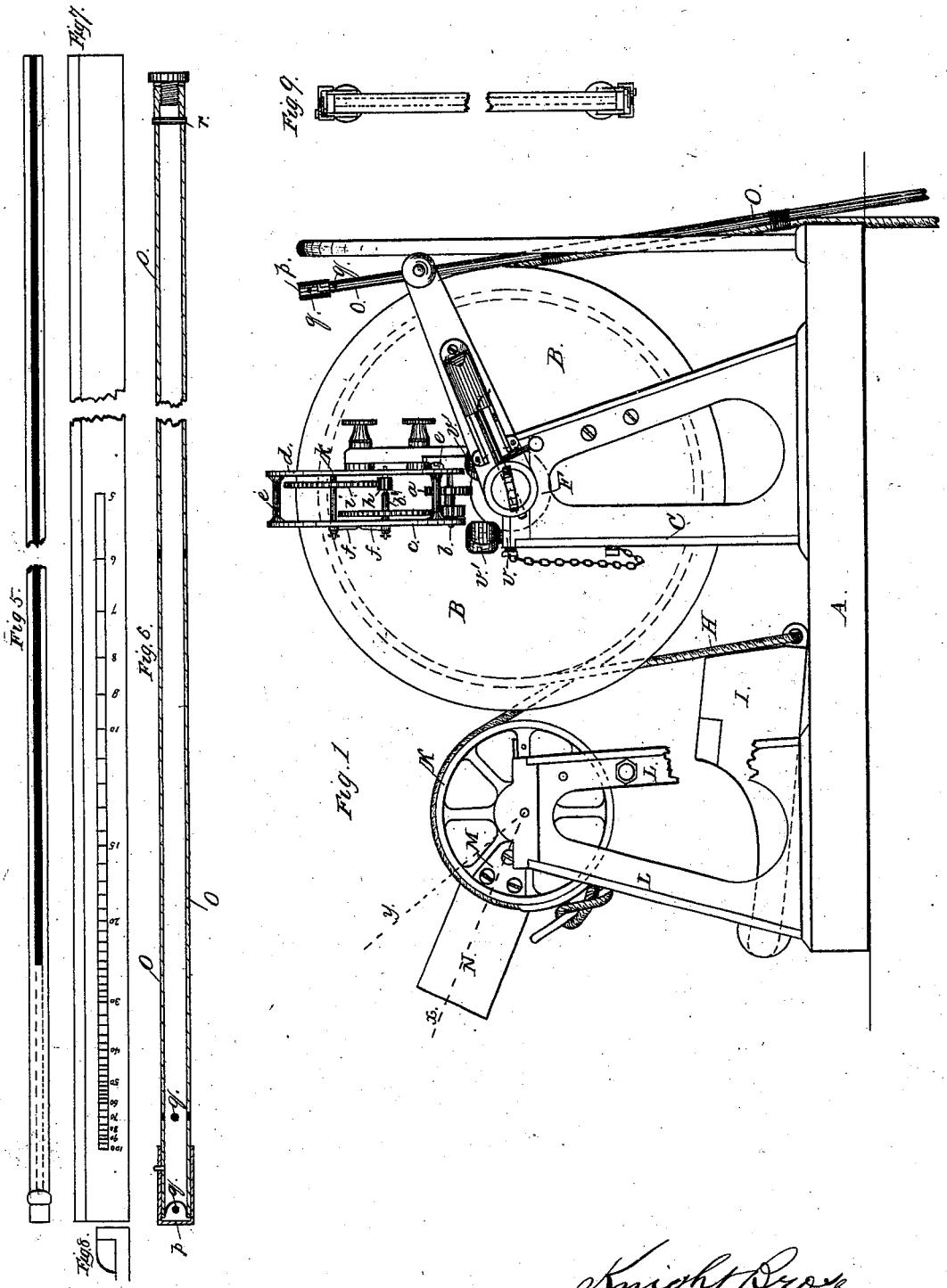
3 Sheets—Sheet 1.

Sir W. THOMSON, Kt.

Deep Sea Sounding Apparatus.

No. 210,067. **Patented Nov. 19, 1878.**



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3 Sheets—Sheet 2.

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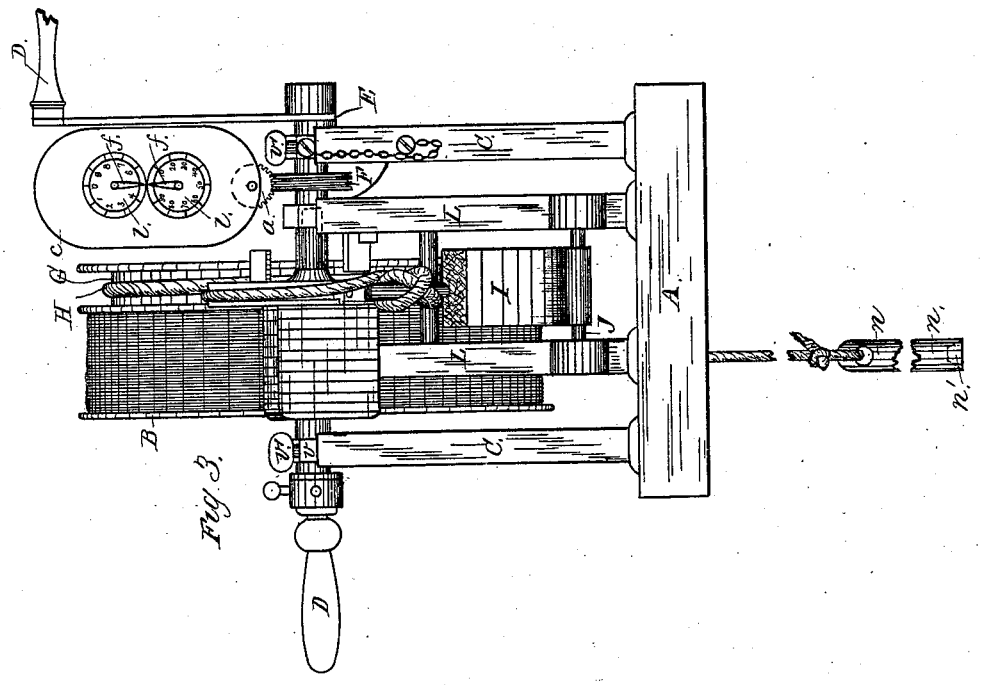

Fig. 3.

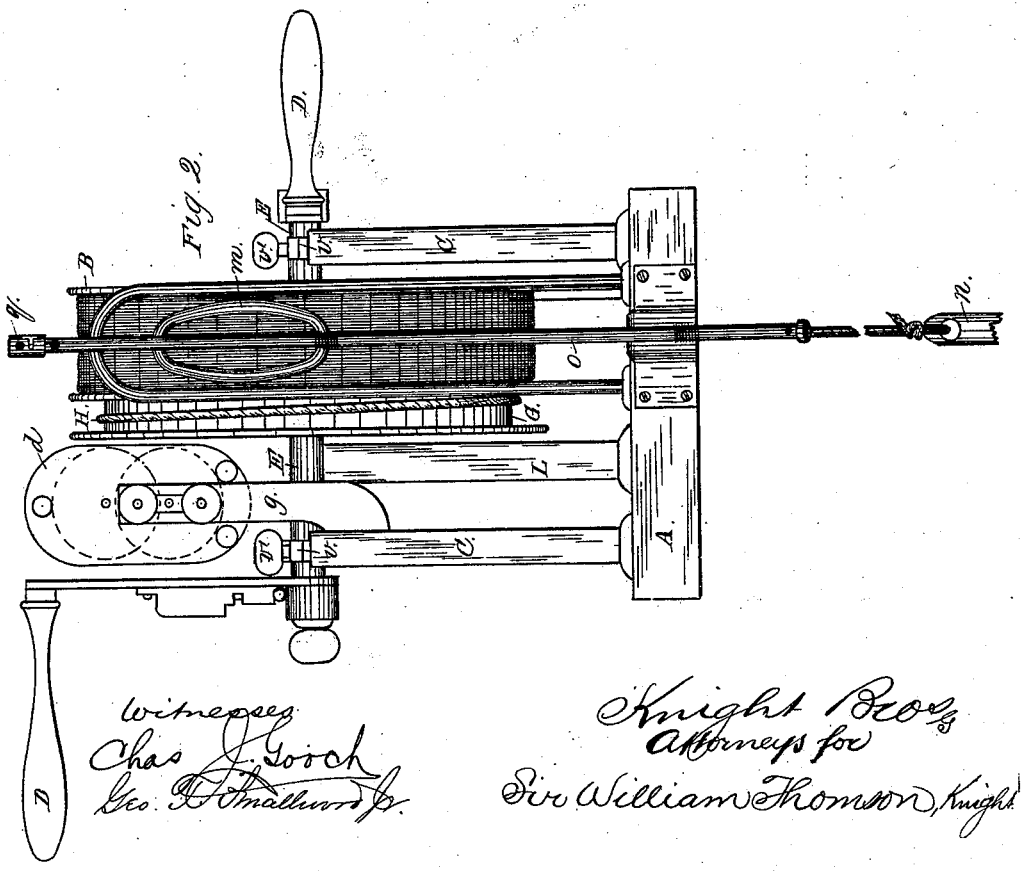

Fig. 2.

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3 Sheets—Sheet 3.

Sir W. THOMSON, Kt.

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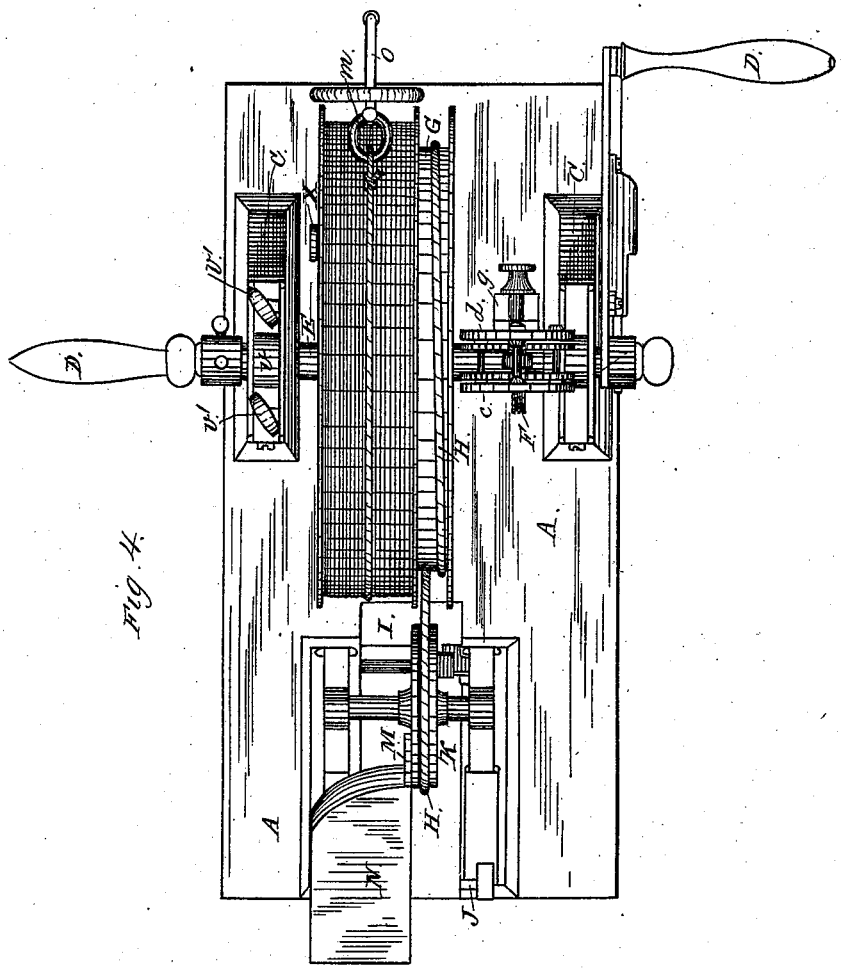

Fig. 4.

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UNITED STATES PATENT OFFICE.

SIR WILLIAM THOMSON, KNIGHT, OF GLASGOW, NORTH BRITAIN.

IMPROVEMENT IN DEEP-SEA-SOUNDING APPARATUS.

Specification forming part of Letters Patent No. **210,067**, dated November 19, 1878; application filed February 25, 1878; patented in England, September 1, 1876.

To all whom it may concern:

Be it known that I, Sir WILLIAM THOMSON, Knight, of Glasgow College, Doctor of Laws, and Professor of Natural Philosophy in the University and College of Glasgow, in the county of Lanark, North Britain, have invented Improvements in Apparatus for Navigational Deep-Sea Soundings, of which the following is a specification:

The object of my said invention is to facilitate the measurement of the depth of water below the ship at any time without reducing her speed.

The apparatus for measurement consists of a narrow glass tube, closed at one end and open at the other, and provided with a preparation, as hereinafter described, for marking the portion of the interior which has continued to be occupied by air under the pressure experienced by it when the tube is sent to the bottom or nearly to the bottom of the sea. This tube is virtually a pressure-gage, and it must be of so narrow a bore that there shall be no splashing of the liquid in it during the sounding process, which consists as follows: The glass tube is guarded by an outer metal tube, and attached to the sounding-line at a short distance above the sinker, or it may be placed in the sinker, made tubular for the purpose; but I prefer having the gage-tube separate from the sinker and lashed to the rope connecting the sinker to the sounding-wire, hereinafter described, as it is thus less exposed to violent shocks, whether in striking the bottom or from the surface of waves when being hauled in. The form of sinker which I prefer is a round iron bar of from an inch to an inch and a half diameter, and three or four feet long, with a hollow in its lower end to receive an arming of soap, tallow, or wax for bringing up a specimen of the bottom. I have found bluffer forms of sinker apt to break the wire, probably from concussion on the surface of a wave.

The sinker may be let go to the bottom by allowing enough of stray line, according to the ordinary method of deep-sea soundings, and may be hauled in again by hand in the usual manner; but I prefer performing the sounding operation by my method of using piano-forte wire, or other strong wire, coiled on a wheel, with a brake applied to the wheel to control the egress of the wire, and handles, or a rope, or band for turning the wheel in the other direction to haul in the wire. The frame-work carrying the wire-wheel is placed near the stern of the ship, the sinker and pressure-gage hanging down below the taffrail, and the wheel held fast to begin with. Then suddenly the wheel is let go with such force on the brake as shall produce a constant resistance of a few pounds—say, about four or five pounds—against the egress of the wire. The moment the sinker strikes the bottom the wheel stops or nearly stops for a few seconds of time. Then the brake is forced down to prevent the wheel from running on again. Hauling in is then commenced, the first effect of which is to cast off the brake, after which but little resistance to hauling in, beyond the weight of the wire and sinker, is experienced.

In sounding from a steamer running at fourteen knots in water of seventy fathoms depth, I have found the sinker to draw about one hundred and ninety-five fathoms of wire off the wheel, and to take about forty seconds of time to reach the bottom. The hauling in by two men turning the wheel easily by handles occupied about seven minutes.

A counter is driven by the wheel, and by noting its reading, at the instant when the sinker touches the bottom, the depth may be instantly declared if there has been sufficient experience in sufficiently similar circumstances of apparatus, speed of ship, and weather; but until there has been sufficient experience to form a trustworthy table of the depth corresponding to the observed readings of the counter in the actual circumstances the depth is to be determined from examination of the gage-tube when brought on board again after the performance of a sounding.

To prepare the gage-tube so that a mark may be left, I prefer the following: The interior of the tube is to be lined all round, or part of the way round, through its whole length, or as much of its whole length as may be needed, with a preparation which shall mark the distance that liquid has been forced into the tube. The preparation may be chromate of silver or red prussiate of potash, for the purpose of showing by chemical action how far

the inside of the tube has been wetted by liquid forced into it. To secure adhesion of the substance to the side of the tube and constancy and clearness of the mark produced on it, I use gum, or starch, or albumen, or other equivalent adhesive substance with the sensitive substance thoroughly mixed with it.

The mark may be produced simply by sea-water staining or dissolving away the sensitive substance, but I have obtained more satisfactorily clear marks by introducing other substances than sea-water in the liquid entering the tube under the influence of pressure. For this purpose, when the lining is red prussiate of potash, I fill the outer guard-tube or the hollow sinker with sulphate-of-iron solution. Sulphate of iron has the advantage of being very inexpensive, and it gives a sharp and strong blue mark by its action on the prussiate of potash adhering to the glass.

If the preparation of the gage-tube is performed at sea, the tube may be open at each end to allow air to be blown or sucked readily through it; and when it is dry and the preparation completed, one end may be stopped by a brass mounting cemented to the tube, provided with a stopper or plug to be screwed upon or into it. It is, however, preferred that the gage-tubes be prepared on shore and put in sufficient number on board ship ready for use. With this plan one end of the tube may be simply sealed by the glass-blower, and a fine metal tube may be used for driving a drying current of air along the whole interior surface of the glass tube.

To tell the depth from the mark on the gage, I use a scale graduated to fathoms, according to the known law of compression of air. This scale may be attached to the metal guard-tube, which guards the gage during the process; but I prefer, especially for soundings by night, having it separate in a well-lighted place on the deck or in the wheel-house or chart-room of the ship. The moment the guard-tube is brought to the taffrail the glass gage is drawn out of it and carried to the scale, where the depth is instantly read off.

When it is desired to obviate the necessity of previous chemical or other preparation of the tube, I use a pressure-tube open at each end and provided with valves, one at the lower end, to let sea-water enter when the sinker is going down, the other at the upper end, to let air escape when it is drawn up, each of these valves remaining closed except when urged in its opening direction by a small definite amount of force.

To preserve the wire from rust when the apparatus is out of use, the wheel is taken off its bearings and closed up in a vessel, in which it is kept wholly immersed under oil, or caustic soda, or quicklime. Fixed cheeks guide the wire when being hauled in, so that the wire may be left clear of the flanges while being coiled on the drum.

The wire before it reaches the drum may be dried by a cloth or cotton-waste held by hand, and also guided so as to be coiled in the proper position on the groove of the main wheel, or any suitable mechanism may be used for this purpose; but in respect to simplicity of the apparatus a hand may be preferred, and certainly suffices for whatever guiding or drying may be wanted.

In using the sounding-machine in very cold weather, when water carried up by the wire and rope is liable to freeze on the drum, the drum, which is hollow, is provided with a removable screw-plug, so that hot water may be poured into it, and thereby thaw or melt the ice or prevent freezing from taking place.

In the drawings hereunto appended, Figure 1 is a side elevation; Fig. 2, a front elevation; Fig. 3, an elevation of the rear end; and Fig. 4, a plan of the sounding-machine with the attachments constituting my said invention.

As shown by the drawings, the apparatus consists of a sole or bed, A, whereon the drum B, on which the piano-forte wire is wound, is supported in brackets or frames C, a handle, D, being secured on each end of the shaft E carrying the drum.

A tangent-screw, F, is situated on the shaft E and geared with a worm-wheel, *a*, which is fixed upon a horizontal shaft, *b*, held between two vertical plates, *c d*, connected together by ties *e*, and supported by pinching-screws, or their equivalent, in a slotted arm, *g*, fixed to one of the side frames, *c*. On the shaft *b'* is a spur-pinion, *h*, geared with a wheel, *i*, carried on a shaft, *k*, also supported by the plates *c d*. Fingers or pointers *f* are secured upon one end of each shaft *b' k*, which work round dials *l* marked upon the plate *c*, as seen at Fig. 3, and the number of revolutions made by the drum B in paying out the wire while taking soundings, and consequently the length of wire so paid out, is thus ascertained. The end of the wire wound upon the drum B has secured to it an iron ring or link, *m*, to which a length of rope, preferably about a fathom and a half, is also attached. The sinker *n* is secured to the other end of this rope, and between the sinker and the ring or link the casing tube or shield *o*, which is preferably made of brass, containing the glass tube prepared in either manner hereinbefore described, is lashed to the said length of rope, preferably at a position which will leave sufficient rope above it to make one turn round the drum when the wire is wound up. The rope is so wound round the drum B in order to prevent or to lessen the tendency which the wire, on account of its spring, has to unwind itself from the drum.

Fig. 5 is a full-sized longitudinal section of the glass tube, and Fig. 6 a similar view of the brass casing tube or shield, which is provided at its upper end with a removable cap or cover, *p*, and at its lower end with a bar, *r*, of vulcanite or other elastic material, against which the lower end of the glass tube rests, and which, from its elastic nature, prevents the tube from being broken by coming in con-

tact with the harder end of the casing while inserting the tube therein.

The lower end of the casing tube or shield *o* is composed of a plug, which being removed leaves the tube free to be cleaned or probed out by wire in the event of the lower end becoming choked by mud or fragments of glass broken by accident. On one side of the drum B is a pulley, G, around which a cord, H, is passed, one end thereof being attached to a weighted lever or bar, I, which is centered on the sole A at J, Fig. 3 of the drawings. The other extremity of the cord H passes over a pulley, K, carried in vertical frames L formed on or fixed to the said pulley, and whereto the cord is secured.

A lever, M, carrying an adjustable weight, N, is also formed on or fixed to the pulley K, and this weight, in conjunction with the cord H and the weighted lever or bar I, acts as a brake on the drum B, both while the wire is being paid out when sounding and when the sinker *n* has reached the bottom.

While the wire is being paid out the lever M is raised into the position indicated by the line *x*, Fig. 1, so that the weighted lever or bar I, by its downward pull on the cord H, shall hang freely between the upper and lower stops limiting its range. It is so weighted as to exert a downward pull of about seven pounds, which gives a sufficient retarding force—say, of from four to six pounds—on the drum, to keep the wire taut and to stop the wheel when the sinker reaches the bottom. When the wheel is, therefore, seen to stop, the lever M is allowed to fall into the horizontal position, whereby the weighted lever or bar I is raised against its upper stop and an amount of retarding force is exerted on the drum B sufficient to prevent it from again commencing to rotate. Instantly after this the handles are used to coil back the wire on the drum.

By the first backward motion of the drum the weighted lever I is let down until it rests on its lower stop, and the other weighted lever, M, is raised into the position indicated by the line *y*, Fig. 1. Thus the retarding force of the cord against the continued motion of the drum in coiling on the wire is almost completely annulled. In this position the center of gravity of the weight N is nearly over the axis round which it turns, and therefore the brake exerts but very small retarding action on the continued motion of the drum B in hauling in the wire.

When the wire has again been all wound on the drum the glass tube is removed from the casing-tube *o* and applied to the scale or wand, (seen at Figs. 7 and 8 of the drawings,) and by this scale or wand, which is divided into fathoms, the depth is ascertained by the length to which the coating of the glass tube has been acted upon and discolored upward from its lower end by the direct action either of the water passing in through the holes *q* in the upper end of the casing-tube, or by the action of the water forcing the solution of iron, or other reacting solution contained in the casing tube or shield *o*, up into the chemically-prepared glass tube.

The screw-plug X is that which is provided for the purpose, when removed, of allowing hot water to be poured inside the wheel to melt or thaw any ice that may become frozen thereon in cold weather.

The caps *v* are preferably formed with slots leading out of each of the holes through which the tightening-screws *v'* pass, the object of which is to enable them to be quickly removed, so that the wheel, with the wire coiled thereon, may be unshipped or removed from its bearings or placed therein with a very little loss of time.

By simply turning each of the thumb-screws *v'*, so as to release their pressure on the caps *v*, the caps are slid out from beneath them, and they are preferably connected by pieces of chain (hanging loosely) to the frames, so that by being thus permanently attached thereto the caps are prevented from being lost.

In the sinker *n* the portion marked *n'* at the bottom indicates the recess for holding the arming of soap, tallow, or wax, hereinbefore referred to.

At Fig. 9 is shown, in longitudinal section, the other arrangement of gage-tube, or that in which the water forced into the tube during its descent in the sea is retained in the tube. The tube, in this case, is provided at each end with a mounting containing a valve which opens inward. As the tube descends the lower valve is opened and the water enters the tube, at the same time compressing the air into the upper part of the tube. When the bottom is reached and hauling in is commenced, by which the tube is caused to move through the water upward, the lower valve shuts and retains the water which had entered therethrough while it was being sunk, and the pressure of the sea acting upon the upper valve causes it to open, thus allowing the air gradually to escape as the tube approaches the surface. Thus the pressure of the air within the tube is kept constantly in balance with the pressure of the sea outside the tube, so that no danger of bursting the tube by pressure of the contained air is incurred.

The last arrangement of the gage-tube, like that hereinbefore described, is, when used, placed within a shield or casing having a slit along one side, on the edge of which is marked a scale showing the depth in fathoms by the height of the contained column of water seen against the scale.

I claim—

1. The gage-tube prepared on its interior with chromate of silver or red prussiate of potash, for the purpose of obtaining a definite mark showing the height to which liquid has been forced into the tube, thereby indicating the depth to which the gage has been submerged below the surface of the sea.

2. The gage-tube fitted with valves at its upper and lower ends, for the purpose of al-

lowing the water to enter and compress the air as the tube is being sunk, and to retain the water and allow the compressed air to escape as the tube is being hauled in, substantially as shown and described.

3. The brake consisting of the pulley G, rope H, weighted lever I, the pulley K, lever M, weight N, operating in combination for automatically binding and releasing the drum B, substantially as set forth.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

WILLIAM THOMSON. [L. S.]

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