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the helix. This adjustment is not easy to carry out at an outstation, because of the difficulty of testing to see if the required result is obtained. If the first adjustment is not quite correct it is usually fairly simple to get the correct result by proportion.

Maintenance and repair. The helix should be handled carefully to avoid mechanical damage, and should be kept clean. The bearings of the spindle should be kept clean, and oiled at intervals by the sparing use of a little clock oil. The instrument is very simple mechanically, and, provided precautions are taken to keep the friction to a minimum and to prevent corrosion, it should give good service.

Accuracy and sources of error. In the thermograph mechanism itself, friction is the main source of error. One cause of this is bad alignment of the helix with respect to the spindle. Unless accurately placed the helix acts as a powerful spring, and, if rigidly anchored, it pushes the main spindle against one side of the bearings. With modern instruments this should not be a serious problem. Friction between the pen and chart can be kept to a minimum by suitable adjustment of the gate suspension (see Appendix 1). When new instruments are tested, the maximum permissible error at any point is ±0.5 °C.

7 MEASUREMENT OF SEA SURFACE TEMPERATURE

7.1 General

The sea surface temperature may be measured using one of three main methods:

(a) A bucket is lowered overboard to obtain a sample of sea water, the temperature of which is then measured. The temperature measured is approximately the average temperature of the uppermost 150 mm deep layer of the sea surface.

(b) The temperature of the sea water in the engine-room intake is measured. This is the temperature at a depth that will vary with the size of the vessel and its loading, and may be as deep as 15 m. The difference in temperature between the surface and the depth of the intake may be appreciable when the sea is calm and the sun is shining brightly. Intake readings are also liable to certain siting errors. For these reasons, whenever practicable, the bucket method is preferable.

(c) A hull sensor, containing a platinum resistance thermometer, is mounted on the inside of the ship's hull below the water-line. The depth will vary with the loading of the vessel. Temperature measurement may be made remotely with either a manually balanced bridge indicator, such as the Mk 5 indicator (see page 2–39), or an automatic digital temperature indicator, such as the DTI Mk 1B (see page 2–41).

7.2 Thermometers for use with sea-temperature buckets

Mounted thermometer Mk 3 (Plate VII). For extra strength and robustness unsheathed mercury thermometers may be mounted on a plastic mount. These thermometers have spherical bulbs and the top of the stem is made in the form of a nib to fasten in the top of the mounting. They are used in conjunction with a canvas bucket.

The scale is engraved on the stem with graduation marks every 0.5 °C; the graduation marks for every 5 °C are also reproduced and figured on the mount, on the right hand side of the thermometer stem. The graduation marks on the stem of the thermometer are always used in observing the units and tenths of a degree, the marks on the mount being used only for the fives figure. If there is any slight discrepancy between the graduation marks on the mount and the corresponding marks on the thermometer stem, the mark on the stem should always be taken as correct. In addition to the normal graduation marks there are etched on the side of the stem, in very small numerals at the appropriate places, such of the following graduation marks as fall within the range of the thermometer:

−20 °C, 0 °C, and +40 °C.

These marks are used by the Instrument Branch Test Laboratory when testing the thermometers, and can also be used to ensure that the thermometer has not been fixed to the wrong mount. Apart from the length (246 mm) the thermometer complies with the British

Standard for the Ord/2C meteorological thermometer, the essential requirements of which are set out in Table X.

The graduation marks on this thermometer are exposed to the atmosphere and the blacking may need renewing at intervals by rubbing the stem of the thermometer with a dark coloured crayon or a black lead pencil, and wiping off the surplus.

Mount. The mount is made of unbreakable rigid plastic. It is rectangular in shape apart from a slightly curved top edge. The length of the mount is 246 mm, width 35 mm, and thickness 4 mm; the long edges are bevelled. Two nickel clips hold the thermometer in position, and the nib at the end of the thermometer stem is let into a hole at the top of the mount and fixed with plaster of Paris. When the thermometer is in position the distance from the bottom of the mount to the bottom of the thermometer bulb is between 2.5 and 3.8 mm. Two small holes are drilled in the top of the mount and are used to attach it to a thermometer protector.

Sea-temperature thermometers Mk 2 and Mk 3 (Figure 19). Both thermometers are of the mercury-in-glass type with cylindrical bulbs, the Mk 3 having a button on the top. The scale covers a range from –5 °C to +35 °C with graduation marks every 0.5 °C, figured every 5 °C. All negative figures have a minus sign placed above them. The permissible errors are similar to those for thermometers for aspirated psychrometers (see page 2–26).

7.3 Thermometer protector

The thermometer protector (Plate VII) is used as a protective support for the mounted thermometer. It consists of a recessed mahogany stock with a brass reservoir provided at the base into which the bulb of the thermometer dips. The thermometer mount rests with its base on a brass support on the bottom of the stock, and is held at its upper end by a brass clamping plate which is screwed to a metal fitting passing over the top of the stock. A spring attached to the clamping plate grips the mount firmly. When the thermometer has to be removed for any reason the clamping plate should first be taken out by unscrewing the two fixing screws.

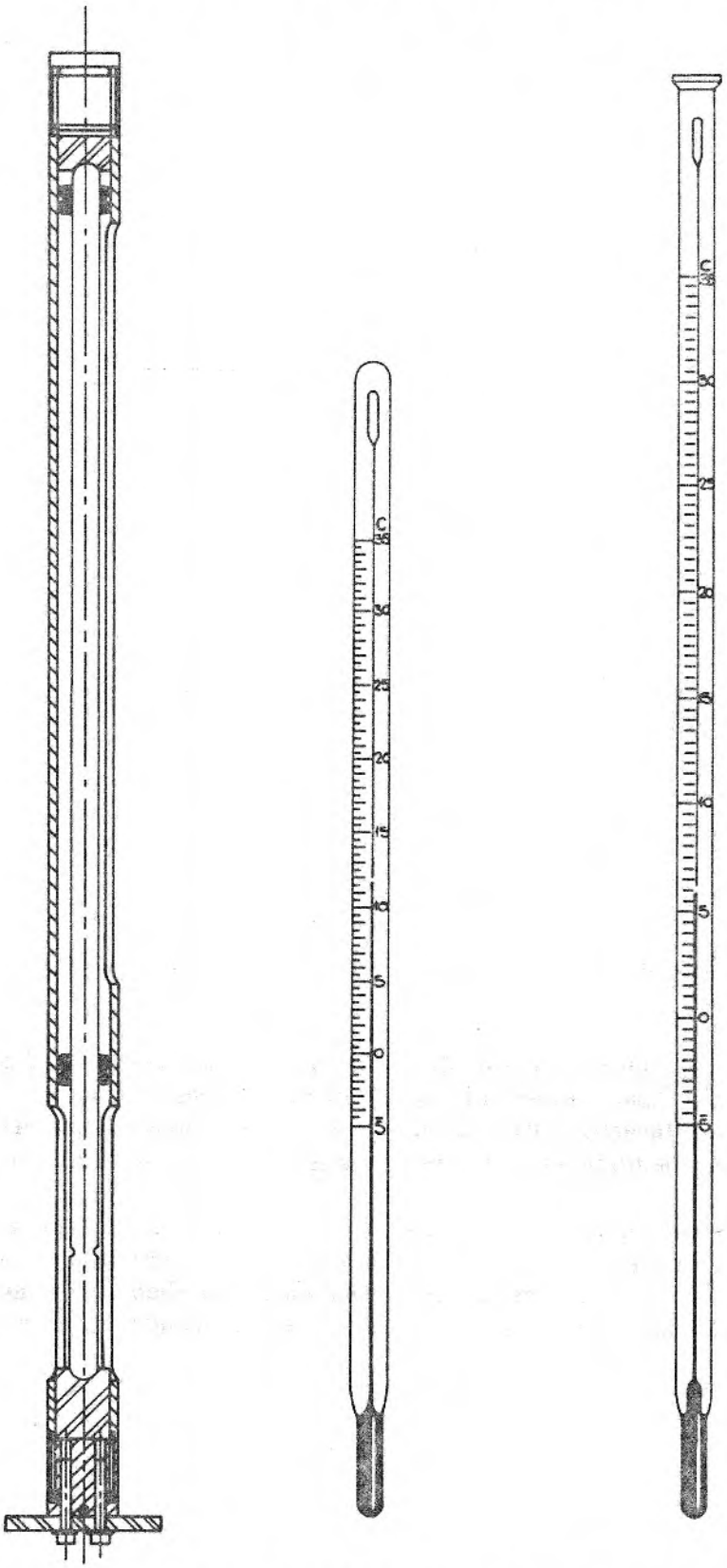
7.4 Thermometer sheath

The thermometer sheath (Figure 19) acts as a protective container for a Mk 2 sea-temperature thermometer. It is made of a length of brass tubing, closed at each end by a threaded solid brass plug. The inner surface of each plug is fitted with a neoprene buffer. Rubber grummets provide additional support for the thermometer when fitted in the sheath. A cutaway, in the form of a long slot, allows reading of the fitted thermometer and two diametrically opposed small slots assist circulation of the water around the thermometer bulb. A polythene washer is fitted to the plug at the bottom of the sheath and acts as a retaining flange when the thermometer–sheath assembly is being withdrawn from the bucket for reading.

7.5 Sea-temperature buckets

Meteorological bucket Mk 2A (Plate VII). The meteorological bucket Mk 2A consists simply of a canvas bucket with a wooden base, fitted with a lid which is kept closed by means of a spring. When the bucket is trailed through the sea the lid is opened by the water pressure and the bucket is filled. The lid reduces the loss of water when the bucket is being hauled to the ship's deck and also reduces the rate of heat loss due to evaporation from the water surface.

Method of use. The bucket should be let into the water forward of all outlet pipes after making fast to the deck rail or other firm support the rope connected to the bucket handle. After letting the bucket trail in the water for at least 30 seconds, keeping the bucket just below the sea surface as far as possible, it should be withdrawn quickly, placed in the shade and out of the wind, the thermometer inserted in the bucket and the water stirred. The temperature recorded by the thermometer should then be read to the nearest 0.1 °C when it attains a steady value (after about 30 seconds). The bulb of the thermometer should be kept



. Figure 19. Thermometer sheath and sea-temperature thermometers Mk 2 and Mk 3.

well beneath the surface of the water throughout with continuous stirring, and the reading should be taken without undue delay as soon as the temperature of the thermometer becomes steady or the rate of change of temperature becomes less than 0.1 °C min^{-1}. The thermometer should not be withdrawn from the water until the reading has been taken. It is

not advisable to keep the bucket trailing for longer than one minute as this period is more than sufficient to allow the bucket to take up the water temperature and any longer immersion shortens the life of the bucket.

Maintenance. The bucket should be emptied completely after use and stored under cover, away from the detrimental effects of strong sunshine or of temperatures below freezing.

Sea-temperature buckets Mk 3A and Mk 3B. The sea-temperature bucket Mk 3A (Figure 20) is a double-walled container made from two lengths of canvas-reinforced rubber hose one inside the other. At the top, the two hoses are secured to each other and to a gun-metal mouth to which is fitted a brass handle. The outer hose is sealed at the bottom by a teak plug, and has four 16 mm diameter holes equidistant around its circumference with centres approximately 68 mm from the top. The bottom end of the inner hose is castellated to assist the flow of water through the bucket.

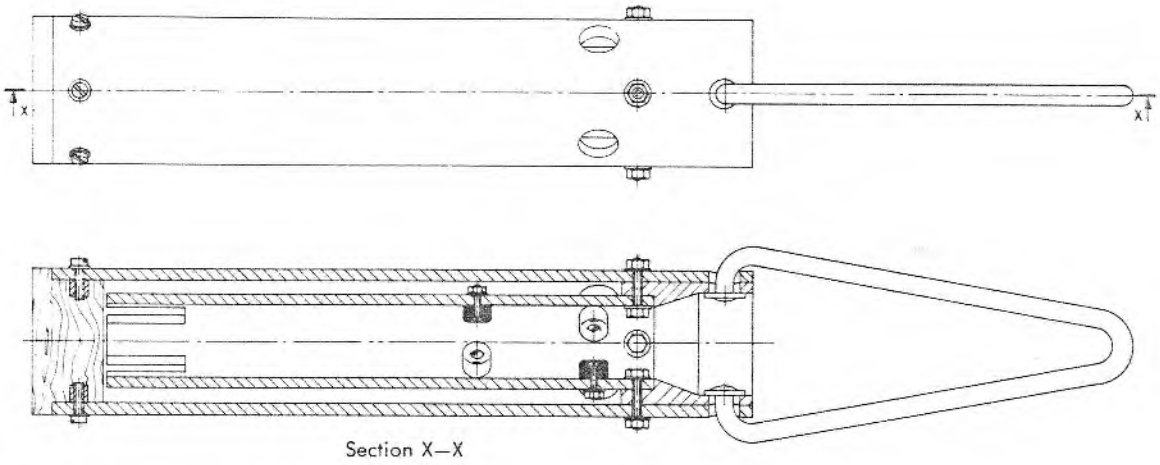


Figure 20. Meteorological Office sea-temperature bucket Mk 3A.

The Mk 3B bucket differs from the Mk 3A in that instead of using a teak plug to seal the bottom of the outer hose a rubber disc is vulcanized in place.

Both buckets may be used with the sea-temperature thermometer Mk 3. Alternatively the Mk 3A bucket may be fitted with a thermometer sheath and sea-temperature thermometer Mk 2.

Method of use. The method of collecting a sea-water sample is the same as with a canvas bucket. If a Mk 3A bucket is used complete with sheath and thermometer, the temperature of the sample should be taken immediately by pulling up the sheath as far as necessary and reading the thermometer. The bucket should then be emptied and the sheath pushed back in.

If the bucket only is used, the thermometer should be dipped into the sample for about 30 seconds and the temperature then read without removing the thermometer.

7.6 Engine-room intake thermometer

On ships where the bucket technique is not practical, the sea temperature can be measured at the engine-room intake. The most accurate arrangement is to have a thermometer permanently inserted in a pocket in the main inlet pipe as near as possible to the ship's side. In cases where the thermometer is a ship's fitting, it is essential that its accuracy be checked against an official tested instrument and corrections made for any index error that is found.

Alternatively a thermometer can be held in water issuing from a tap in the intake, taking care that the bulb is completely immersed for long enough to ensure that a correct reading is obtained. In many engine-rooms the intake pipe is inconveniently situated, and great care has to be taken to avoid parallax errors. The thermometer or the tap for taking water samples