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OPTICAL EQUIPMENT

PERISCOPES, MARK XV, XVI, XVII, XVIII AND XIX

DESCRIPTION

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This publication is RESTRICTED and will be handled in accordance with Article 76, United States Naval Regulations, 1920

PREFACE

This Ordnance Pamphlet No. 495 is a reprint of the pamphlet which was formerly prepared in blue print form, dated March, 1924.

This pamphlet will be superseded by O.P. Nos. 416 and 416-A, which when revised will incorporate the description of these periscopes.

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OPTICAL EQUIPMENT

PERISCOPES FOR FIRE CONTROL

PERISCOPES, MARK XV AND XVI

GENERAL DESCRIPTION

1. These periscopes, manufactured by the Bausch & Lomb Optical Co., Rochester, N.Y., and shown on Bureau of Ordnance drawing Nos. 105064 and 105065, have the following optical characteristics.

Magnification	- High power 7.8X	- low power 3.9X.
Angular field	- High power 5°	- low power 10°.
Exit pupil	- High power 5.1 mm.	- low power 7.3 mm.
Eye distance, Mark XV	- High power 33 mm.	- low power 35 mm.
Eye distance, Mark XVI	- High power 37 mm.	- low power 40 mm.

Light transmission - 39%

2. The Mark XV and Mark XVI periscopes are known as "quick tilt periscopes" and are similar in all respects, except as follows:

(*a*) The vertical distance between the line of sight at the objective prism and the axis of the eyepiece in the Mark XV periscope is 5 feet 6 inches; in the Mark XVI periscope this distance is 4 feet 5 inches. The body tube and internal parts of the periscope between the eyepiece and objective prism are correspondingly shorter in the Mark XVI periscope.

(*b*) The location of the Mark XV periscope in azimuth and height is determined by a locating pin hole in the azimuth adjusting ring on the outer sleeve. A locating pin on the mount for the periscope fits in this hole and locates the periscope. In place of a locating pin hole, the Mark XVI periscope is fitted with a locating lug on the outer sleeve. This lug fits into a slot in the periscope mount which locates the periscope in azimuth. The periscope is located in height by a distance block on the bottom of the locating lug.

(*c*) The eye distance of the Mark XV periscope is slightly shorter than the eye distance of the Mark XVI periscope.

USE

3. The Mark XV periscopes are installed in the high turrets, one in the forward high turret and two in the after high turret. All Mark XV periscopes are mounted in periscope mounts Mark V. These periscopes are for the use of the turret officers in the high turrets.

4. The Mark XVI periscopes are installed in the conning tower and fire control tower, one in the conning tower and two in the fire control tower. These periscopes are mounted in General Electric Co. mounts. The periscope in the conning tower is for the use of the commanding officer, those in the fire control tower are cross-connected mechanically with the fire control tower gun director and are used as spotting periscopes.

OPTICAL SYSTEM

5. The optical parts of the periscopes consist of an objective prism, objective lens, crossline lens, erecting lens, eyepiece prism, and eyepiece lens system.

6. The objective prism, or tilting prism, is a 45^{o} prism mounted in a prism housing which in turn is mounted in bearings so that the prism is capable of rotation through an arc of 15^{o} in elevation, thereby rotating the line of sight through an arc of 30^{o} in elevation, 15^{o} above and 15^{o} below the reference plane of the ship.

7. The objective lens, crossline lens, and erecting lens are mounted in an optical tube secured inside the body tube. This optical tube is fitted with bearings which bear against the body tube and locate the optical tube in the optical axis. The optical tube is secured at the objective end only, in order to allow for expansion or contraction due to temperature.

8. The objective lens is mounted in a housing at the top end of the optical tube.

9. The crossline lens is mounted in a housing in the optical tube and located in the second focal plane of the objective lens. The crosslines are etched on the glass and the etching is filled with an opaque material. A mil scale is etched on the crossline lens also. This mil scale is graduated on both sides of the vertical line and is located in the upper part of the field.

10. The erecting lens is mounted in a short tube in the optical tube below the crossline lens. This erecting lens tube slides in the optical tube and at each end of its travel changes the magnification.

11. The eyepiece prism is a 45^{o} prism located in a stationary prism housing, below the optical tube.

12. The eyepiece lenses are located in the eyepiece tube which is easily removed from the eyepiece head. There are two lenses, a field lens and an eyepiece lens.

TILT MECHANISM

13. The tilting of the objective prism and consequent elevation or depression of the line of sight is accomplished by rotating the prism tilt handwheel located on the base casting to the left of the eyepiece. This handwheel is equipped with stops to prevent rotation of the line of sight beyond approximately 15^{o} on each side of a line perpendicular to the axis of the periscope tube, and also with an index to indicate when the line of sight is at right angles to the axis of the periscope tube.

14. Turning the prism tilt handwheel rotates a shaft to which is secured a bevel gear. This bevel gear in turn rotates a prism tilting shaft extending from the base of the periscope to the objective head. The upper end of this shaft is threaded and is fitted with a traveling nut, which moves up and down as the prism tilting shaft rotates. On the traveling nut is a gear rack in which meshes a gear sector secured to one of the trunnions of the objective prism housing. As the gear rack moves up or down it rotates the gear sector which in turn rotates the objective prism, thereby elevating or depressing the line of sight.

CHANGE OF MAGNIFICATION

15. Change of magnification is accomplished by rotating the change of magnification crank handle located on the base casting to the right of the eyepiece. Arrows are stamped into the base casting indicating the direction of turning for high power or low power.

16. Rotating the change of magnification crank handle rotates a shaft on which is secured a bevel gear. This bevel gear in turn rotates a vertical shaft, the upper end of which is threaded. On the tube containing the erecting system there is a lug which is threaded and fits on the vertical change of magnification shaft acting as a traveling nut. The lug on the erecting lens tube passes through a slot in the optical tube. Stops are provided to limit the travel of the erecting lens tube. The travel of the lug up or down on the vertical shaft changes the vertical position of the erecting lens system, and at each end of travel the lens is in position for high power or low power magnification.

BODY TUBE

17. The main body tube of the periscope is of cold drawn seamless steel tubing of 1/4 inch thickness, threaded at each end to receive the centering rings for the base casting and objective head casting, and machined near the lower end to receive the outer sleeve.

OUTER SLEEVE

18. In the Mark XV periscope, an outer sleeve is shrunk on the body tube. To the bottom of the outer sleeve is secured an azimuth adjusting ring for the purpose of locating and supporting the periscope in its mount. The azimuth adjusting ring is secured to the outer sleeve by means of seven bolts fitting through slotted holes in the adjusting ring. The slotted holes allow for adjusting in azimuth. In the azimuth adjusting ring is a locating pin hole, located so accurately on all periscopes that when two periscopes are interchanged in their mounts, the line of sight of the periscopes will be the same within one minute of arc.

19. In the Mark XVI periscope, the outer sleeve is clamped to the main body tube instead of being shrunk on. Two split wedge rings, one at the top of the outer sleeve and one at the bottom of the outer sleeve are located between the body tube and the outer sleeve, and clamp the outer sleeve securely in place when these split wedge rings are forced in by screwin the outer sleeve clamping rings. Instead of a locating pin hole as in the Mark XV periscope, there is an azimuth locating lug and distance lug for locating the periscope in its mount. One side of the azimuth lug is carefully machined and fits against a machined face of a guide slot in the periscope mount. On the opposite face of this lug are spring loaded ball bearings which bear against the opposite face of the guide slot and force the machined face of the lug against the machined face of the guide slot. The outer sleeves of all periscopes are so adjusted in azimuth, that periscopes may be interchanged in their mounts without changing the line of sight of the periscope for an angular amount greater than one minute of arc.

OBJECTIVE HEAD CAP

20. The objective head cap or outer objective head, is of bronze. It contains a window which is placed in front of the objective prism. The objective head cap rests on a centering ring which in turn is threaded to the top of the body tube. It is held securely in place and made watertight by a clamping ring.

BASE CASTING

21. The base casting is also of bronze and is threaded to receive the eyepiece optical system. It contains the bearings for the prism tilt and change of magnification shafts, the dry air inlet and outlet valves, and calcium containers.

RAY FILTER ATTACHMENT

22. The eyepiece mount is fitted to receive an adapter for the Mark I, Mod. 1 ray filter attachment. The ray filter attachment clamps on this adapter. It is fitted with rubber eyeguards for both eyes, and a scale of interpupillary distances is provided for adjusting the blinder for the eye not in use. The ray filter attachment is capable of rotation through 180° so that either eye may be used. The ray filter attachment contains one blank space and four ray filters, viz., dark smoke, light smoke, yellow and red.

DRY AIR INLET AND OUTLET

23. On the base casting opposite the eyepiece are located the dry air inlet and outlet valves for use in filling the periscope with dry air to prevent moisture from condensing. An air circulating tube extends from the inlet valve to the objective head to insure the dry air reaching all parts of the instrument.

CALCIUM CONTAINER

24. A calcium container is located in the bottom plate of the base casting. This container contains metallic calcium for the purpose of absorbing any moisture which may have entered the periscope.

OPERATION

FOCUSING

25. Change of focus is accomplished by rotating the corrugated eyepiece actuating ring. This ring should be rotated from plus to minus diopters until the image is in sharp focus. There is an index on the base casting and a diopter scale on the actuating ring. When the image is in sharp focus, the diopter scale should be read in order to save time in refocusing. The eyepiece is capable of change of focus of 5 diopters, from plus 2 diopters to minus 3 diopters. The focus changes slightly when magnification is changed.

CHANGING MAGNIFICATION

26. Under ordinary conditions, the high power is most generally used. When a large field is desired, the low power is used. In changing magnification, the crank handle should be turned until it comes up against the stop.

PRISM TILT

27. The prism tilting feature is provided in these periscopes in order that the observer may follow the target while the ship is rolling. An index mark on the prism tilting handwheel shaft indicates the point at which the line of sight is perpendicular to the axis of the periscope tube, and parallel to the horizontal plane of the ship. The periscope is trained in azimuth by a handwheel on the periscope mount. An extra handwheel is provided with each Mark XVI periscope. This handwheel may be fitted and used where space prevents use of regular handwheel.

MIL SCALE

28. The mil scale is provided for assistance in spotting deflection. The graduations are placed at each 5 mils, on both sides of the vertical cross line, and at every 10 mils, the graduation is numbered 10, 20, 30, etc.

RAY FILTERS

29. For all favorable conditions of visibility the clear filter is used. For observation against searchlights or very bright sun glare, the dark smoke filter should be used. For mild glare the light smoke filter should be used. The yellow filter and red filter should be used under hazy conditions. These colored filters under many conditions of haze increase the visibility by increasing the contrast of the target against a hazy background. The use of ray filters may necessitate refocusing.

30. In using ray filters, an appreciable period of time, sometimes as long as 30 seconds, is necessary to allow the eye to accommodate itself to the ray filter and thus obtain the best possible vision.

PERISCOPE, MARK XVII
(Accurate Tilt)

GENERAL DESCRIPTION

31. This instrument, manufactured by the Bausch & Lomb Optical Co., Rochester, N.Y., and shown on Bureau of Ordnance drawing No. 105066, has the following optical characteristics.

Magnification	- High power 7.9X	- low power 3.9X.
Angular field	- High power 5°	- low power 10°.
Exit pupil	- High power 5.1 mm.	- low power 7.2 mm.
Eye distance	- High power 35 mm.	- low power 37 mm.
Light transmission	- 39%	

32. The Mark XVII periscope is known as an accurate tilt periscope as distinguished from the Marks XV and XVI or quick tilt periscopes. The main features in which the Mark XVII periscope differs from the Mark XV and XVI periscopes are the tilting mechanism, the addition of a director scale, the addition of illuminators for the director scale and crosslines, and the substitution of an objective tilting mirror in place of an objective tilting prism.

USE

33. The Mark XVII periscopes are installed in the Mark XIV gun directors located in the high turrets. The prism tilting mechanism is connected mechanically to the General Electric director correction transmitter, and the angle of elevation or depression of the line of sight above or below reference plane of the ship is transmitted mechanically in minutes of arc to the director correction transmitter.

OPTICAL SYSTEM

34. The optical system of the Mark XVII is similar to the optical system of the Mark XV periscope except that an objective tilting mirror is used in place of the 45° objective tilting prism. This mirror is mounted in a housing which in turn is mounted in bearings, such that the mirror is capable of rotation in a vertical plane through an arc of 15°, thereby rotating the line of sight in a vertical plane through an arc of 30°, 15° above and 15° below the reference plane of the ship.

35. The crossline lens is not graduated with a mil scale.

TILT MECHANISM

36. The tilting of the objective mirror and consequent elevation and depression of the line of sight is accomplished by rotating the handwheel located on the gear box to the left of the eyepiece. Turning this handwheel rotates a shaft on which is a bevel gear. This bevel gear rotates a short vertical shaft on which is a gear wheel meshing with a gear wheel on the mirror tilting shaft. This mirror tilting shaft extends from the base of the instrument into the objective head and is threaded at the top to receive a traveling split nut which moves up or down as the shaft rotates. On the traveling nut is a lug which is carefully machined to fit a guide slot thus preventing the nut from rotating with the tilting shaft. On this lug there is also a gear rack in which meshes a gear sector secured to one of the trunnions of the objective mirror housing, so that movement of the gear rack causes a rotation of the objective mirror in a vertical plane. In order to secure greater accuracy the radius of the gear sector is greater in the Mark XVII periscope than in the Mark XV periscope.

DIRECTOR SCALE

37. The director scale consists of two scales, the upper scale being graduated in minutes of arc from 100 to 1900 at each 100 minutes and the lower scale being graduated in minutes of arc from 0 to 100, at each minute, every 5 minutes being numbered. This scale measures the accuracy of tilt within one minute of arc. The lower scale is keyed directly to the vertical tilting shaft and turns with it. The upper scale is part of an outer shaft which rotates on the tilting shaft. On this outer shaft and part of it, is a worm gear which is actuated by a worm on the tilting handwheel shaft. The ratio of the two sets of gearing which actuates the scales is such that the lower scale makes one complete revolution while the upper scale rotates from one graduation to the next graduation, in much the same manner as the minute hand of a watch makes a complete revolution while the hour hand travels from one hour to the next hour.

38. A small index line and point secured to the stationary part of the gear box give the reference point in reading the scale.

39. The zero point, or point at which the line of sight corresponds to the reference plane of the ship, is represented on the director scale as 1000.

40. The handwheel shaft is threaded to receive a travel-nut. At points of the travel of this nut corresponding to readings of 1900 and 100 on the director scale, stops are provided to prevent the line of sight being elevated or depressed beyond these two points to any great amount.

41. A keyway is slotted in the bottom of the mirror tilting shaft which extends through the gear box, and the tilting shaft is keyed to a shaft from the director correction transmitter.

CHANGE OF MAGNIFICATION

42. The change of magnification is accomplished in the same manner as in the Mark XVI periscope.

BODY TUBE

43. The body tube and outer sleeve are similar to those of the Mark XVI periscope except that the dimensions are somewhat greater in the Mark XVII periscope.

OBJECTIVE HEAD CAP

44. The objective head cap is of a slightly different shape than that on the Mark XVI but is similar in design and construction.

EYEPIECE

45. The eyepiece system is similar to that of the Mark XVI periscope.

CROSSLINE ILLUMINATOR

46. For night use, the crosslines may be illuminated by an illuminator mounted in the body tube at a height corresponding to the height of the crossline lens. The illuminating lamp is mounted in a socket and lamp holder. The lamp holder has four slotted lugs which are held in place by four screws in the illuminator mount. These four screws afford a means of adjusting the lamp holder in the illuminator mount so that the beam of light from the lamp can be made to strike the intersection of the crosslines. The lamp and lamp holder may be removed without disturbing in any way the watertightness of the periscope. In the illuminator mount, between the lamp and the crossline lens, is a small bull's-eye lens for condensing the light rays and sending slightly divergent rays through a small diaphragm and through the crossline lens to the crosslines. The light rays enter the edge of the lens and pass through the lens radially to the crosslines. An illuminator cover screws on the illuminator mount and protects the illuminator.

47. The lamp used in the illuminator is a 10 volt lamp of the same type that is used in other parts of the director system.

48. The lighting circuit is a two wire circuit, the terminals being located in the base casting just above the eyepiece.

SCALE ILLUMINATOR

49. The scale illuminator consists of a 10 volt lamp, the same as used in the crossline illuminator. This lamp is mounted in a socket which fits in a hole in the bottom plate. It is held in place by a small clip and is easily and quickly removed. The lighting circuit is a two wire circuit, the terminals being located on the illuminator in the base casting just below the eyepiece.

DRY AIR INLET AND OUTLET VALVES

50. The dry air inlet and outlet valves and the air circulating tubes are the same as in the Mark XVI periscopes.

CALCIUM CONTAINER

51. The calcium container is the same as in the Mark XVI periscopes, as is also the ray filter attachment.

OPERATION

52. Focusing and change of magnification are accomplished in the same manner as in the Mark XVI periscope.

53. After setting magnification and focus, the gun director operator tilts the objective mirror until the line of sight, as indicated by the horizontal cross wire, is at the proper angle of elevation or depression. If the director correction system is operating, this angle of the line of sight is automatically transmitted to the plotting room by the director correction transmitter. This angle may also be read on the director scale, the upper half of the scale indicating the hundreds and the lower half indicating the units in minutes of arcs.

54. The periscope is trained in azimuth by a handwheel on the periscope mount.

PERISCOPE, MARK XVIII

GENERAL DESCRIPTION

55. The Mark XVIII periscope is a double periscope, two separate optical systems being mounted each in a separate tube, these tubes being contained in a single outside body tube. The optical characteristics of the director operator's part of the periscope is the same as in the Mark XVII periscope, for the trainer's part of the periscope, they are the same as in the Mark XV periscope. See Bureau of Ordnance drawing Nos. 105067 and 105068.

USE

56. The Mark XVIII periscope is located in the fire control tower and is used in the combined gun director and target bearing transmitter. One optical system corresponds to the Mark XVII periscope and the eyepiece for this system is used by the director operator. The other optical system corresponds to the trainer's periscope and its eyepiece (separated 180° in azimuth from the other eyepiece) is used by the target bearing operator.

OPTICAL SYSTEMS

57. The director operator's optical system is similar to that of the Mark XVII periscope. The trainer's optical system is similar to that of the Mark XV periscope, except that a roof prism instead of a 45° prism is used at the objective head and a penta prism instead of a 45° prism is used at the eyepiece end. The use of a roof prism and penta prism is necessary to pervert and invert the image, so that the image appears in the same relative position to the trainer as it appears to the director operator.

TILTING MECHANISMS

58. The tilting mechanism of the director's system is the same as in the Mark XVII periscope, except that a slightly different design of traveling nut, guide slot and gear sector is necessary at the objective end.

59. The tilting mechanism of the trainer's system operates in the same manner as in the Mark XV periscope.

CHANGE OF MAGNIFICATION

60. The change of magnification mechanism is the same as in the Mark XV and XVII periscopes.

BODY TUBE

61. The body tube and outer sleeve are the same as in the Mark XVI periscope, except that they are necessarily larger in diameter in order to accommodate two optical tubes.

OBJECTIVE HEAD CAP

62. The objective head cap is the same as in the Mark XVI periscope except that the window is made larger in order to provide a field for two optical systems.

EYEPIECE

63. Two eyepieces are provided, one for the director operator and one for the trainer. These eyepieces are the same as in the Mark XV periscope, except that the trainer's eyepiece is mounted 180° in azimuth from the director operator's eyepiece. The director operator looks in the same direction as the bearing of the target. The trainer looks in the opposite direction but the target appears in the same position to him as though he were looking directly at the target.

ILLUMINATORS

64. Two crossline illuminators are provided, one for each crossline lens. These illuminators are of the same general type as those in the Mark XVII periscope (except that the illuminator mounts are set at an angle to the radius of the body tube).

65. The scale illuminator is the same as in the Mark XVII periscope.

RAY FILTER ATTACHMENT AND DRYING SYSTEMS

66. The ray filter attachment, dry air inlet and outlet valves, and calcium container are provided and are the same as in the Mark XVI periscope.

OPERATION

67. Focusing and change of magnification are accomplished in the same manner as in the Mark XVI periscope.

68. The trainer trains the periscope in azimuth by means of a training wheel on the periscope mount, keeping his vertical crossline on the point of aim and tilting his objective prism with the other hand to keep the target in the field.

69. The director operator operates the objective mirror of his system in the same manner as in the Mark XVII periscope.

PERISCOPE, MARK XIX

GENERAL DESCRIPTION

70. The Mark XIX periscope is the Mark VI, Mod. 2 periscope modified by the addition of an outer sleeve to fit the torpedo target bearing transmitters, Mark I and Mark I, Mod. 1 manufactured by the General Electric Co. Twelve periscopes, Mark VI, Mod. 2, register Nos. 385-396 inclusive, were changed to periscopes Mark XIX for installation on ships of the U.S.S. Colorado class.

71. The outer sleeve is designed for accurately locating the periscope in azimuth in the torpedo target bearing transmitter, the purpose being to make the various periscopes of this type interchangeable in the mounts without the necessity for readjustment in azimuth. This sleeve is similar in design to, and attached to the periscope in the same manner as the sleeve on periscopes, Mark XVI.

72. Two periscopes, Mark XIX are installed in the conning tower, one in each torpedo target bearing transmitter, Mark II or Mark II, Mod. 1.

CARE OF THE PERISCOPES

GENERAL PRECAUTION

73. These periscopes are carefully assembled and accurately aligned in a special collimator at the works of the manufacturer, so that the director scales measure the angle of elevation of the line of sight within one minute of arc, and so that all periscopes are interchangeable in their mounts without changing the line of sight in azimuth over one minute of arc. *They should never be disassembled unless facilities are available to realign them exactly.*

REPLACEMENTS

74. All periscopes of the same mark are interchangeable in their mounts without changing the accuracy of the line of sight over one minute of arc. In case a periscope is defective, it should be replaced by a spare periscope while the defective periscope is being repaired. One spare periscope of each mark is provided for each ship. The only parts of the periscope which should be replaced by the ship's force are the eyepiece mount, the ray filter attachment, the tilting handwheel, the change of magnification crank handle, the crossline illuminator, the scale illuminator, dry air inlet and outlet valves and the calcium containers.

75. The eyepiece mounts are the same for all marks of periscopes. The mount can be removed by unscrewing a small set screw in the base casting and then unscrewing the mount from the base casting into which it fits. Removal of the eyepiece mount exposes the eyepiece prism which should be protected from dust or moisture. The lenses of the eyepiece mount should be removed only by an optical expert on a repair ship or at an optical shop.

76. The crossline illuminator cable terminals are secured to the illuminator mount by screws. Sufficient slack cable is allowed to remove the illuminator mount and detach the terminals. This should be done before removal of an optical tube from the periscope is undertaken. To replace an illuminator lamp, remove the illuminator cover, unscrew two adjacent screws of the lamp holder, and the lamp holder with the lamp can be easily lifted out of the mount. Replace the lamp and insert the lamp holder in the mount. After replacement it will probably be necessary to adjust the lamp by manipulating the four screws which hold the lamp holder in place, so that the beam from the lamp strikes the center of the crosslines.

MOISTURE PREVENTION

77. Before acceptance, the periscopes are filled with dry air subjected to a watertight test at the place of manufacture, in order to insure that all joints are thoroughly tight. In order to prevent moisture collecting in the periscope, it is very necessary that the joints which expose the interior of the periscope to outside air should be broken only when absolutely necessary. A calcium container for holding metallic calcium is fitted to each periscope. The metallic calcium readily absorbs moisture from the air and should be inspected monthly, renewing the calcium when necessary.

78. In case moisture gathers inside the periscope it should be removed by forcing dry air into the dry air inlet valve. The inlet and outlet valves each have two screws, one slotted and the other fitted with a square hole. The slotted screw in the inlet valve should be removed first, and a small amount of dry air blown into the screw hole, so that any dirt which may be in the screw threads will not be blown into the periscope. The air valve should then be opened by giving about one full turn of the screw. The screw should not be removed as this may allow dirt to settle on the valve seat and cause the valve to leak. The slotted screw in the outlet valve should then be removed, and the screw with the square hole given one full turn to the left. The air line should then be attached and the dry air allowed to pass into the inlet valve. This dry air current is conducted through a pipe to the objective end of the periscopes and exhausts through

the periscope and out of the outlet valve. The air should be allowed to pass into the instrument slowly in order that all parts of the instruments will be reached. The periscopes are tested with an internal pressure of 4 pounds at the works of the manufacturer, and care should be taken that this pressure is not exceeded.

79. Removing the calcium container or the screws of the dry air inlet and outlet valves exposes the interior of the periscope to outside air, and care should be observed in replacing these fittings to see that they are screwed on tightly to prevent air leakage.

CLEANING

80. The usual precautions against corrosion of the outside surfaces should be observed. All corrosive outside surfaces except the outer sleeve bearings are painted or plated to prevent corrosion. The outer sleeve should be inspected frequently for signs of corrosion, and any signs of corrosion immediately removed. The outer sleeve should be covered by a film of light oil before installation in the mounts.

81. The objective window and eyepiece lens are made watertight by the use of gaskets and there should be no necessity for their removal for cleaning. The outer surfaces of the objective window and eyepiece lens should be wiped off only when necessary, and no material other than lens paper, clean chamois or selvyt cloth should be used for this purpose. Cleaning is sometimes facilitated by blowing the breath on the glass surfaces and wiping off the moisture. The use of alcohol or ether for this purpose is dangerous, as these liquids will dissolve the balsam between lenses. The glass surfaces should never be touched with the fingers. Fingerprints on glass will in time cause the glass to corrode.

82. The exposed gearing and shafting of the director scale mechanism should be kept well greased to prevent wear and corrosion.

TOOLS

83. Each packing case contains a tool box containing the following tools:

1 Eyepiece wrench
1 Dry air valve wrench
1 Small screw driver
1 Medium sized screw driver
1 Piece chamois
1 Camel's hair brush

84. The eyepiece wrench is a spanner wrench which fits the slots in the eyepiece mount, and is used for unscrewing the eyepiece mount from the base casting after the removal of the small set screw in the base casting.

85. The small screw driver is provided for removing the eyepiece mount set screw. The medium sized screw driver is for the screws on the tilting handwheel and change of magnification crank handle.

86. The camel's hair brush is for use in removing dirt or dust on glass surfaces of the objective window or the eyepiece lens, and the chamois is for use in cleaning these surfaces.

SPARE PARTS

87. Special tool boxes and spare part boxes for these periscopes are supplied with the periscopes but these tool boxes and spare part boxes are kept on board repair ships or at optical shops.

NAVY DEPARTMENT
BUREAU OF ORDNANCE
March, 1924.

C. C. BLOCH
Chief of Bureau.