telescope in the direction of "1" in the normal position, and sight it precisely. Read the horizontal angle.
3. Sight 2 precisely. Read the horizontal angle.
4. In the same way, observe the directional angles 3, 4 and 5 clockwise in turn. (Fig. 14)

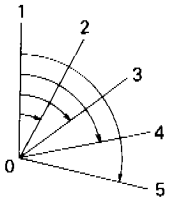

Fig. 14 Normal position

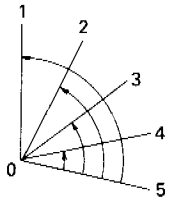

Fig. 15 Reversed position

5. Reverse the telescope, and sight "5" precisely. Read the horizontal angle.
6. In the same way, observe the directional angles 4, 3, 2 and 1 counterclockwise in turn (Fig. 15). The above is called a "one pair observation".

- Usually "two pair observations" are performed.
- For second pair observation, the circle position is rotated through 90° and observation made in the same manner as for the first pair.

6-2 Vertical angle measurement

Accurate vertical angle can be obtained by compensation through the means of coinciding two bubble images even if the instrument is slightly inclined.
Set the telescope in normal position and align the horizontal hair line to the target turning the telescope tangent screw.
Then, coincide the tips of two bubble images looking through vertical compensation prism by turning vertical compensation screw.
If the above method is repeated with the telescope in reversed position, more accurate result can be obtained.

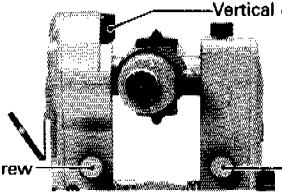

Fig. 16

6-3 Stadia surveying

The stadia hairs on the reticle provide the method of measuring distance and height from the instrument center to a leveling rod.

- Calculations are easy since the stadia addition constant is 0.

When the line of sight is inclined

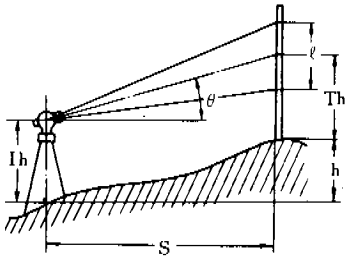

Fig. 17

$S=100\ell \cos 2\theta$
$h=50\ell \sin 2\theta$
$(Ih=Th)$

When the line of sight is horizontal

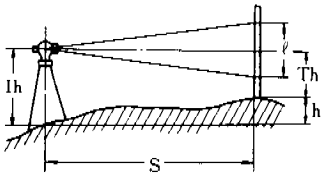

Fig. 18

$S=100\ell$
$h=Ih-Th$

S: Horizontal distance
h: Difference in elevation
θ: Vertical angle
ℓ: Difference in top and bottom stadia hair readings
Ih: Instrument height
Th: Line of sight reading

6-4 Angle measurement with traverse equipment

Traverse surveying requires at least 2 sets each tripod and target with tribrach other than theodolite.

Bofore surveying work is completed, tripods are left at original point with tribrach being mounted. Theodolite or target is replaced according to necessity. Even in this case, surveying work will be prompted since centering is no longer required.

Fig. 19

7. Storage

Loosen each clamp screws and align the yellow dots. Then, tighten each clamp screw after setting the telescope horizontal. Refer to following photo for right position of storage.

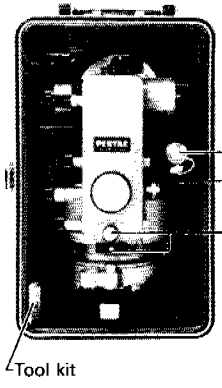

Fig. 20

8. Optional Accessories

8-1 Wooden tripod TS-2

Use of a high quality tripod is one of the essential conditions for obtaining accurate measurement values in surveying. Use wooden extension tripod TS-2 for the surveying which requires 1" reading theodolite.

8-2 Illumination device E-1

Illumination device E-1 is used for the surveying work in night time or at the dark places as in the tunnel.

E-1 consists of a lamp house, a battery box and a connecting cord for the two. The lamp house is used by being hunged on the lamp house holder. Light volume is adjusted with illumination adjusting lever at the side of aiming collimator.

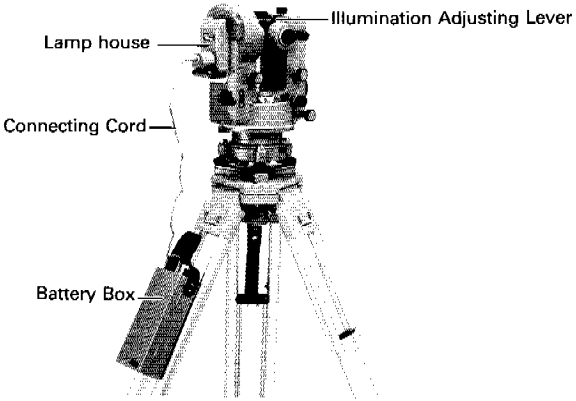

Fig. 21

8-3 Traverse set PT-2

Traverse set PT-2 enables efficient surveying work in various types of surveying. The difference in height between horizontal mark of the target and the upside of tribrach is same with that between sighting axis of the instrument and the upside of tribrach incorporated in the instrument.

Target (with optical plummet) 2
Tribrach 2
Lighting device set 2
Plumb bob set 2
Storage case 1

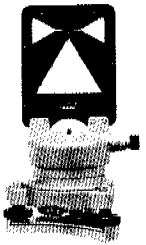

Fig. 22

8-4 Diagonal eyepiece

The diagonal eyepiece can be attached to the telescope eyepiece or circle reading eyepiece for convenience in observing the zenith or surveying in confined spaces. To attach the diagonal eyepiece to the telescope, turn the telescope eyepiece ring counterclockwise to remove the eyepiece, and attach the diagonal eyepiece by turning its ring clockwise.

To attach the eyepiece to the circle reading eyepiece, turn the knurly rubber knob of the circle reading eyepiece counterclockwise to remove it.

The eyepiece can be rotated through 360°.

When sighting is made through the telescope with the diagonal eyepiece attached, the reticle may be seen deflected vertically or horizontally, but this has no influence upon accuracy. It can be corrected with three adjusting screws if necessary.

8-5 Eyepiece filter

The eyepiece filter can be attached to the telescope eyepiece or diagonal eyepiece for sun observation, etc.

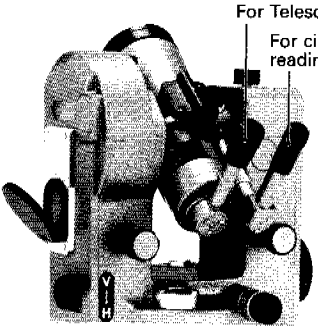

Fig. 23 Diagonal Eyepiece

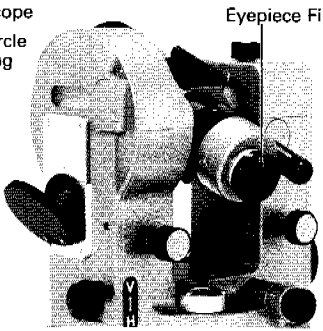

Fig. 24 Eyepiece Filter

9. Inspection and Adjustment

9-1 Tripod

The play at the connecting section between wooden legs and metal parts should be avoided. If necessary, tighten screws of respective seciton with driver or wrench.

9-2 Plate vial

Adjust the plate vial if the bubble moves from the center as follows.

1. Check the position of the bubble by rotating the standard 180° after completion of procedures 4-2-1 and 2.
2. Bring it half way back to the center with adjusting pin and remaining half by adjusting leveling screw (C).
3. Check if the bubble is positioned at the center disregarding of direction of the standard. If the bubble moves from the center, repeat procedure 2.

9-3 Circular level

The bubble of circular level should be positioned at the center when adjustment of plate vial (9-2) is completed. If the bubble moves from the center, adjust it by turning adjusting screw with adjusting pin.

9-4 Perpendicularity of line of sight to horizontal axis.

Error in horizontal line of sight can be erased by obtaining averaged value of normal and reversed position of the telescope.

Inspection

1. Set an object point A at a distance of 30 to 50m away from the instrument, and sight it through the telecope.
2. Loosen the telescope clamp screw and reverse the telescope around the horizontal axis. Mark a point set on the line of sight at about the same distance to the object point A, and call it point B.
3. Loosen the clamp screw, and rotate the instrument around the vertical axis. Sight point A again.
4. Loosen the telescope clamp screw, and reverse the telescope around the horizontal axis. Mark a point on the line of sight at about the same distance as point B, and call it mark C.
5. No adjustment is necessary if points B and C coincide.

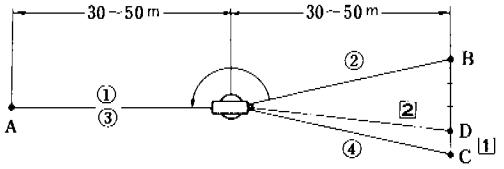

Fig. 25

Adjustment

1. If points B and C do not coincide, set up a point D located ¼ of the length BC toward B.
2. Removing the adjusting cover of eyepiece section, turn the adjusting screws opposed horizontally with adjusting pin to make horizontal hair line align with point D.
   Vertical line moves toward the same direction as turning direction of screws. So, when vertical line is moved laterally, loosen adjusting screw at opposit side of desired direction and tighten the other adjusting screw by same amount.
3. When stopping turning screws, make sure that turning direction of screws should be clockwise. Repeat the inspection and check that the adjustment is correct.

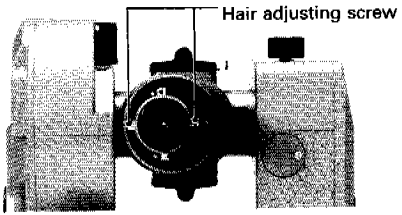

Fig. 26

9-5 Perpendicularity of line of sight to vertical axis.

Perpendicularity of line of sight to vertical axis is essential to surveying results. However, slight error can be erased by averaged value which is read both in normal and reversed position of the telescope. So, refrain from adjusting by yourself as possible.

1. Set the point A at 30°–40° upward
2. Level the telescope and set the point B.
3. Turning the standard 180°, sight point A with the telescope in reversed position.
4. Level the telescope and set the point C. Adjustment is necessary if points B and C do not coincide.

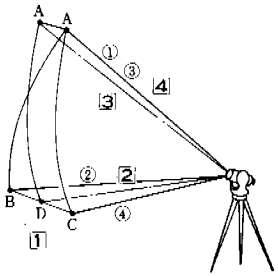

Fig. 27

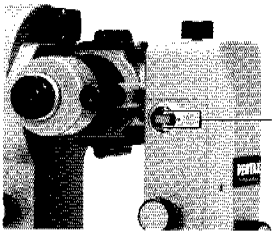

Fig. 28

Adjustment

1. Set the point D half way between point B and C. (Fig. 27)
2. Sight point D, turning horizontal tangent screw.
3. Loosing telescope clamp screw, target the telescope at the same direction with point A (point A')
4. Removing adjusting cover, sight point A by turning horizontal adjusting screw with adjusting pin. (Fig. 28)
5. Repeat from inspection 2 and check if adjustment is correct.

9-6 Index error

Vertical angle reading is 0°00′00″ (100.00.00G for 400G), when line of sight is horizontal with the telescope in normal position. However, slight error can be erased by doing surveying in normal and reversed position of the telescope. Refrain yourself from adjusting as possible.

Inspection

1. Set and level the instrument at a place of 30 to 50mm away from a wall.
2. Point the telescope at the wall by setting it in a revered position. Set the vertical angle reading at 180°00′00″ or 300.00.00G for 400G by coinciding tips of two bubbles looked through compensation prism.
3. Turning the standard 180°, set the telescope in a normal position and point A precisely.
4. Adjustment is not necessary if vertical angle reading is 0°00′00″ or 90.00.00G for 400G.

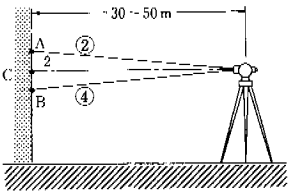

Fig. 29

Bubble adjusting nut.

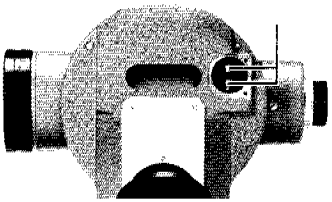

Fig. 30

Adjustment

1. Set the vertical angle reading at 0°00′00″ of 90.00.00 for 400G as shown in Inspection 4. Then, set the point B by sighting with a horizontal hair.
2. Set a point C half way between points A and B. Set the vertical angle reading at 0°00′00″ of 90.00.00 for 400G by turning a vertical adjusting screw.
3. Adjust a bubble adjusting nut with a adjusting pin so that tips of bubbles coincide.
4. Repeat from Inspection 2 and check if vertical angle reading is 0°00′00″ or 90.00.00 for 400G when sighting point C correctly.

9-7 Optical plummet

Inspection

1. Set the instrument on the tripod, and place a piece of white paper with a cross drawn on it right under the instrument.
2. Look through the optical plummet, and move the paper so that the intersecting point of the cross comes to the center of the field of view.
3. Adjust the leveling screw so that the center mark of the optical plummet coincides with the intersection point of the cross.

Adjustment

1. If the center mark does not coincide with the intersection point, mark the points set on the line of sight at each step of 90° rotation on the paper, and call them points A, B, C and D (see Fig. 31).
2. Join the opposed points (A, C and B, D) with a straight line, and set intersecting point 0.
3. Turn three optical plummet adjusting screws with a screwdriver so that the center mark coincides with intersecting point 0 (see Fig. 32).
4. Repeat the inspection procedures starting with number 4, and check that the adjustment is correct.

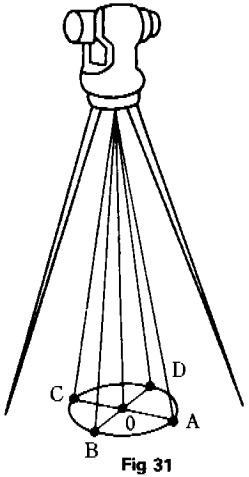

Fig 31

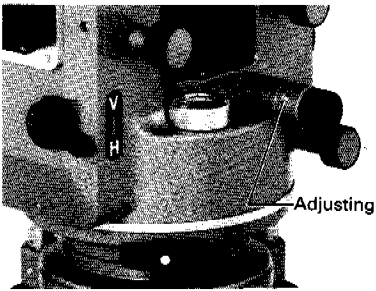

Fig. 32

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