CHO-T TYPE SEXTANT

Technical Description and Operating Instructions

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1. Technical Description

1.1. Introduction

1.1.1. Technical description and operating instructions (TO) are intended for studying the design and operating principle of the CHO-T type sextant.

1.1.2. The technical description consists of two sections:

technical description - section 1,

operating instructions - section 2.

1.2. Purpose

1.2.1. Navigational sextant of CHO-T type with illuminator is tropicalized and intended for measuring altitudes of celestial bodies in the sea or on shore as well as angles between coastal objects with the view of determination of observer coordinates. The sextant may be used on boards the ships and vessels of unlimited areas of navigation.

1.3. Technical Data

1.3.1. Range of angles readings - 0 to 140°.

1.3.2. Range of angles measurement - 0 to 120°.

1.3.3. Instrumental accuracy within angle measurement range 0 to 120° - ±6".

1.3.4. Limb division value - 1°.

1.3.5. Division value of drum scale - 1'.

1.3.6. Accuracy of drum scale reading - ±6".

1.3.7. Correction of sextant within 0 to 120° range - no more than ± 30".

1.3.8. Backlash between sextant worm and frame - no more than 6".

1.3.9. Galilean telescope parameters:

magnification - 4^{x}, field of sight - 8°

1.3.10. Astronomical telescope parameters:

magnification - 6^{x}, field of sight - 4°30'

1.3.11. Mass of sextant:

less stowage box - 1.5 kg,

with stowage box - 4.5 kg

1.3.12. Overall dimensions of sextant with Galilean telescope, mm: 300x228x137.

1.4. Sextant Components

1.4.1. The sextant comprises the sextant itself, spares, tools and accessories and service documents.

1.4.2. The sextant design comprises the following components (Fig.1): frame 1; light filters 2 of index mirror; index mirror 3; Galilean telescope 5; plate 6; handle 7; alidade with reading - arresting device (vernier) 8; illuminator 9; light filters 10 of horizon mirror; horizon mirror 11.

1.4.3. Spares, tools and accessories comprise: mirror, wrench (for special nuts of reading - arresting device), wrench (for mirror position correction), clock screw driver, screw driver, astronomical telescope 4 (Fig.1), two diopters, bottle with lubricating oil, brush, a piece of flannel.

1.4.4. The sextant, spares, tools and accessories as well as service documents are placed in one stowage box.

1.5. Sextant Principle of Operation

The principle of angles measurement between objects with the help of sextant is based on simultaneous observing those objects through sextant telescope; one object being observed directly, the other - after reflecting from two mirrors. Suppose, it is necessary to determine the angle between objects, the light from which gets to the observer in two directions A and B (Fig. 2).

The beams B from one object get through the transparent upper half of mirror 2 directly into the telescope 5 or 6, depending on that, which of these telescopes is installed on sextant. Beams A from the other object get on the index mirror 4, and reflecting from it - on the lower amalgamated half of mirror 2 and then - into the telescope. To observe the objects A and B simultaneously it is necessary to turn index mirror 4 around its vertical axis at some angle. In the moment of coincidence of the two objects images the angle between the objects is equal to the dual angle of mirror 4 turn. The mirror is rigidly fixed to the alidade, which turns around the frame axis and moves along the toothed sector together with the mirror and the reading-arresting device.

In moment of two objects coincidence the sextant limb reading in grades and scale reading in minutes will be equal to the measured angle between the objects.

1.6. Sextant Design

1.6.1. Frame (Fig.1) is the main part of sextant. It is made

of special alloy and is a toothed sector. The upper surface of the sector arc is the sextant limb. The limb surface is provided with divisions from 0 to 140°. Each tenth division is numbered. Plate 6 is provided on the frame for handle 7 fixing.

1.6.2. Index mirror 3 is intended for getting the second object image into the field of sight of the telescope. The mirror is a rectangular shaped plate of optical glass. The front plane of this plate is covered with a smooth reflecting layer.

The mirror is arranged in a metal strut and fastened in it by springs. The strut is provided with an adjusting screw, intended to obtain the perpendicularity of the index mirror to the limb plane.

1.6.3. The horizon mirror 11 is a plane-parallel round plate of optical glass. The rear lower half of the plate is covered with mirror layer, the upper half is transparent.

The mirror is arranged in a metal strut and fastened in it by springs. The strut is provided with adjusting screw intended for obtaining the perpendicularity of the mirror to the limb plane.

1.6.4. Light filters 2 and 10 are sets of coloured glasses of different optical density, intended for weakening the light flux from bright objects and for eliminating specks. The light filter glasses are rolled in metal oval mountings and fastened on the frame with posts. In case of need one or several light filters may be introduced simultaneously.

1.6.5. Alidade with reading-arresting device (vernier) 8 and index mirror 3 turns around the frame axis within its sector.

Thereby the index of reading-arresting device moves along the sextant limb, allowing to read the scale.

Arranged in bracket 3 of the reading-arresting device (Fig. 3) are : casing 4, worm 5, spring 7 pressing the worm to the sector teeth and screw 9 intended for adjusting the worm gearing. Fastened outside of casing 4 are the handle 6 and drum index 2. Put on worm 5 is reading-off drum 1, graduated into 60 divisions. Each fifth division is numbered. One complete drum revolution allows to remove the alidade at 1°. The reading-arresting device is fixed to alidade with screws through holes 8.

1.6.6. The illuminator (Fig.4) is intended for limb and drum scale reading and comprises bushing 1, lens 2 and bushing 3. The bushing 3 is covered with light stuff of temporary action, which gives out light only after being exposed to lighting by some outer source of light. It allows to read the scale in night time or when it is dark.

The illuminator is fixed to the reading-arresting device. The lens 2 allows to read the drum scale with accuracy to $\pm 6''$. In case of need the illuminator can be installed above the sextant limb, above the drum scale or in inoperative position. The lens can be fixed at sharpness by observer's eye.

1.6.7. The astronomical telescope (Fig.5) serves for day observation and gives real reversed image. The telescope consists of objective 1 and eyepiece 5 mounted in cylindrical housings.

Fixing the eyepiece at sharpness by observer's eye is provided by eyepiece moving along housing axis.

Diaphragm 4, mounted in the objective focus, is intended for limiting the beam getting into the eyepiece and for obtaining in the center of telescope field of sight a section with identical image brightness. Two pairs of threads forming a square are soldered to the diaphragm ring. Inside of this square the direct and reflected images are brought together. Put on the objective housing is bushing 2 fastened with screws 3 with strut 6. Screws 3 permit to adjust the tilt of telescope optical axis to the limb plane.

1.6.8. Galilean telescope (Fig.6) is intended for night observations and consists of objective 1, housing 2, eyepiece 3 and strut 4, which allows to install the telescope on sextant.

At dioptrical setting the eyepiece is replaced through eyepiece bend threading, screwed in the telescope housing. The telescope gives the virtual and direct image of objects.

2. Operating Instructions

2.1. General

2.1.1. Maintenance and operation of sextant to be carried out by skilled specialists well acquainted with the design, operating principle and maintenance rules of sextant.

2.1.2. It is necessary to follow all the rules of operation, carry out all items and recommendations, stated in the present Instructions, to keep the sextant in order and cleanliness.

2.1.3. In case of any trouble the sextant must be handed in for repairs.

2.1.4. All data on operation, checking and repairs of the sextant are introduced into corresponding columns of Service Log.

2.1.5. When removing the sextant from the box hold it by the frame ribs and the handle. Do not touch the alidade, tooth sector and mirrors.

2.1.6. The sextant may be put only on the supporting legs.

2.1.7. If the tooth sector is dirty, clean it with brush and lubricate with oil entering into spares.

2.1.8. While placing the sextant into the stowage box it is necessary to remove the optical telescope and to set the alidade at 60-70° of limb scale.

2.1.9. Dust is removed from the surfaces of optical components with flannel in order not to damage the mirror or low-reflection layer.

2.1.10. It is strictly forbidded to disassemble the sextant

and use the screw 9 (Fig.3) during operation.

2.2. Preparation to Operation

2.2.1. 20-30 minutes prior to observation the sextant in the stowage box must be carried out of the premises. The box cover is to be opened in order to expose sextant to the environment temperature.

2.2.2. The terminals clamping the sextant are to be removed and turned; taking the sextant by its frame ribs and handle remove it out of the box.

2.2.3. If the sextant is prepared for day observation it is necessary to take out the astronomical telescope, focusing it at eye along the apparent horizon and install it at the sextant.

2.2.4. If the sextant is prepared for night observation it is necessary to take out the Galilean telescope and after focusing it at stars install it at the sextant.

2.2.5. Prior to operation with sextant in dark time it is necessary to expose the illuminator. To this purpose it is advisable to use light sources featuring intensity of light flux equivalent to or exceeding that of electric light of 40W at a distance of 0.5 m during 5 minutes. The brightness of the stuff luminescence is sufficient for 40 minutes after exposer.

2.3. Checking of Sextant Technical Condition

2.3.1. After the sextant is prepared for observations one must check it. Checking is necessary as accidental shocks, sharp change of temperature and so on distort mutual arrangements of

components, and in the angles measurement appears error. Checking is carried out both on board and on the shore as it is described under item 2.3.2. The sextant error and the backlash between the worm and the frame are determined not less than once a year.

Attention! To eliminate the backlash, which may appear during operation, it is recommended to turn the reading drum only in one direction clockwise or counterclockwise, depending on observer's practice.

2.3.2. Sequence and Volume of Checking

What is checked. Means and methods of checking	Technical requirements
Perpendicularity of Index Mirror to Limb Plane Install the sextant on a horizontal base (table), the sextant alidade 8 (Fig. 1) set at reading 35-40°. Put the diopters on the sextant limb plane in a following manner: one at mark 0, the other at 120°. Observe the right edge of the index mirror at 30° to its plane and moving the alidade within 30-45° range obtain the image of diopter set at 120° in the index mirror. Look at the upper shears of diopters from above in such a way that the sighted	The mirror must be perpendicular to the limb plane, i.e. the upper shears of observed diopters must coincide.

What is checked. Means and methods of checking	Technical requirements
planes of the diopters made a full line. In this case the index mirror is perpendicular to the plane of sextant limb. If the upper edge of one diopter is higher than the other, the index mirror is not perpendicular to the limb plane. Put the index mirror perpendicular to the sextant limb plane turning the adjusting screw of this mirror by wrench until the upper shears of the diopters make the full line. <u>Parallelism of the Astronomical Telescope Optical Axis to Limb Plane</u> Focus the astronomical telescope on infinity, install it on sextant and place the instrument on a fixed base, from which it is possible to observe distant objects. Put the diopters on the limb near 0 and 140° respectively in such a way that the line connecting their centers is approximately parallel to the telescope. Now observe some remote object by upper shears of diopters.	The astronomical telescope must be parallel to limb plane, i.e. the observed object must be in the center of diaphragm grid.

What is checked. Means and method of checking	Technical requirements
The height of the diopters is the same, that is why the sighting beam is parallel to the limb plane. Observe the same object through the telescope not replacing the sextant. If the observed object is not in the center of the diaphragm grid, the parallelism of the telescope axis is distorted. The parallelism of limb plane optical axis must be obtained by means of adjusting screws 3 (Fig.5) of the telescope strut. Put the diopters into the stowage box after the above operation. The parallelism of Galilean telescope optical axis is not checked.	
<u>Perpendicularity of Horizon Mirror to Limb Plane</u> Set the alidade on reading close to 0° and then observe the astre (the sun, the moon or star) coinciding the twice reflected with the directly visible images by turning the reading drum. If the images are not coincided, i.e. one image does not overlap the other, the mirror perpendicularity is distorted.	The mirror must be perpendicular to limb plane, i.e. the twice reflected and directly visible images of the astre must be fully coincided.

What is checked. Means and method of checking	Technical requirements
Get the complete coincidence of the astre turning the adjusting screws of the horizon mirror at the rear side of its framing by means of a wrench for correcting of mirror position.	
Index Error	
1. Determination of the index error at the sun.	
Set the alidade on reading close to 0; direct the telescope to the sun taking the telescope in a vertical position. Then, turning the micrometer screw get the edges of the directly visible and the twice reflected images come into contact and take the limb reading (M_1). Now move the twice reflected image of the sun across the directly visible one and get the opposite edges of these images come into contact. Take the second limb reading (M_2). After that calculate the difference between these readings, it will be equal to four visible angular radii of the sun	Mirrors must be parallel each other
$4R_{\odot} = M_2 - M_1$	
Take the precise value of the sun radius $R_{\odot}$ with respect to the date from the	

What is checked. Means and methods of checking	Technical requirements
Nautical Almanac (NA) and multiply these values by 4; compare the value $4R_{\top}$ with the value $4R_{\odot}$ get from observations. If the difference between the angular radii of the sun is less than the double error of sextant readings ($4R_{\top} - 4R_{\odot} = 0.4$) the observation was carried out rather correctly. If not, observations should be carried out once more. After that determine the mean reading $M = \frac{1}{2}(M_1 + M_2)$ which corresponds to coincidence of centers of the directly visible and the reflected images of the sun and then calculate the index error. $i = 360° - M$ 2. Determination of the index error at the star, remote object and the visible horizon. Set the alidade on reading close to 0° and direct the sextant telescope to one of the mentioned objects. Then, turning the micrometer screw, coincide the twice reflected and the directly visible images of the object. Take reading Mi on sextant limb and calculate the index error $i = 360° - Mi$	

What is checked. Means and methods of checking	Technical requirements
Backlash between Worm and Sextant Frame Place the sextant with the astronomical telescope on the fixed base and find the object for observation. Coincide the directly visible and the twice reflected images of the object. The mentioned coincidence is performed two times by turning the drum first in one direction, then in the other, reading being written each time. Observations must be carried out at 0, 45, 60 and 120°. Calculate the difference between the first and the second readings thus finding the value of the backlash between the worm and the frame in the sector of each four points. Put down the mean data into the sextant service log. Regulating of backlash is carried out only in nautical chambers, navigating lofts or at manufacturing plants.	The backlash between the worm and the frame of sextant must be no more than 6".
Correction of Sextant (It is determined only in nautical chambers, navigating lofts or at manufacturing plants).	

What is checked. Means and methods of checking	Technical requirements
Place the sextant on a high accuracy instrument for sextant checking. Determine the correction for 0 to 120° angles in each 5° and put the obtained values in the sextant service log. Corrections for intermediate readings are determined by interpolation.	Correction of sextant must not exceed ±30".

2.4. Storage and Transportation Rules

2.4.1. The sextant is stored and transported only in a stowage box.

2.4.2. After operation clean the toothed sector with bristle brush and slightly lubricate it with lubricating oil entering into spares.

2.4.3. Set the light filters of index and horizon mirrors in operating position and the alidade at 60°-70° reading of limb. Place the sextant into the stowage box so that the supporting legs of the sextant were in the nests, then fasten the sextant with terminals.

2.4.4. Close the cover without efforts. If something prevents closing, eliminate it and close the cover once more. By no means use efforts when closing the cover.

2.4.5. Store the sextant in a stowage box in premises with relative humidity not exceeding 70% at temperature of 20±5°C. There should be no acid vapours in the premises.

2.4.6. The sextant is transported from one object to another only in a stowage box.

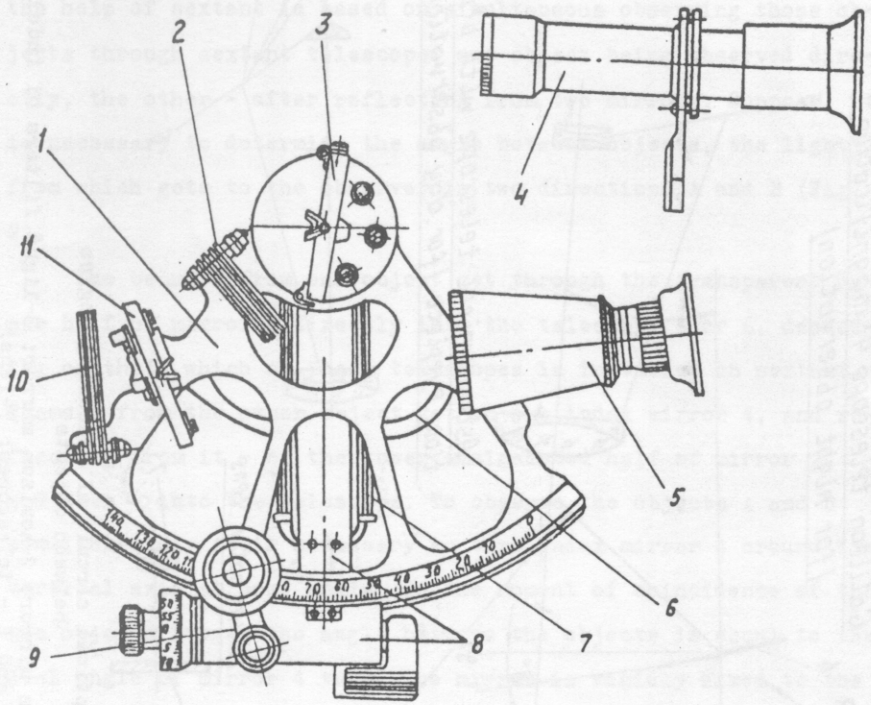

Fig.1. General View of Sextant

1-frame; 2-light filters of index mirror; 3-index mirror; 4-astronomical telescope; 5-Galilean telescope; 6-plate; 7-handle; 8-alidade with reading-arresting device (vernier); 9-illuminator; 10-light filters of horizon mirror; 11-horizon mirror.

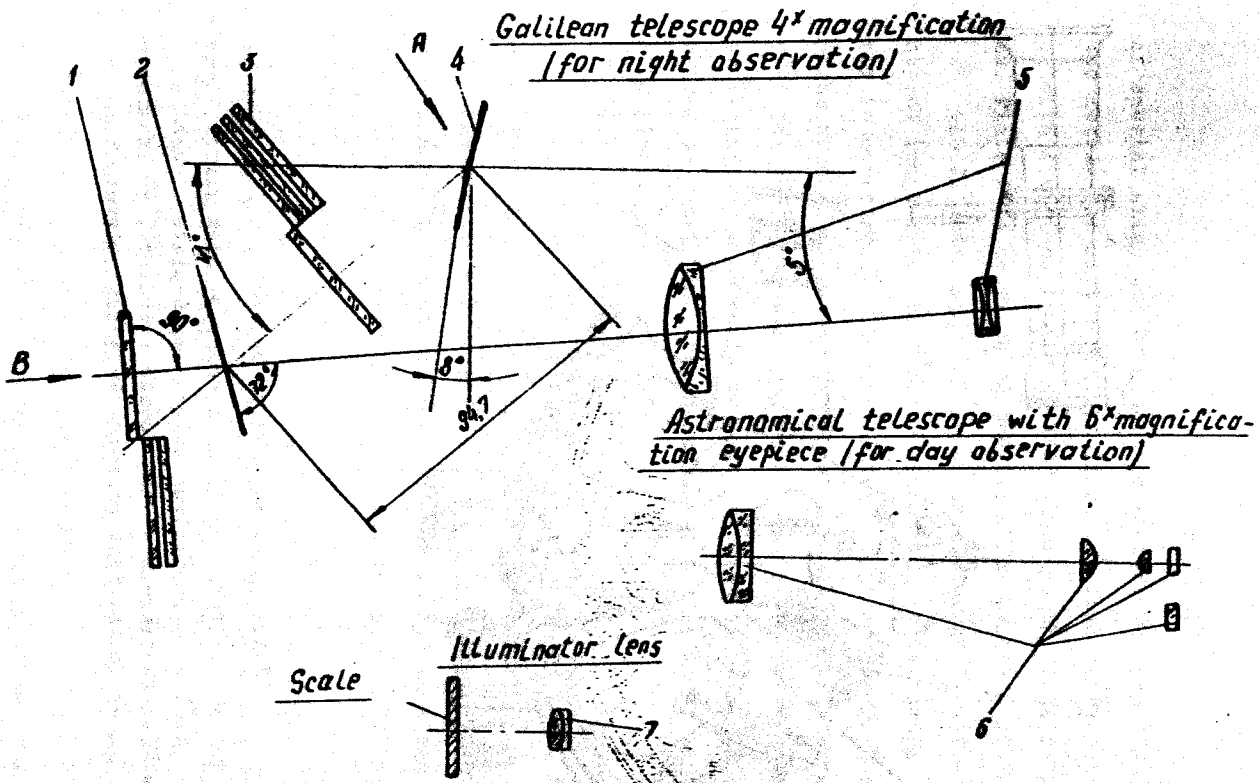

Fig.2. Optical circuit of measuring angles between objects

1-light filters of horizon mirror; 2-horizon mirror; 3-light filters of index mirror; 4-index mirror; 5 and 6 - telescopes; 7-lens.

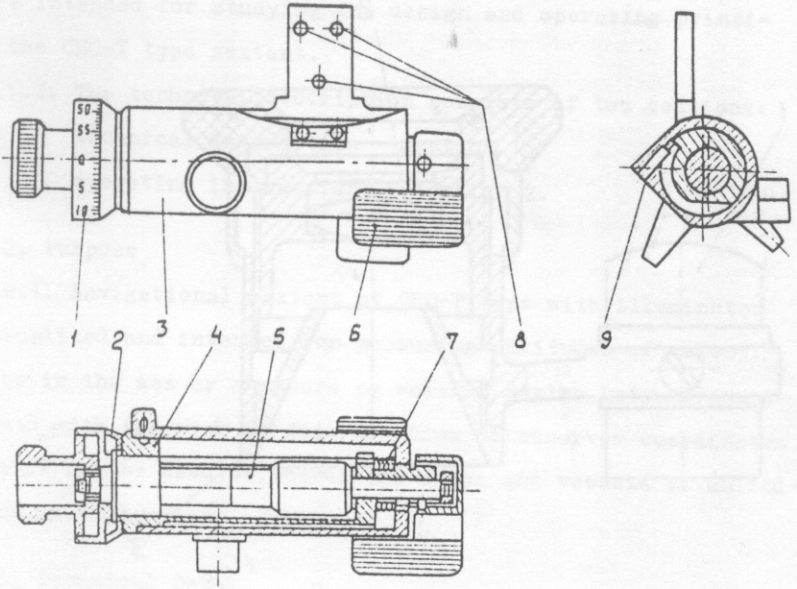

Fig.3. Reading-Arresting Device (Vernier)

1-reading-off drum; 2-drum index; 3-bracket; 4-casing; 5-worm; 6-handle; 7-spring; 8-holes for fastening; 9-screw.

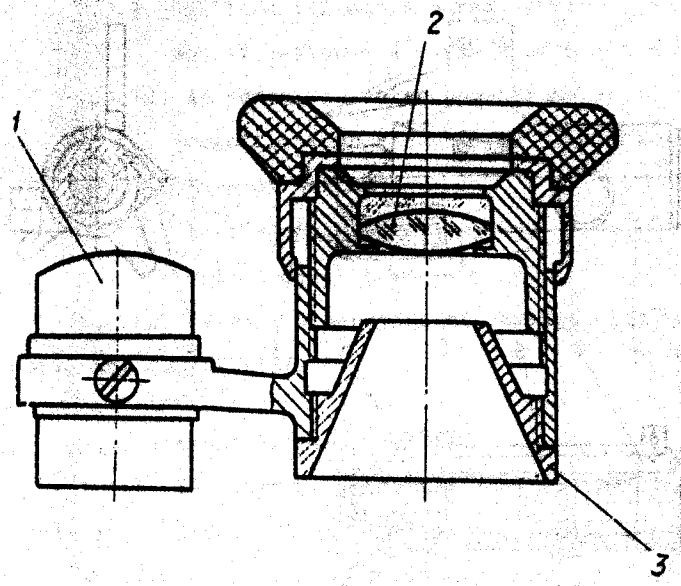

Fig.4. Illuminator
1-bushing; 2-lens; 3-bushing.

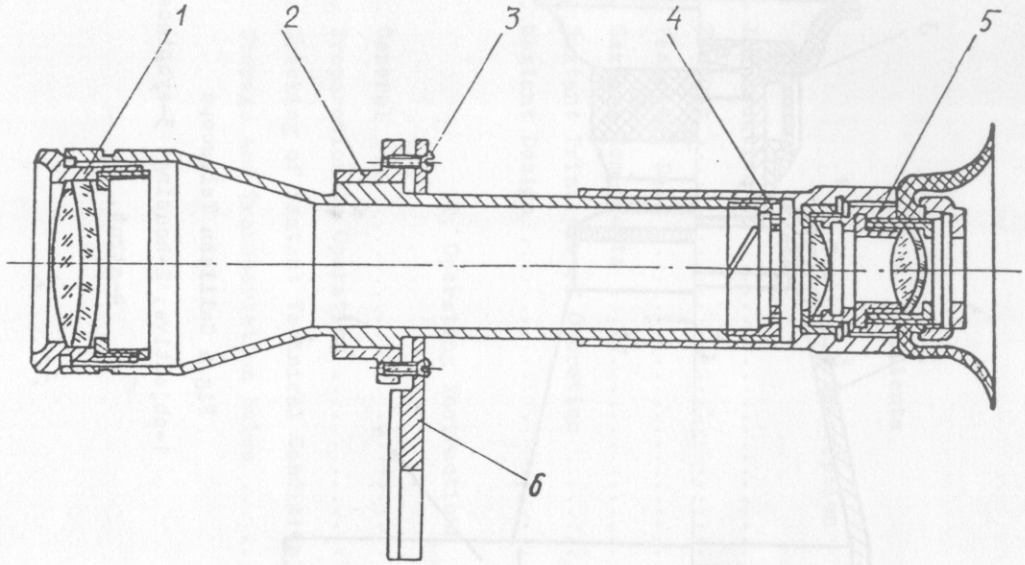

Fig.5. Astronomical Telescope
1-objective; 2-bushing; 3-screws; 4-diaphragm;
5-eyepiece; 6-strut.

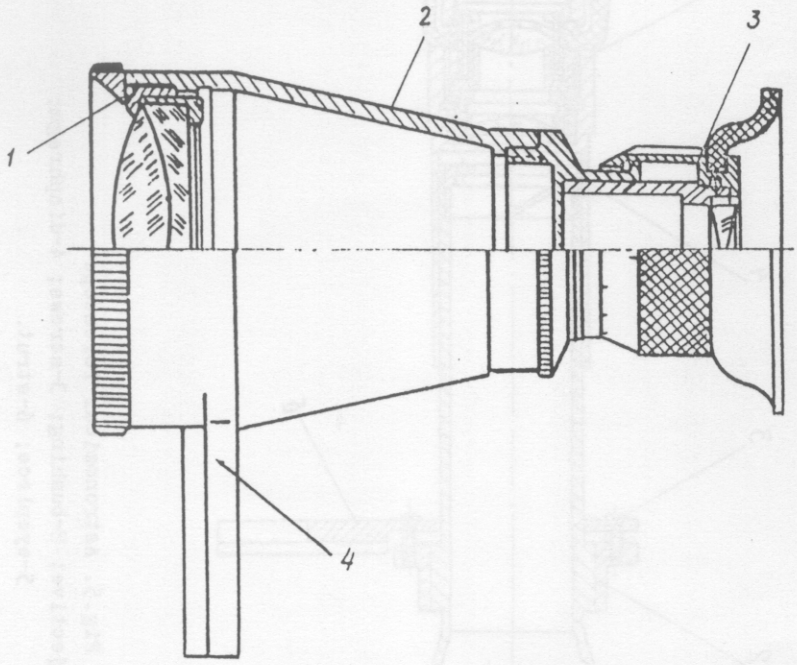

Fig.6 Galilean Telescope

1-objective; 2-housing; 3-eyepiece;

4-strut.

REVISION RECORD SHEET

Rev.	Nos of sheets (pages)				Total sheet (pages) in doc.	Doc. No.	Incoming No. of covering document and date	Signature	Date
	Revised	Replaced	New	Omitted					