# A Deep-sea Bacteriological Water-bottle.

By

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With Four Figures in the Text.

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In the past, deep-sea water samples for bacteriological purposes have been taken either by means of water-bottles provided with taps, and so made that the sample came in contact with metal, or in evacuated sterilized glass vessels drawn out to a fine point and sealed in the flame. The water-bottle is difficult to sterilize on account of the taps, and the results obtained are vitiated by the bactericidal action of metals.* The sealed glass tube is free from these defects, but at even moderate depths it is liable to collapse on the sudden change of pressure when the end of the capillary portion is broken off.

The water-bottle here described has none of these disadvantages, and has been used by Mr. G. H. Drew down to depths of 800 fathoms with complete success. It was designed and made at short notice, and time did not allow of more than one hurried trial before packing for shipment. Experience has shown since that many small alterations might be made which would render it more convenient, though not more accurate, in use; but as no opportunity of making and testing an improved model is likely to present itself in the near future, it is here shown in its original form.

The body of the water-bottle consists of a brass cylinder *a* of about 250 c.c. capacity, lined with a glass tube *b*. It moves freely by means of the guides *c* on the side frames *d*, which are made of brass rod and connected by circular plates *h* and *i*. Above and below the central cylinder are movable plates *e* and *f*, with recesses in which fit rubber washers, shown by shading. The washer plates and cylinder are pressed downwards by spiral springs *m* and *n* working against the fixed plate *g*, and can be held up against this pressure by two rods, only one of which, *l*, is shown in the section. The shorter rod, *l*, is fixed to the upper washer plate by a thread and lock nut which allow of a small vertical adjustment; it can be held up against the spring *m* by a bent lever bracketed on to the top plate (Fig. 3). The upper end of the

* G. H. Drew on "The Precipitation of Calcium Carbonate in the Sea," etc. This Journal, Vol. IX, p. 479.

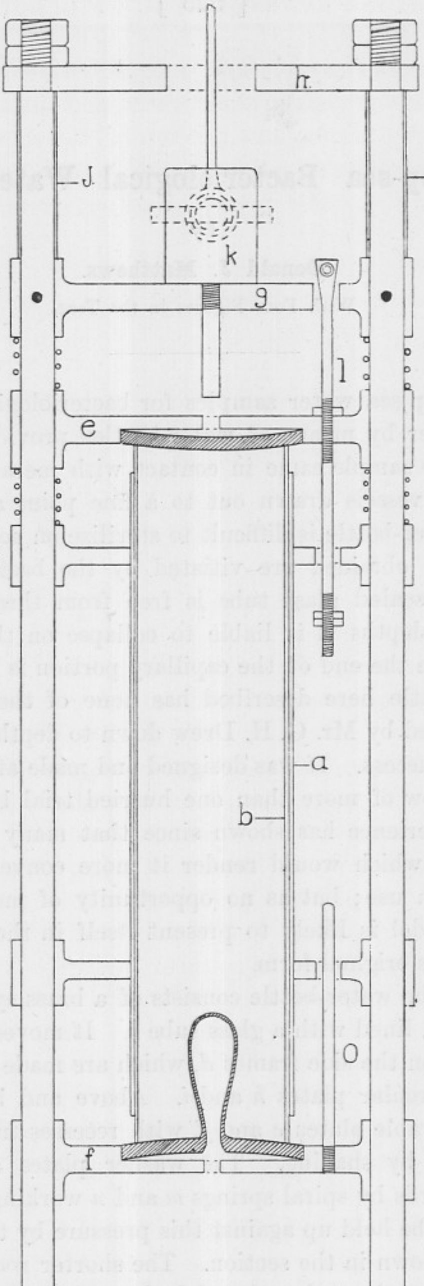


Fig. 1.

lever projects through the top plate; a broad messenger dropped down the wire drives this projection downwards and disengages the lower end of the lever from the hole in the top of the short rod *l*, allowing the upper washer plate to fall. Another longer rod, not shown, is similarly fixed to the lower washer plate; it passes freely through

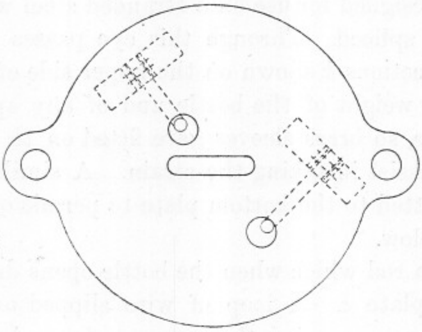

FIG. 2.

holes in the various plates and guides and engages with a second bent lever. The position of these two levers with respect to one another and the side frames is shown in Fig. 2. They project through the top plate at unequal distances from the centre, the inner one engaging with the long rod fastened to the lower washer plate. To prepare the water-bottle for use the lower washer plate is lifted slightly, so that it presses against the glass lining; alcohol (95 %) is then poured in, and the cylinder further raised until it is closed by the upper washer; the inner lever is now made to engage with the longer rod, and the outer one with the short rod *l*; this closes the bottle tightly. It is now lowered to the required depth, and the first messenger (the inner, smaller one in Fig. 4) is dropped down the line. This disengages the lever holding up the longer rod, but is not wide enough to touch the other. The lower washer plate falls to the bottom of the frame, and the cylinder also falls, but not so far, until it is stopped by the lock nuts on the lower end of the rod *l*. It is now open widely at each end,

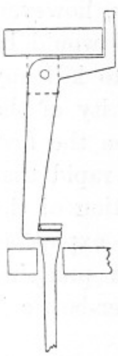

FIG. 3.

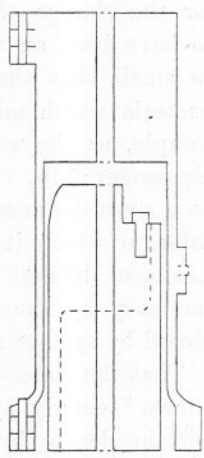

FIG. 4.

and the alcohol is displaced by the water. The second messenger, which is hollowed out below so as to pass over the first, is allowed to fall down the wire, and its broad base strikes the lever holding up the shorter rod. This allows the upper washer plate to fall on to the top of the cylinder, and the spiral springs keep the bottle tightly closed. It is now hauled up and a sample removed by a sterilized rubber tube.

The bottle is designed for use on a stranded steel wire, in the end of which an eye is spliced. Through this eye passes a screw threaded through two projections *k* shown on the upper side of the fixed plate *g*. The whole of the weight of the bottle and of any apparatus below it falls on this plate, so brass sleeves *j* are fitted on to the frames below the top plate to assist in taking the strain. A similar pair of cheeks with a screw is fitted to the bottom plate to permit of other apparatus being attached below.

At *o* is shown a rod which when the bottle opens drops till it is flush with the lower plate *c*. A loop of wire slipped over this makes it possible to release a reversing thermometer frame hanging below the bottle, or a messenger to actuate other apparatus.

The great defects to which water-bottles are liable are leakage and closing at the wrong moment. During descent leakage inwards might easily take place as the alcohol contracts on account of falling temperature and rising pressure. To counteract this, the lower washer has been made with a large dilatation ending blindly inwards but open to the sea at the other end; this would stretch slightly and compensate for the change of volume to a certain extent. It seems, however, to have been an unnecessary precaution. Leakage inward would be so small that the alcohol would remain strong enough to kill any bacteria which might enter, and could not affect the salinity of the sample, as the water-bottle is thoroughly washed out when the first messenger falls. Indeed, the escape of the alcohol is so rapid that at a short distance below the surface the sudden precipitation of the salts to which it gives rise has the appearance of an explosion. Leakage during hauling up would be outwards, and a pumping tendency by the rubber washers is not likely, as the water-bottle is closed by springs and not by weights.

That the water-bottle neither leaks nor closes at the wrong time is shown * clearly by the sharp fall in the number of bacteria below a certain depth, by the close agreement between the salinity at 400 fathoms at neighbouring stations, and by the agreement between the salinities at the greatest depth at which it has been used and those found by the *Michael Sars* at the same depth during her cruise in the

* Drew, loc. cit.

North Atlantic in 1910. There has been no reason to doubt any of the results obtained with it, and on the single occasion when it failed to close it appears to have been lying on the bottom. It is true that at one station the results are decidedly difficult to explain, but in this case the weather made it necessary to keep the boat moving ahead while the water-bottle was out, and the depth actually reached is problematical; the stray was so great that at the time it was estimated that it might be only half that shown by the amount of wire out.

Various improvements might be made which would add considerably to the convenience of the water-bottle. In particular, the releasing rods should be arranged centrally, by means of elbows in the case of the longer one. As at present made, the supporting rods are placed asymmetrically with regard to the springs, and there is consequently a twisting moment which tends to jamb the guides on the frames; this can be prevented at present only by a very careful adjustment of the strength of the various springs.

The larger messenger is also somewhat unsatisfactory; in spite of numerous holes bored in its lower half to allow the water to escape, it takes about half an hour to fall through 800 fathoms, and at the same time it oscillates from side to side so violently that the wire quickly wears out the central hole to a funnel shape.