holders, and the positions of telescopes relatively to the gun when the sight-bar is set at zero.

32. Periscopic sights for turret-guns.—Troubles with the adjustment and difficulties with the installation of parallel-motion

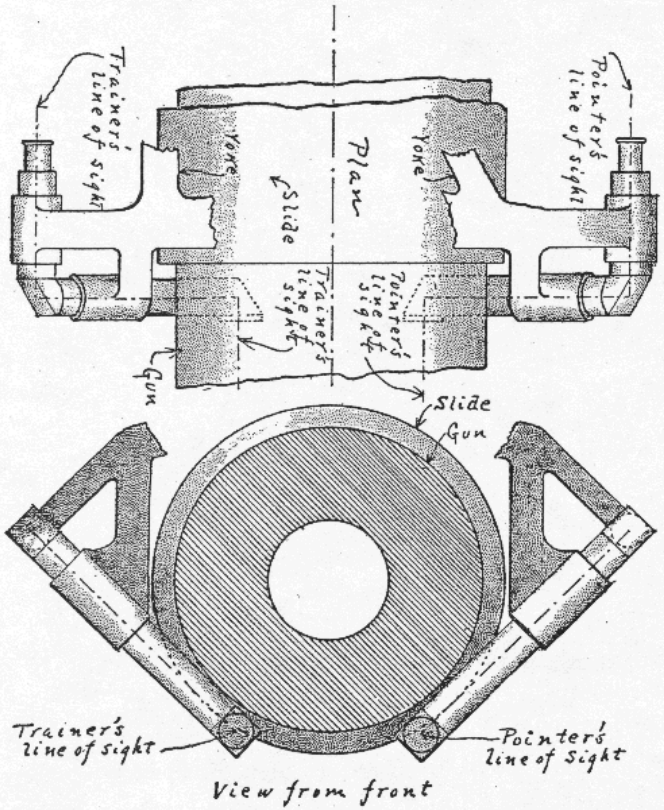

FIG. 22.

sight-mounts have led to the design of a prism telescope in which the line of sight is, in effect, turned through two right angles. This telescope is placed so that it projects through a hole in the side of the turret in line with the axis of the trunnions of the gun as shown in Fig. 23. It is carried in a sight-mount similar in principle to the mount shown in Fig. 1; being attached directly to the slide and trunnion, it has no parallel-motion mechanism.

Besides avoiding the troubles of a parallel motion, this sight does away with the hoods on the roof of the turret, and has thus made possible the arrangement of turrets "in tandem," as on the Michigan and later battleships; one turret can fire over another without injury to the crew of the turret from the effect of blast.

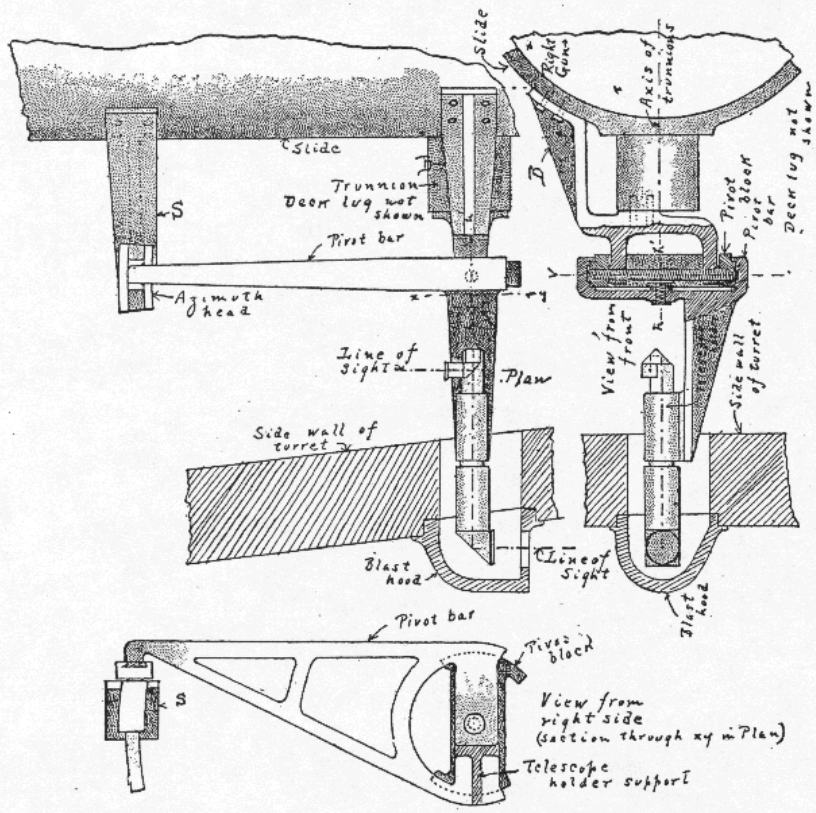

FIG. 23.

It will be seen that the only injury likely to occur to this sight and its mount by the enemy's gun-fire will be destruction of the objective end of the telescope; the sight-mount will be intact, the pointer uninjured, and a spare telescope can readily be shipped in place. In turrets with roof-sights, a hit on the hood will very likely destroy the mechanism of the sight-mount and kill the pointer, besides destroying the telescope.

The fixed parts of the sight-mount are the sight-bar bracket *B*, bolted to the slide and trunnion, and the sight-bracket *S*, bolted to the slide. The pivot-block engages the shaft-pin *vv'*, which journals in the sight-bar bracket, and forms the vertical sight-axis. The pivot-bar is machined to bearings on the top and bottom of the pivot-block in order to give lateral stiffness to the support for the telescope-holder; it also engages the pin *hh'* which is tapped into the rocker and forms the horizontal sight-axis. The two sight-axes intersect at right angles. The rear end of the pivot-bar works laterally in a slot in the azimuth-head, which, with the sight-bar and sight-bar bracket, is practically the same as in Fig. 1. On account of the flatness of the trajectory of the gun with which this sight is used, the range- and deflection-scales are of the multiplying type. The directions of the line of sight at the objective end and eye-piece end of the telescope are shown in dot-and-dash lines on the plan. The outer end of the hole in the side wall of the turret is partly covered by a small hood called the *blast-hood*.

33. The trainer's telescope in turrets fitted with periscopic sights is of the same design as the pointers' telescopes, but is mounted vertically instead of horizontally. The opening for it, in the turret armor, is in the front face of the turret between the guns and close to the shelf-plate. On account of the restricted space available, the mount for this sight, as shown in Fig. 24, is somewhat different from the trainer's sight-mount shown in Fig. 19. Here, instead of a pivot-bar, the part that carries the telescope-trunnions moves in a slot in the azimuth-head which is machined to the arc of a circle that has a virtual center corresponding to the vertical axis of the pivot-bar in Fig. 19. The deflection-drum and pointers are practically the same as in Fig. 19, but the sight-setter's position is in front instead of in rear of the trainer.

34. A bore-sight is a telescope-sight mounted as shown in Fig. 25. The telescope-holder *H* screws into a threaded hole in the center of the casting *D*, called the breech-disk, which is machined to fit into the screw-box of the gun the bore-sight telescope is to be used with. The telescope is mounted in its holder by a ball-and-socket joint *J*—the center of the ball, *c*, being in the axis of

the holder and the geometrical axis of the telescope. The specifications for the telescope require its line of sight to be coincident

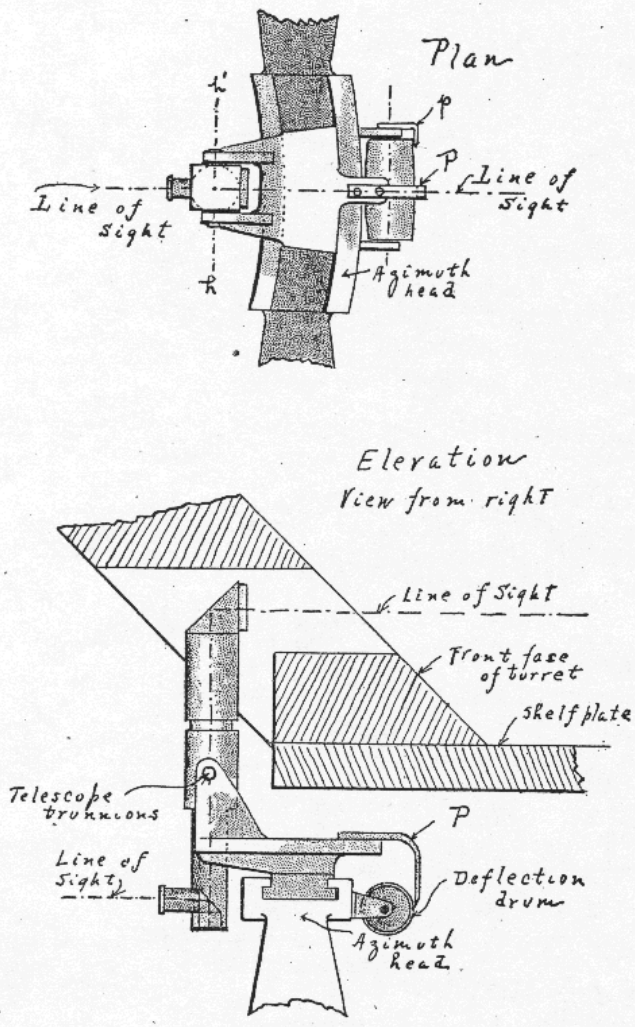

FIG. 24.

with its geometrical axis; thus *c*, the center of the ball-and-socket, lies in the line of sight. The telescope is adjustable about *c* as a center of motion by means of the three thumb-screws *a*, *b*, and *c*.

There is an accessory of the bore-sight called the *muzzle-disk*. This consists of a circular casting machined to fit snugly in the muzzle of the gun the bore-sight telescope is to be used with. It contains a central hole that is $\frac{1}{16}$ inch in diameter, if the disk is for heavy guns, but is smaller in the disks for short guns. To adjust the bore-sight we proceed as follows:

(1) Open the breech-plug of the gun and lash it open, so there will be no chance of its swinging part way shut and injuring the bore-sight.

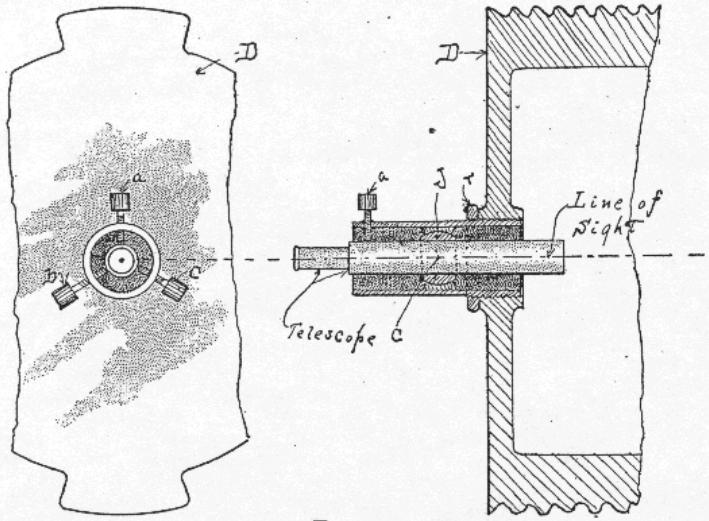

FIG. 25.

(2) Ship the breech-disk in the screw-box and clamp it rigidly in position.

(3) Enter the telescope-holder in the threaded hole in the breech-disk, screw it home, and then set up tight on the locking-ring *r*.

(4) Focus the telescope for distinct vision on an object distant not much less than one mile, by moving the eye-piece tube in or out. The cross-lines of this telescope are permanently fixed in the second focal plane of the objective, so there should never be any appearance of parallax when sighting on a distant object.

(5) Ship the muzzle-disk; see that the lip on its periphery touches the face of the muzzle all around.

(6) By motion of the thumb-screws *a*, *b*, and *c*, direct the line of sight of the telescope to the hole in the muzzle-disk. Since this hole is comparatively close, its image will lie in rear of the cross-lines and will appear as an indistinct, rather large, round bright spot. We would have considerable parallax between the cross-lines and this image if it were not for the fact that the brass cover on the eye end of the telescope has only a small opening, and therefore the eye cannot move much off the axis of the telescope without losing sight of the image. When the intersection of the cross-lines appears to lie in the center of the image, see that the three thumb-screws are set up tight. On a cloudy day, there may not be enough light through the hole in the muzzle-disk to make the cross-lines visible. In this event the lines can be seen by means of a portable electric light hung inside the breech-disk, a little to one side of the telescope.

(7) Test the adjustment of the bore-sight by rotating the muzzle-disk through 180°; if this makes no difference in the apparent position of the intersection of the cross-lines on the image, it is evident we have placed the line of sight coincident with the axis of the bore.

(8) Remove muzzle-disk.

After the bore-sighting of the gun has been completed, put the muzzle-disk in again and see if the bore-sight line of sight is still coincident with the axis of bore. Then unship bore-sight telescope and both disks, and stow them away.

35. Bore-sighting.—Before adjusting sight-scales to zero, the battery officer should satisfy himself of the following:

(1) That the vertical adjustments of frictionless trunnions of the gun are correct; if the gun is a broadside gun, or a turret-gun with a sight that has no parallel motion, errors in this adjustment will produce tilting of the line of sight. (See Art. 1, paragraph 3.) If the gun is a turret-gun that has a parallel-motion sight, incorrect trunnion-adjustment will make the parallel motion inexact. (See Art. 24.)

(2) See that the telescopes are clean and are focused for distinct vision, with no parallax on an object distant at least one

mile; then see that they are bolted securely in the proper positions in their holders.

(3) In the case of turret-guns that have fore-and-aft adjustment of frictionless trunnions, errors in this adjustment will affect the parallelism of the guns, and besides, if the sight has a parallel-motion mechanism, will distort the parallelogram.

NOTE.—If the gun has a parallel-motion sight, the accuracy of its installation should be checked at the first available opportunity (see Art. 27); thereafter, the battery officer need expect no troubles with the proportions of the parallelogram until the gun has been fired a number of times, so long as all adjustments of frictionless trunnions are correct. However, after each firing, the installation of the parallel motion should be checked, for the shocks of firing may have caused some change in the position of the deck-lugs, or sight-bracket.

(4) If the gun has a parallel-motion sight, test this mechanism for lost-motion errors. (See Art. 27.)

(5) Test for lost motion between pivot-bar and sight-scales. (See Art. 12.)

(6) See that all working-parts of the sight-mechanism are well oiled; then remove all oil or grease from sight-scales and their clamp-screws.

(7) See that all bolts, nuts, lock-nuts and cotter-pins in the sight-mount are in place.

36. Bore-sighting (continued).—Having inspected the sight and sight-mount as above, and having adjusted the bore-sight as in Art. 34, we are ready to adjust scales to zero. For accurate work, the ship should be in still water and the mark selected should be one that is well defined and not liable to be confused with some similar mark. The distance should be the mean range expected at firing. First adjust range-scale to zero (see Arts. 5 and 6); then adjust the deflection-scale to zero (see Art. 9). The observers should now change places and check; after sight-scales (or references) are secured by their clamp-screws, lay on the mark and again check the zero adjustment. Then put in the muzzle-disk and check the adjustment of the bore-sight telescope. If this is all right, the gun is ready for firing independently; but if the firing is to be in battle practice or in action, the scales must first be shifted for the calibration corrections, as in Art. 18.