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BUCKNILL AND CASELLA'S PATENT SEA-SOUNDING APPARATUS FOR NAVIGATING PURPOSES.

By Lieut. BUCKNILL, R.E.¹

IN 1870, when on board one of H.M.'s ships, and again in 1872 on one of the Allen Line steamers, the great difficulty in obtaining a reliable deep sea sounding came under my observation, and the idea of measuring the depth by means of a pressure gauge lowered with the sounding lead occurred to me.

The first pattern of such an apparatus was made for me by an American firm at Boston, Mass., and it left the city 24 hours before the great fire which entirely destroyed the plant and buildings of the firm. In this pattern a Bourdon gauge was employed, the moving parts being balanced in accordance with Lane's patent. The Bourdon tube was hermetically sealed, and the varying pressure was brought to bear upon the exterior of the tube. This was effected by filling the gauge with glycerine, the external water pressure being carried to the glycerine through an elastic diaphragm placed in a suitable position on the side or end of the metal jacket. In this arrangement a thin glass over the dial could be used, because the pressure on the exterior was communicated to the interior. Experiments with this instrument showed that blows on the exterior produced inaccuracies in the maximum readings.

Mr. Casella, the well-known instrument maker to the Admiralty, the Ordnance, &c., now took the matter up, and several instruments were made, differing much from my pattern. Eventually, however, it was found expedient to return to an arrangement of the Bourdon tube, and an efficient governor for controlling the moving parts and preventing fluctuations and inaccuracies of the maximum indicator, designed by Mr. Casella, was embodied in the instrument, drawings of which are given in Plate, Figs. 1, 2, 3.

The metal case with glass face is nearly filled with a transparent and stable fluid, such as glycerine. The cylinder at one end of the case contains a loosely fitting piston, clamped to a rod, which is fixed to some convenient part of the motion. The hole in the cylinder-cover, through which the rod is taken, is made slightly larger than the rod. The maximum indicator is actuated in one direction only by the projection on the indicating arm, and is set at zero by the set-rod, which passes through a stuffing-box, and is connected to a thumb-screw outside the case. The screw cap and ring at one end of the case is

¹ Read at the evening meeting on Monday, January 20th. Admiral of the Fleet Sir Henry J. Codrington, K.C.B., in the Chair.

perforated with a small hole, which gives the salt water free access to the outside of the elastic diaphragm.

The thickness of the glass face is only given in order to guard against its fracture from a blow.

I am assured by Officers, both of the Royal Navy and of the great ocean steamship companies, that a trustworthy sounding apparatus for navigating purposes is much required.

The ordinary lead cannot be relied upon when taking soundings of over 100 fathoms, and not long since I was informed of the following incident, which distinctly proves the assertion.

A large passenger steamer was making the American coast in thick weather, which had prevented any observation of the sun for several days. The captain stopped his vessel and took a sounding with an ordinary heavy lead. There was apparently no hitch of any kind, and "no bottom at 100 fathoms," induced the captain (a cautious and intelligent officer) to proceed at a fair speed. Shortly afterwards the look-out descried "breakers ahead," and the ship was only stopped just in time to prevent a great catastrophe. If the sounding had been correct the ship would have been 30 miles from the breakers.

I have myself witnessed the inaccurate results obtained from those sounding apparatus, in which clock-work is driven by a fan revolving in the water as the lead sinks, and I think it will be safe to assert that the sounding apparatus now before you is much more easily used in rough weather than the apparatus designed by Sir William Thomson, in which a wire runs off a reel which is thrown overboard and floats behind the vessel.

It is not considered that the ingenious bathometer designed by Messrs. Siemens Brothers, and described in the *Times* of the 28th February, 1876, will obviate the necessity of taking soundings; but on the contrary, that the chief use of a Siemens' bathometer will be to indicate when it is necessary or advisable to take an accurate sounding.

The apparatus now before you has been designed in order to enable vessels to take accurate soundings to depths of 180 to 200 fathoms, though, if required, the sounders may be had to record greater depths. It is actuated by the water pressure, which varies directly as the depth. The specific gravity of salt water varies but little in different parts of the world, the difference between the extremes being less than $1\frac{1}{2}$ per cent. The average weight of salt water is $64\frac{1}{4}$ lbs. per cubic foot, and the instruments are graduated to read to fathoms when submerged in water of the above density.

The apparatus should be used as follows:—An ordinary lead is attached 6 feet below the lower eye of the instrument, and the end of an ordinary sounding line is rove through the upper eye. The maximum reader or indicating arm is then placed at zero, by means of the thumb-screw at the back, and the instrument and lead are thrown overboard. As soon as a decrease in the tension on the line shows that the instrument has reached the bottom, it is again brought to the surface, and the number of fathoms it sank will be recorded by the maximum reader on the dial. The length of the sounding line should not exceed the depth to which the instrument is graduated.

The advantages claimed for this sounding apparatus, are as follows:—

1. That accurate soundings can be taken without entirely stopping a vessel's way, which is sometimes a matter of great difficulty.

2. That under-currents which prevent the line taking a true vertical direction, do not impair the accuracy of this instrument.

3. That its action being independent of its motion through the water, its accuracy is not affected by the moving parts being lubricated, either too much or too little, as no lubrication is required.

The price of the instrument is 10*l*.

The weight of salt water in different parts of the world differs but little.

This is shown in the following table.

Pressures in pounds on the square inch at various depths below the surface at 60 degrees Fahrenheit.

Depth in fathoms.	Pressure in pounds on square inch.			
	Distilled water.	Baltic.	Atlantic.	Mediterranean.
24	62·50	63·44	64·25	64·31
48	125·00	126·88	128·50	128·62
72	187·50	190·32	192·75	192·93
96	250·00	253·76	257·00	257·24
120	312·50	317·20	321·25	321·55
144	375·00	380·64	385·50	385·86
168	437·50	444·08	449·75	450·17

The effect of temperature on the accuracy of the sounder is inappreciable.

This is shown in the following table.

Pressures in pounds on the square inch at 24 fathoms below the surface at various Temperatures.

Temperature in degrees Fahr.	Distilled water.	Baltic.	Atlantic.	Mediterranean.
35°	62·556	63·496	64·306	64·366
40°	·558	·498	·308	·368
45°	·555	·495	·305	·365
50°	·536	·476	·286	·346
55°	·524	·464	·274	·334
60°	·500	·440	·250	·310
65°	·469			
70°	·434			
75°	·394			
80°	·349			

The Admiralty are now trying one of our sounders, similar to that shown in the Plate, and a foreign Government has also obtained one for trial and experiment.

In answer to a question by the Chairman asking if the gauge had been tried, Mr. Casella said that, though only now introduced, he believed it had been tried at sea, but it certainly had been tested in its manufacture, as he had the means of testing each gauge in water by his hydraulic apparatus, which had been expressly arranged to test the compressibility of thermometers and various substances in water at any depth. The capabilities of each gauge were thus perfectly known at the time of manufacture. This mode of testing was quite open for the inspection of any one taking interest in the matter.