MEASUREMENT OF THE SPATIAL POSITION OF GEOMETRICAL FIGURES

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Current structures make it possible to fix a point in space only in two planes. To fix this point as the center of a geometrical figure, time for making counts and for the subsequent arithmetic is required.

The guiding problem is made much easier if the position of the axis of a geometrical figure can be fixed simultaneously in three planes, by the optical axis of the instrument.

Attempts to find a simpler and cheaper control method which would save time and give greater accuracy have led to the creation of a completely new instrument: the double-image telescopic sight. This instrument makes it possible, in principle, to apply the control and adjustment method; in particular to carry out the sighting operation by placing the optical device inside the adjustable object. Moreover, no kind of mechanical contact with the object is required, i.e., there is absolutely no need to prepare any special, laborious equipment; one and the same instrument can be used for adjustment and control of the antennas of various structures. It gives a significant increase in accuracy when compared with known control methods; and simultaneous adjustment of two angles in three planes is fairly simple and easy.

The optical arrangement of the instrument (Fig. 1) consists of a long focus objective (1), the light-dividing cube (2), two roof-shaped (triangular) prisms (3) and (4), the rectangular prism (5), the focal plate (6), and the eyepiece (7).

The image of any geometrically symmetric figure is taken from the instrument to some distance or to infinity, and is constructed by the objective (1). After the objective, the light pencil falls on the light-dividing plane of the cube (2), and is split into two beams at right angles; these beams fall on the triangular prisms (3) and (4). The beams are reflected in the prisms (3) and (4) and again converge on the light-dividing plane of the cube, and then fall on the rectangular prism (5). The beam is reflected through 90° by (5), and then forms two images on the plate (6). The plate (6) is in the focal plane of the objective (1) and the eyepiece (7), and the image of the visible figure is looked at through the eyepiece.

If the geometrical axis a (Fig. 2) of the figure being considered coincides with the optical axis of the instrument, and the planes B and C are perpendicular to it, then the images of the figures coincide, and in the field of view of the eyepiece we see one image of the figure (Fig. 3a)). If the figure is projected relative to the optical axis of the instrument in one of the planes B or C (Fig. 2) or in the two simultaneously, then two images of the figure will be seen in the field of view of the instrument (Fig. 3b, and c)).

In the focal plane of the instrument, there may not be any crossed lines, since any double image indicates a displacement of the geometrical axis relative to the optical axis of the instrument.

If a screw-reading eyepiece (8) is located at the focal plane of the instrument (Fig. 1), then it is possible to measure the amount of this displacement, when necessary. The scale division on the cylinder in these cases is converted to angular values by taking the object distance into consideration. When the focal distance of the objective is 300 mm, then an image of the


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millimeter scale is clearly seen in the field of view, which means that there is a real possibility of superimposing the image with an error of ± 1 mm. Moreover \( \tan \alpha = 1/10,000 \), where \( \alpha \approx 20^\circ \).

Thus this instrument makes it possible to estimate the guiding accuracy with an error of ± 20", for distances up to 10 m. The greater the distance to the object, the greater is the accuracy of the reading.

The installation of the given optical device instead of a theodolite viewing tube makes it possible to relate the position of the article with respect to the horizontal and the directions of the light. The instrument was manufactured in the laboratory, and not only did it perfectly solve the problem posed above, but it was used to set up a series of other objects.

Another instrument (Fig. 4) has been developed to control a group of tubes so that their geometrical axes are parallel with a tolerance of 5" in their common alignment. The tubes in the group are arranged in checkerboard fashion. The pseudo-shaft control employed above was very cumbersome, and did not ensure the specified accuracy. The search for a new structure led to the development of an optical-mechanical instrument which was manufactured and installed, and it provided a reliable control with the specified tolerance. The instrument has a telescopic tube (19) with the focal distance of the objective (21) being 400 mm; there is also an eyepiece (3), and the crossed lines (4) are in the focal plane. The glass plate with the crossed lines is adjusted by four screws (5). The tube of the