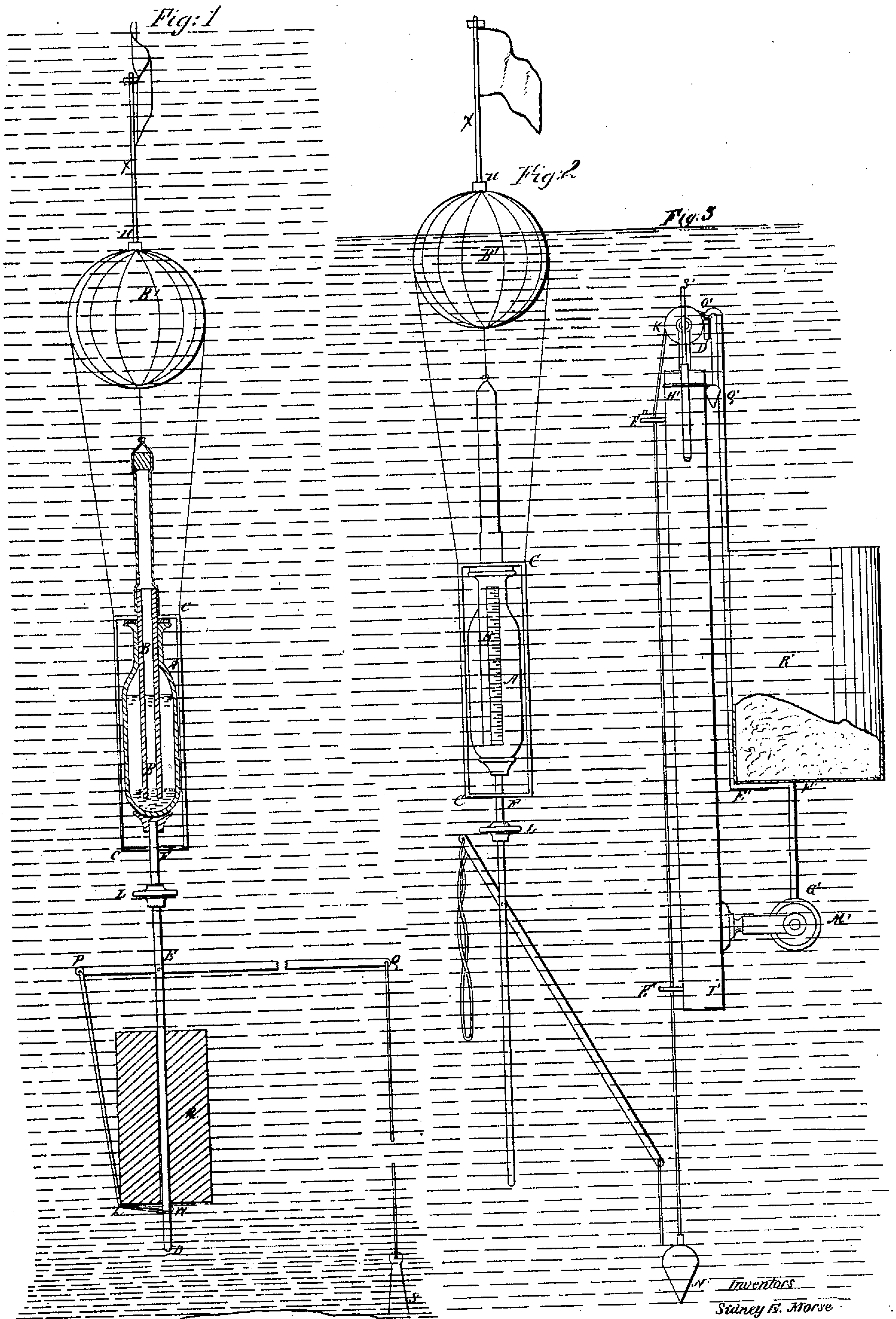
Morse & Morse,

Bathometer.

No. 56,436. Patented July 17, 1866.



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UNITED STATES PATENT OFFICE.

S. E. MORSE AND G. L. MORSE, OF HARRISON, NEW JERSEY.

IMPROVEMENT IN SOUNDING APPARATUS.

Specification forming part of Letters Patent No. **56,436**, dated July 17, 1866.

To all whom it may concern:

Be it known that we, SIDNEY E. MORSE and G. LIVINGSTON MORSE, of Harrison, in the county of Hudson and State of New Jersey, have made a useful improvement in the method of measuring the depth of water and the compression of liquids by the invention of a new instrument, which we call a "Bathometer;" and we do hereby declare that the following is a full, clear, and exact description thereof, which will enable others skilled in the art to make and use the same, reference being had to the accompanying drawings, forming part of this specification, in which—

Figure 1 is an elevation, partly in section, of an apparatus made according to our invention as it appears in its descent. Fig. 2 is an elevation showing it after its descent, when it has again reached the surface of a body of water. Fig. 3 is a modification of the sinking apparatus.

Similar letters of reference indicate like parts.

It has been found difficult to ascertain the true depth of rivers and other bodies of water in motion by means of a line, on account of the currents causing deviation of the line from perpendicularity; and in sounding deep seas and oceans much time is consumed on account of the retardation of the line by friction both in ascending and descending.

Our invention obviates these difficulties; and it consists, in general terms, in measuring the depth of water by the compression of a fluid or fluids contained in a vessel sunk by a weight which is automatically detached from the rest of the apparatus on striking bottom, allowing the vessel and its other accompaniments to be raised by a buoy, the apparatus being sunk without any connection with a line, and the buoy being provided with a signal to enable the operator to recover it when it ascends to the surface of the water.

In carrying out our invention we take a glass bottle—say about five or six inches long and of such interior diameter that its capacity, exclusive of any solid substance and of the mercury and air it may contain, shall be about five cubic inches—and let it be shaped as in the accompanying drawings, where it is designated A. Take also a glass meter-tube, B, about seven or eight inches long, open at both ends, with a bore of such diameter that the capacity of the tube shall be one-quarter of a cubic inch—*i. e.*, a bore about one-fifth of an inch in diameter. Let this tube be swelled near the upper end, and the swelled part ground into a stopper to fit the neck when the lower orifice of the tube is within about an eighth of an inch from the bottom of the bottle. Pour into the bottle mercury just sufficient to be on a level with the lower orifice of the meter-tube when it shall be inserted, and enough more to fill the meter-tube once. Then fill the bottle with water and insert the meter-tube, so that the swelled part or ground-glass stopper shall be fitted perfectly tight into the neck of the bottle.

To secure the stopper in its place a frame of brass or other suitable material, C C, with a circular hole in the upper side to permit the meter-tube to pass through it, may be put around the vessel, and, resting on a shoulder in the meter-tube formed by the top of the swelled or stopper part, may be fastened with a screw, F, which, passing through the middle of the lower side of the brass band, and pressing against the bottom of the vessel or some intervening substance, shall bind the stopper firmly in the neck of the vessel. Take, then, a thin india-rubber tube five or six inches long and of such diameter that when opened it can be drawn easily but closely for about half an inch over the outer end of the meter-tube. Draw it over and fasten it by winding a cord around it, which shall force the india-rubber into circular grooves ground in the glass. Fill the rubber tube with water, and insert a plug about half an inch long into its upper end, and fasten it by winding and tying a cord around the tube. It will then form a bag of water, and it should be long enough to hold a quantity of water at least sufficient to fill the meter-tube once.

A scale may be made on the outside of the meter-tube, either by etching the glass or by attaching thereto marked paper, varnished, to protect it from water; or the scale may be made on the inside, on a rod extending from the bottom of the bottle through the meter and india-rubber tubes, and fastened as a stopper in the mouth of the india-rubber tube, in place of the plug described above. When the instrument is ready for operation the water or lighter fluid will completely fill the meter-tube.

If the instrument is now sunk in deep water, as it descends the external pressure of the water will cause the fluids in the india-rubber bag, the meter-tube, and the body of the vessel to contract, and will force the water in the meter-tube through the mercury into the body of the vessel, to supply the vacancy caused there by the compression of its contents. On the return of the instrument to the surface the expansion of the fluid or fluids in the body of the vessel, under the relaxation of the external pressure during the ascent, will force the mercury into the meter-tube to the amount of their greatest compression, thereby indicating the degree of that compression, and, by inference, the depth to which the instrument has descended.

It is stated in Lardner's Hand-Book of Natural Philosophy, page 48, that "water submitted to a mechanical pressure of fifteen pounds on a square inch is diminished in its volume by forty-five parts in a million," and that the compression continues in this proportion as you increase the pressure. Now, as the pressure of a column of salt-water thirty-four feet high is fifteen pounds on a square inch, a table can easily be made from these data of the amount of compression due to every depth of water, from one foot or one inch to the greatest depths of the ocean. At the depth of thirty-four thousand feet the compression of sea-water must be, by this rule, forty-five thousand millionths, and at the depth of thirty-seven thousand seven hundred and seventy-seven feet, or a little more than seven miles, the compression must be fifty-thousand millionths, or one-twentieth part of its volume at the surface of the ocean. If, therefore, we have a bathometer with a meter-tube of one-twentieth part of the capacity of the body of the vessel—*e. g.*, if the meter-tube (which we will suppose is of even bore and seven inches long) have a capacity of one-quarter of a cubic inch and there were five cubic inches of water in the body of the vessel above the mercury, we could measure with such an instrument any depth of the ocean not exceeding seven miles. Every inch of the scale of the meter-tube would represent almost precisely a mile of depth in the ocean; and if, on the return of the instrument to the surface, the mercury should fill the tube it would indicate that it had descended to the depth of seven miles.

If great accuracy should be deemed necessary in making the table to which we have referred, allowance must of course be made for the increased density and weight of the water as you descend, caused by compression; and this, at the depth of seven miles, being one-twentieth, the compression of thirty-four cubic inches would be into 32.30 cubic inches, and of thirty-four linear inches into about 33.43 linear inches. When corrected by this allowance, the water would be compressed one-twentieth of its volume at the depth of thirty-seven thousand seven hundred and seventy-seven feet minus three hundred and fourteen feet, equal to thirty-seven thousand four hundred and sixty-three feet, or seven miles and five hundred and three feet.

If still greater accuracy should be required, allowance must be made for the expansion of glass, water, and mercury by heat and their contraction by cold. The best mode of graduating the bathometer will be by sinking it with a graduated line in still water of medium temperature—say 55° or 60° of Fahrenheit.

To adapt the instrument for measuring depths in comparatively shallow water—say depths of five hundred feet or less—a small quantity of air should be introduced into the bottle.

If in the instrument described above a quantity of air just enough to fill four inches of the meter-tube were added to the five cubic inches of water in the bottle, the result would be about as follows: On the return of the instrument from the depth of thirty-four feet the mercury will stand at about two inches; one hundred and two feet, three inches; two hundred and thirty-eight feet, three and a half inches; five hundred and ten feet, three and three-fourths inches.

At the depth of five hundred and ten feet five cubic inches of water would be so much compressed that in a bathometer constructed as described above the mercury would, on that account alone, rise in the meter-tube, on the return of the instrument to the surface from that depth, about one-tenth of an inch. This, added to the three and three-fourths produced by the compression of the air, would cause the mercury to rise nearly to the four-inch mark.

For greater depths than five hundred feet it will be best, ordinarily, to depend on the compression of water or some other liquid alone; and if a scale of an inch to a mile should be deemed inconveniently small it could be altered, even while preserving the same capacity of bottle, by lengthening the meter-tube and proportionally diminishing its bore. If, for example, the length of the meter-tube were twenty-eight inches, instead of seven inches, and its bore so reduced that its capacity should be still a quarter of a cubic inch, four inches, instead of one inch, of the scale would indicate a mile, and so on. If, however, the diameter of the bore should be reduced much below one-fifth of an inch, mercury and water would not readily pass each other to assume the position due to their relative specific gravity, and on the return of the instrument to the surface it might be necessary to unstop the bottle and press upon the india-rubber bag to force the mercury from the meter-tube into the bottle as a preparation for a new operation. If, however, there be sufficient air in the bottle, the mercury may be discharged, even from a very small bore, without upstopping the bottle, merely by pressing the bag. The instrument should be turned on its side before pressing upon the bag. If the meter-tube be sufficiently wide in the bore, the adjustment of the instrument for a new operation can be made without any pressure by simply turning the tube on its side and then restoring it to a perpendicular position.

To save time in deep-sea soundings, we dispense entirely with the use of the line. Three or four hours, it is said, are usually required to take a single sounding at the depth of two thousand fathoms with a line or wire, in consequence of the retardation by the friction of the water on so large a surface, while a five-inch cannon-ball would reach the bottom at this depth and a five-inch hollow glass sphere would rise to the surface from this depth each in much less time.

To cause our bathometer to descend and ascend rapidly in the deep sea we therefore attach to it an apparatus constructed as follows:

A hollow sphere of glass, B′, about one-eighth of an inch thick and five inches interior diameter, is attached by cords or fine wire to the bathometer, as represented in the accompanying drawings. Such a sphere will buoy in water a weight of two pounds, which is about one pound more than the weight of the bathometer and its accompaniments described in this specification. Into the knob L, on the lower side of the brass frame C C, screw a circular rod or tube of wood, brass, or galvanized iron, E D, eight or ten inches long and one-quarter of an inch diameter, through which a slot is made near the top, at E, to receive the thin flat lever P Q. Insert the lever so that the length E Q shall be ten times the length E P of said lever, and connect the rod and lever by a pin or pivot on which they are free to vibrate. To the end of the long arm of the lever, at Q, attach, by a cord two or three feet long, a body of lead, S, weighing about one-quarter of a pound. To the end of the short arm of the lever attach a cord, P Z W, about twelve or fourteen inches long, having a loop at W. Through a cylindrical hole in a bar or sinker of cast-iron, R, which should weigh about a pound, pass the rod E D, and bring the loop W in the cord P Z W over the end of the rod below the sinker R. The weight S will then hold the weight R in its position on the rod, as represented in the drawings. If, now, the bathometer, with the appendages, be dropped in the sea it will sink till the weight S strikes the bottom, and, being supported there, the weight R draws down the short arm of the lever, causing the loop at the end of the cord P Z W to release itself from the rod E D, and the weight R then drops into the sea. The buoy B′ is then free to ascend, carrying the bathometer and all its remaining appendages to the surface.

If it should be deemed desirable to save the expense of the iron weight, which is lost by this mode of releasing the buoy, sand or other cheap weight may be used instead of iron by an apparatus constructed as follows: To a cylindrical tin vessel, R′, Fig. 3, about four inches in diameter, six inches high, and open at the top, we solder a stiff steel or iron wire, D′ E′ F′ G′, about fifteen inches long, bent near the top into a double right angle, and near the bottom into a single right angle, as in the drawings. We then fasten, by soldering or otherwise, the tin vessel to the wire, so that the part E′ F′, which may be one and a half inch long, shall be directly under one of the radii of the bottom, and the part E′ D′ shall pass vertically along the outside of the vessel, while the part F′ G′ projects downward from the bottom. We then take a strip of wood, H′ I′, about fourteen inches long, and into the center of the upper end screw vertically a pulley, K′, about three-fourths of an inch in diameter, and in the middle of the side of the strip, about twelve inches below, screw horizontally another pulley, M′, about one and a half inch in diameter, so that the faces and grooves of the two wheels K′ and M′ shall be parallel and in the same plane.

We bore a hole into the outer end of any of the radii of the larger pulley at a point equidistant from the two flat sides to the depth of one-fourth of an inch, to receive the wire rod F′ G′ from the bottom of the tin vessel, and insert and fasten it there by soldering or otherwise. To one end of a cord about three feet long we attach a weight of about half a pound, N′, and passing the cord through iron-wire eyes E″ E″ on the back of the strip of wood H′ I′, and over the pulley K′, attach it to a small ring, O′, and this ring to a two-ounce weight, Q′. Slip the ring O′ over the bent end of the wire at D′, so as to hold the vessel upright, and fill the vessel with sand or other cheap weight, attach the whole to the bathometer, and buoy by screwing into the knob L in Fig. 1 a rod, S′, fastened to the top or upper end of the strip of wood H′ I′, and drop the instrument into the sea. It will sink, as before, till the weight N′ strikes the bottom. More than half the weight in the tin vessel being beyond the pivot or axis of the larger pulley M′, will then fall, and the two-ounce weight being then allowed to drop, will draw the ring O′ from the end of the wire rod at D′, and the tin vessel will be completely upset, discharging the sand or other weight into the sea and leaving the buoy to ascend, as before, carrying the bathometer to the surface.

To facilitate the finding of the instrument on its return to the surface a long light rod or pole, X, is inserted in a socket, U, fastened on the upper side of the buoy by wires that pass round it in various directions, protecting the body of the buoy and meeting at the bottom, where they connect it with the bathometer and its appendages. The upper end of this rod should be prepared with small pieces of bright tin, polished metal, silvered and colored glass, or other substances which will reflect the light and attract attention from a distance.

Having thus described our invention, we

claim as new and desire to secure by Letters Patent—

1. Arranging fluids of different specific gravities in a vessel or vessels, so that when sunk in water, or submitted to pressure otherwise, a mark of the amount of compression of one or more of these fluids at the greatest depth, or at the point of greatest compression, is retained for inspection on the return of the instrument to the operator, substantially as described.

2. The arrangement of two liquids having unequal specific gravities with a meter-tube, in a vessel closed, except at one end of the meter-tube, in such a way that external pressure, caused by the descent of the instrument in water or otherwise, will force a portion of the lighter liquid through the heavier liquid into the body of the vessel, to supply the vacancy there made by the compression of its contents, and that then, under a relaxation of the external pressure, caused by the ascent of the instrument in water or otherwise, the expansion or reaction of the liquids in the body of the vessel will force the heavier liquid into the meter-tube to the amount of the compression, thus forming a meter of the compression, and, by inference, of the greatest depth to which it has descended, substantially as described.

3. The introduction of a minute quantity of air or other elastic fluid into the vessel containing the liquids, as described in the clause next preceding, to make the instrument sensitive as a meter of depth in comparatively shallow water.

4. The application to the bathometer of a meter-tube so constructed that the liquids can easily pass each other in the bore of the said meter-tube, thereby enabling the operator to restore them to their original position for a new operation merely by turning the instrument, substantially as described.

5. Attaching a bag of india-rubber or other suitable flexible material to the outer end of the meter-tube, for the purpose of preserving the exact quantities of the fluids in the vessel as at first adjusted, and of enabling the operator, by pressure upon the bag, to discharge the contents of the meter-tube into the vessel, and therefore to use a meter-tube of small bore, substantially as described.

6. Attaching a buoy and weight to a bathometer in such a way that when the instrument or its appendage touches the bottom the weight shall be detached and allow the buoy to carry the instrument to the surface, substantially as described, thereby dispensing with a line.

7. The method of releasing a submerged buoy by causing a small weight attached to the long arm of a lever to support on the short arm the larger weight, which sinks the buoy, till the smaller weight, touching the bottom, is supported thereon, thus causing the short arm, no longer counterpoised, to fall and discharge the greater weight, substantially as described.

8. Attaching to a bathometer a rod or pole in such a way that on its return to the surface of the water it will attract attention at a distance, so as to facilitate the recovery of the apparatus of which it forms a part, substantially as described.

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