4 Sheets—Sheet 1.

P. B. O'NEILL.

Salinometer.

No. 50,380. Patented Oct. 10, 1865.

Fig: 1.

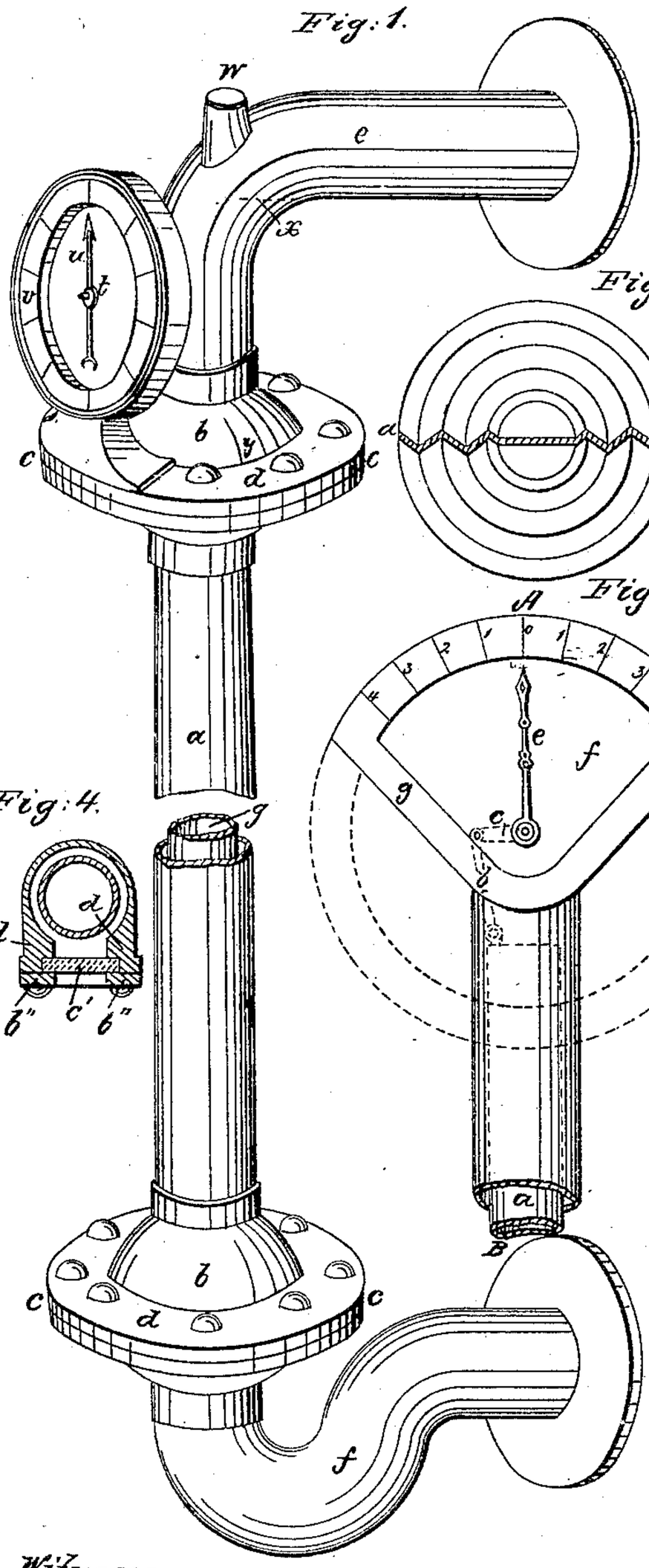


Fig: 5.

Fig: 6.

Fig: 2.

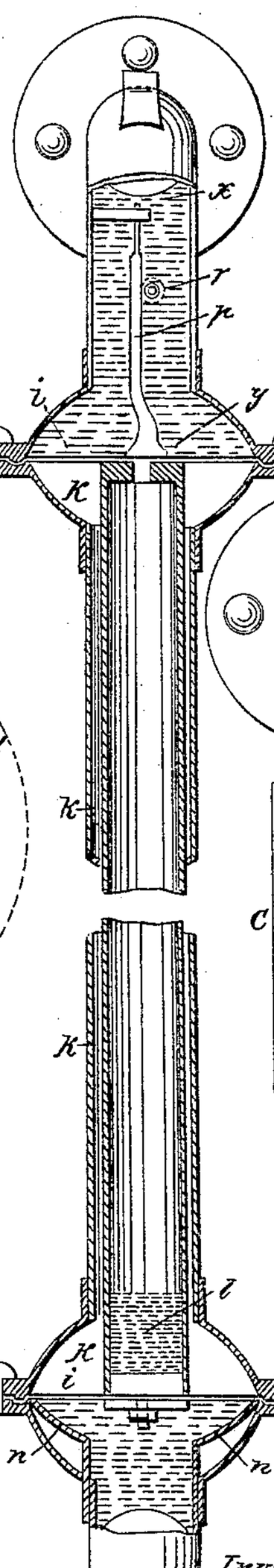


Fig: 3.

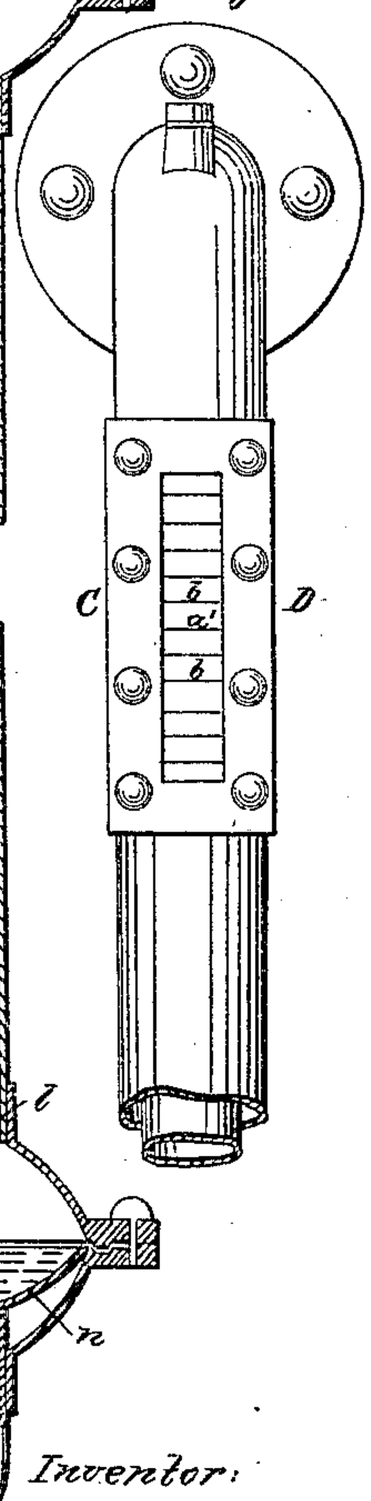


Fig: 4.

Witnesses:
William Bull
Arthur Chabot.

Inventor:
P. B. O'Neill

Witnesses:
William Bull
Arthur Chabot.

4 Sheets—Sheet 2.

P. B. O'NEILL.

Salinometer.

No. 50,380.

Patented Oct. 10, 1865.

Fig: 8.

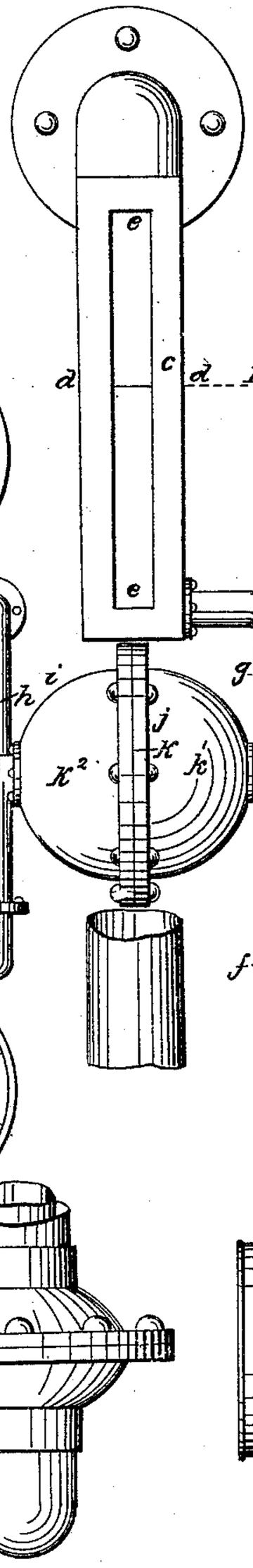


Fig: 11.

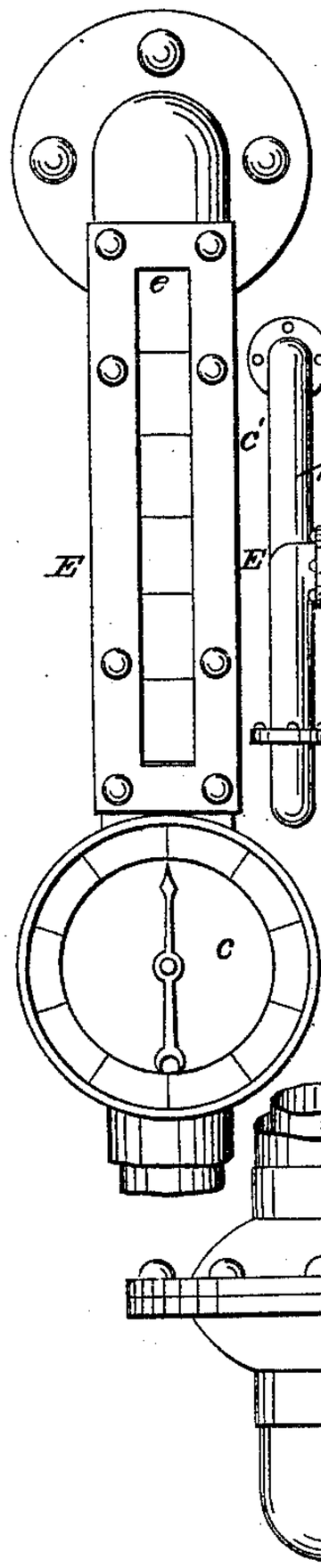


Fig: 9.

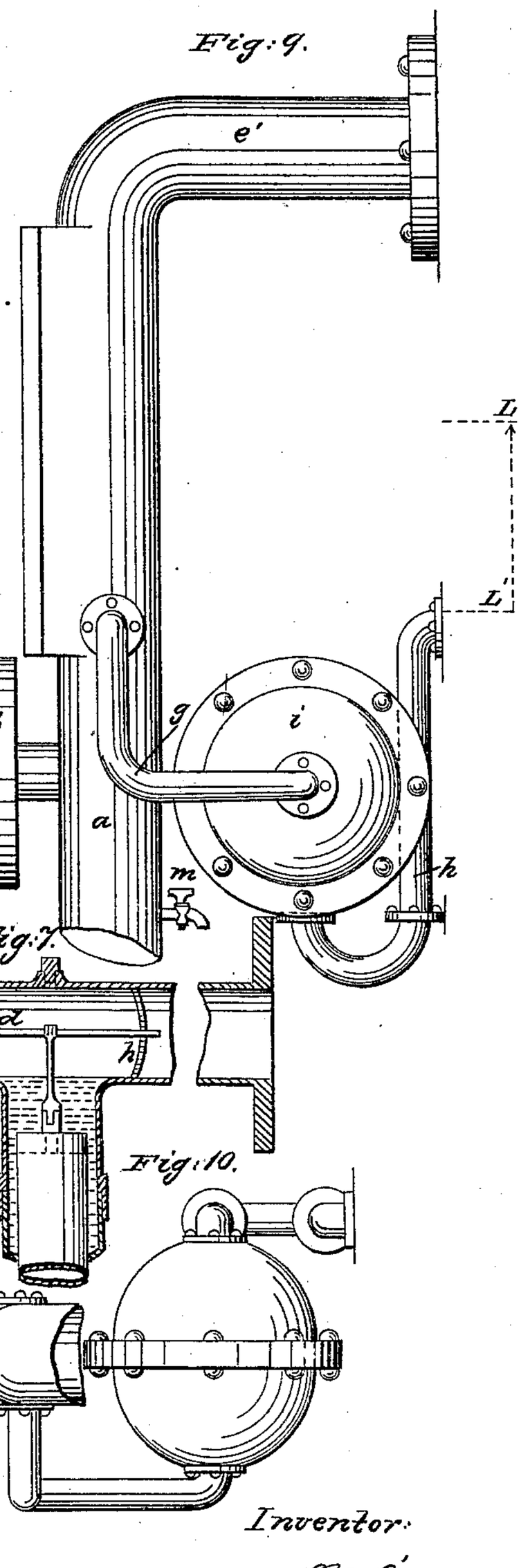


Fig: 7.

Fig: 10.

Inventor:

P. B. O'Neill

4 Sheets—Sheet 3.

P. B. O'NEILL.

Salinometer.

No. 50,380. Patented Oct. 10, 1865.

Fig: 12.

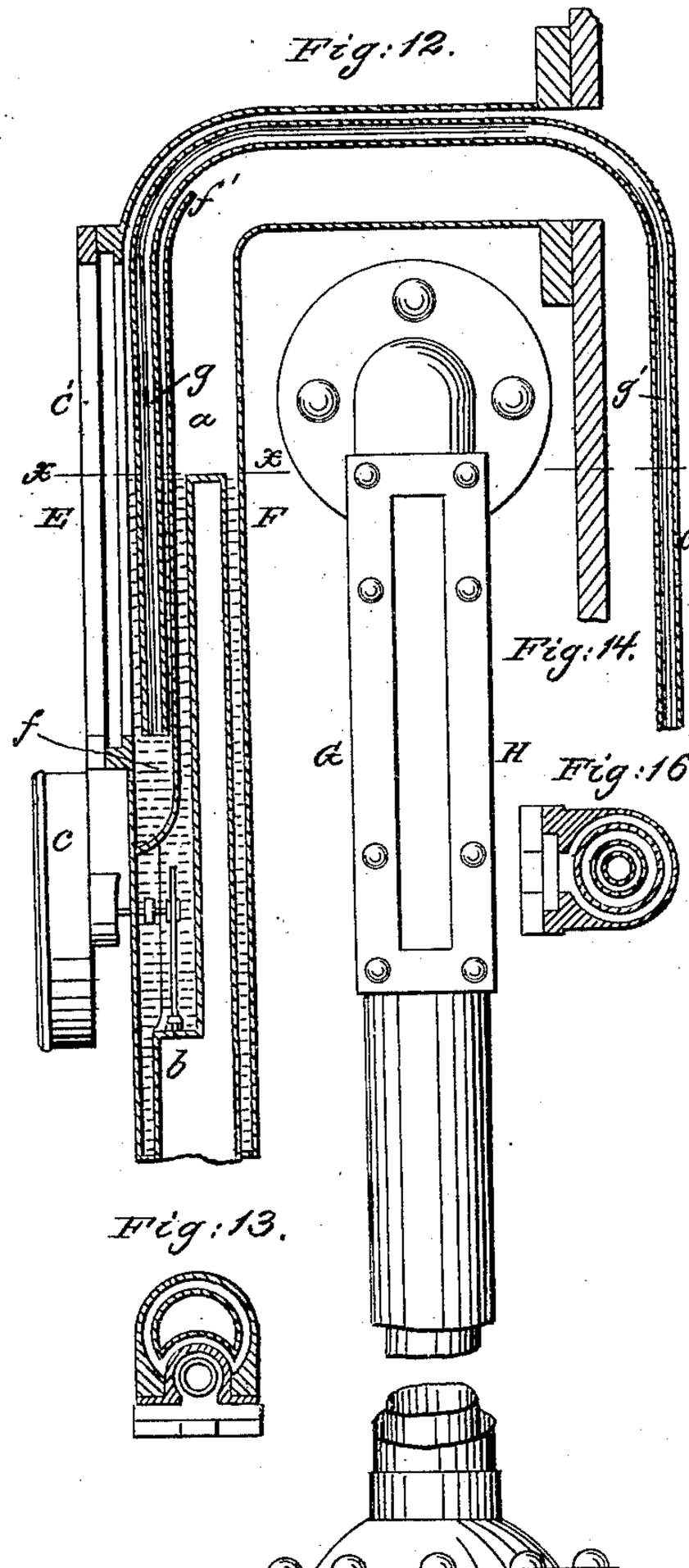


Fig: 13.

Fig: 14.

Fig: 16

Fig: 15.

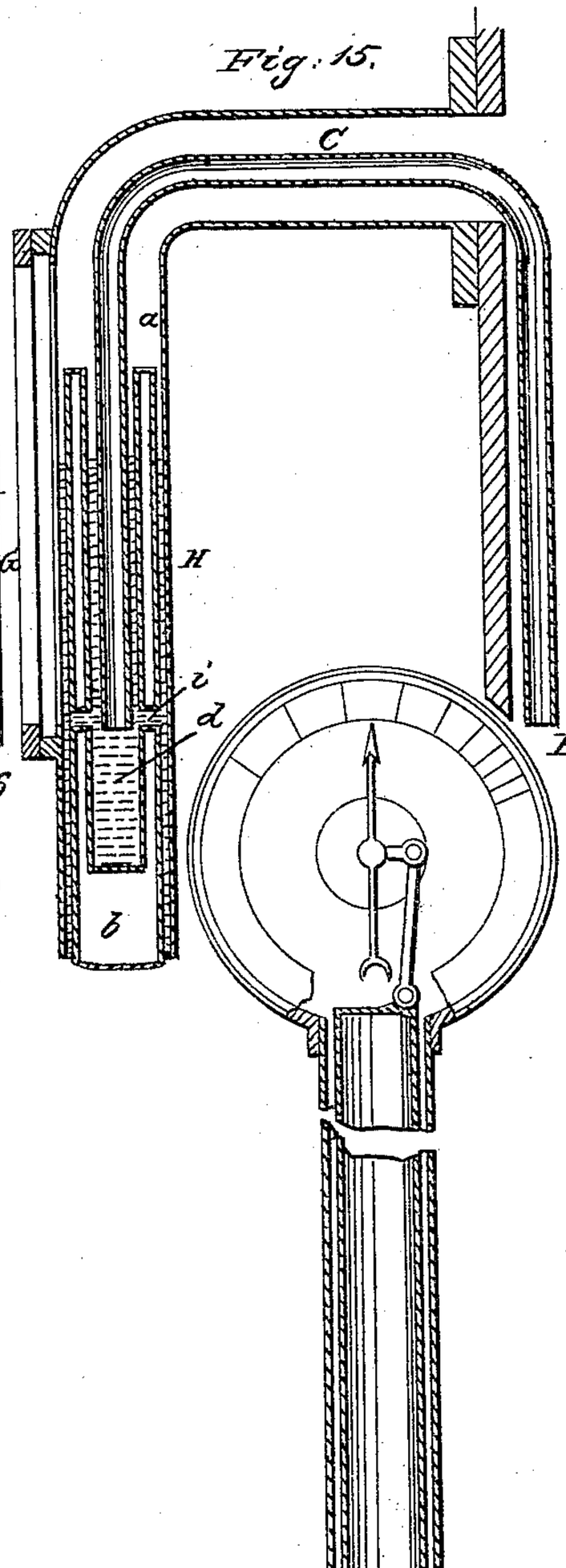


Fig: 18

Witnesses:
William Bull.
Arthur Chabot.

Inventor:
P. B. O'Neill

Witnesses:
William Bu
Arthur Cha

4 Sheets—Sheet 4.

P. B. O'NEILL.

Salinometer.

No. 50,380. Patented Oct. 10, 1865.

Fig: 17.

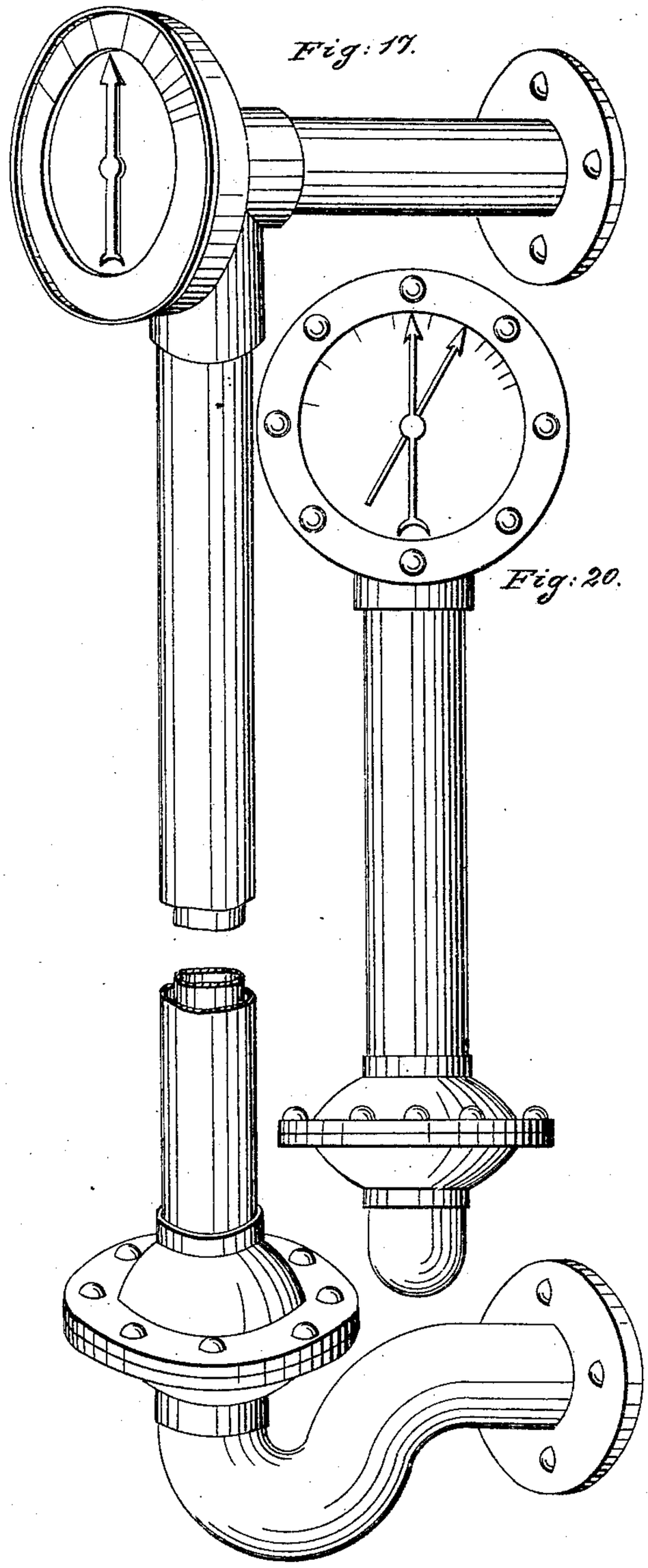
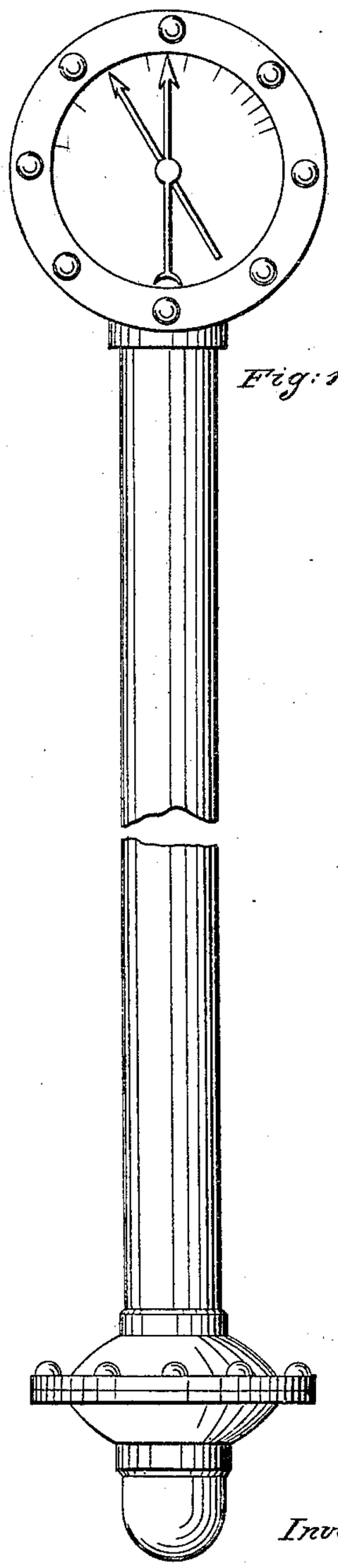


Fig: 20.

Fig: 19.



Inventor:

P. B. O'Neill.

UNITED STATES PATENT OFFICE.

PATRICK B. O'NEILL, OF ST. MARY'S VILLA, COUNTY OF MIDDLESEX, GREAT BRITAIN.

IMPROVEMENT IN SALINOMETERS.

Specification forming part of Letters Patent No. **50,380,** dated October 10, 1865.

To all whom it may concern:

Be it known that I, PATRICK BENIGNUS O'NEILL, of St. Mary's Villa, Grove Bank, Fulham, in the county of Middlesex, in the United Kingdom of Great Britain and Ireland, have invented a new and useful Machine or Apparatus for Measuring and Indicating the Salinity of Sea-Water in Marine-Engine Boilers; and I do hereby declare that the following is a full, clear, and exact description of the construction and operation of the same, reference being made to the annexed drawings, marked A B C D E F G, respectively, making part of this specification, in which drawings—

Figrue 1, Drawing A, is a perspective view of one of the said machines, or an apparatus which is intended to be applied to marine boilers, and which I denominate a "salinometer," and of which Fig. 2 is a vertical section. Fig. 3, Drawing B, shows a modification of the dial-scale or indicator portion of the salinometer; and Fig. 4 is a plan at C D, Fig. 3. Fig. 5 shows a corrugated disk or diaphragm, which forms part of the apparatus, detached. Fig. 6 shows another modification of indicator, which may be substituted for those shown as above mentioned. Fig. 7 is a longitudinal section through the line A B, Fig. 6. Fig. 8, Drawing C, shows a sectional elevation of a combined salinometer and hydrometer in front view; Fig. 9, the same apparatus in side view, and Fig. 10 a plan view thereof. Fig. 11, Drawing D, shows another modification of a combined salinometer and hydrometer in front view; Fig. 12, the same in longitudinal section, Fig. 13 being a plan view at the line E F. Fig. 14, Drawing E, shows another modification of a combined salinometer and hydrometer in front view; Fig. 15, a longitudinal section, and Fig. 16 a plan view at G H. Fig. 17, Drawing F, shows a perspective elevation of a salinometer formed with a single diaphragm, and Fig. 18 the same in transverse section. Fig. 19 is a geometrical front elevation of the same salinometer shown at Figs. 17 and 18, and Fig. 20 a hydrometer formed upon the same plan.

The general form of the machine or apparatus is as follows: At the opposite ends of a suitable tube of about forty inches in length, more or less, two hollow balls, spheres, or enlarged chambers, separating in the middle, are formed or affixed. These enlarged hollows are divided into upper and lower compartments by disks or diaphragms of vulcanized india-rubber, thin metal, or other material of a flexible, elastic, or other suitable nature. When the enlarged chambers or spheres are made to separate (the joint being generally about the center) flanges are formed; or any other suitable method may be employed for fixing and securing the two halves together. The diaphragms, which may be either plain or corrugated, with spiral, concentric, or other corrugations, are made larger than the inner diameter or area of the chambers, so that the outer edges of the said disks may be held all round between the joint or flanges above mentioned, where the upper and lower portions of the balls, spheres, or chambers are fixed together. In the case of the salinometer the upper compartment of the higher hollow ball or cup is connected with the boiler above the surface of the water or in the steam-space by a pipe, through which pipe the steam passes and acts upon the upper diaphragm by pressing it downward. The space immediately over this diaphragm is charged with water in order to prevent the steam from direct contact with the disk. The under compartment of the lower hollow ball or cup is also connected by a siphon-shaped pipe with the boiler below the surface of the water and as near the bottom thereof as convenient, through which latter siphon or pipe the water or brine from the boiler acts upon the lower diaphragm by pressing it upward. The space immediately under this diaphragm is also charged with water (cold) to prevent the boiling brine from injuring its under surface.

The upper and lower disks or diaphragms are connected by a float-rod weighted or acted upon by a spring, or by a float-tube, which is also weighted, as hereinafter explained. This rod or tube keeps the disks always at an equal distance apart, and the space between them and between the outer and inner pipe or rod is filled with water or other suitable fluid, in which they float. The connecting-rod is made buoyant by being incased in cork or other material of suitable specific gravity. The connecting-tube, being filled with air only, possesses the necessary buoyant power of itself.

To the top of the upper diaphragm a small

rod is attached, so as to rise and fall therewith. This rod may have a glass and be graduated, or carry a pointer and the glass be graduated; or this rod may be toothed on one side, and as it rises and falls turn a small pinion upon the inner end of a spindle passing through a stuffing-box in the side of the tube to the front of a dial, where the outer end of the said spindle, being fitted with a hand or pointer, will thus indicate upon the face of a dial suitably graduated the relative density of fluid acting below the lower disk to that of the standard fluid or weight acting above the said lower disk.

In adjusting the apparatus the rod or tube connecting the upper and lower diaphragm is suitably weighted or acted upon by a spring, so as to balance exactly a given column of fluid of a known density or standard weight, so that it would just float therein, displacing its own weight or bulk of the fluid. (For the salinometer this standard is that of distilled water and the height of the column forty inches.) The diaphragms being then perfectly flat, or neither elevated nor depressed, the hand is fixed to the zero-point.

The graduations on the dial or indicator are determined and the scale of degrees marked by subjecting the apparatus to the action of a forty-inch or equal column of fluid of various known degrees of density or salinity, and consequently the indications of these instruments are positive and unerring. I prefer a forty-inch column, but do not restrict myself thereto, as a greater or less column may be adopted, according as circumstances may require.

The apparatus thus formed, adjusted, and graduated is now ready for use.

In affixing one of these improved salinometers to a marine-engine boiler the diaphragm of the upper sphere when two disks are used, or the zero-point when only one disk is employed, should be placed on a level with the working-surface water-line, the pipe connecting the same with the boiler being attached thereto above the water-line, as before stated. The pipe leading from the lower diaphragm to the boiler should be attached thereto as near the bottom of the latter as circumstances will admit, in order that the whole column of salt-water (the salinity of which is to be measured or weighed) may be actually in a boiling state while it is acting upon the lower disk. The graduations on the indicator scale or dial being determined, as before explained, from equal columns of varying weight or density, or from unequal columns of the standard density, then so long as the water in the boiler remains at its normal working-level the indications on the dial will give the true result or actual state of salinity; but should the height of the water in the boiler be either above or below the normal level, then such variation must be allowed for in the following manner: Suppose the water-gage indicator shows that the level of the water in the boiler is standing at No. 2 on the scale above zero—*i. e.*, two inches above the normal water-level—and the pointer on the salinometer indicator index or dial is standing at No. 3 above zero—*i. e.*, above the standard—then the number indicated on the water-gage must be subtracted from the number indicated on the salinometer, because in forming these instruments their respective scales are so adjusted to each other that the extra height of a column of water equal to one division or graduation on the hydrometer will exactly balance one degree of salinity, or one division or graduation marked on the salinometer. Whenever the indicated number or height on the hydrometer is above the zero-point the indicated number or degree on the salinometer will also be above the zero-point; but in case the number indicated upon the hydrometer (or level of the water in the boiler) is below its zero-point, and the number indicated on the salinometer is above its own point, the two indicated numbers must be added together, and the result will be the true state of the water in the boiler. The working limit of salinity is generally considered to be $2\frac{1}{2}°$.

From the foregoing explanation of the principle of construction it will readily be understood that similar instruments with slight modifications in their details may be formed upon the same principle of construction for testing the weight, density, or pressure of any matter, fluid, elastic or other vapor, all that is necessary being to adopt any convenient known standard or weight above the disk and acting thereon with a known pressure or force, and then to admit the pressure, weight, or force (as the case may be) of the matter, fluid, or vapor to be tested, so that it will act below the disk and indicate the same by a hand-pointer or upon a dial or scale suitably graduated.

Let us suppose that it is required to adapt the new instrument for the purpose of a pressure-gage. All that is required is to first fix upon the standard for the zero-point, then graduate the dial to the required scale—say 0, 5, 10, 15, &c., pounds per square inch. Upon bringing the pressure to be measured to bear at the under side of the disk, which may be done by any kind of tap fitted thereto, or by any other suitable method or contrivance, the result will appear on the dial or scale by the hand or pointer fitted thereto.

Having thus stated the nature of my said invention and explained the principle upon which the salinometer and other instruments for measuring and registering the weight, pressure, or density of matter, fluids, gases, vapors, and for other similar or analogous purposes are to be constructed, I now proceed to further describe the various forms and combinations thereof, reference being made to the details shown upon the drawings.

The Salinometer.—Figs. 1 and 2, Drawing A: *a* is the main tube, having the balls or spheres *b b* formed or fitted at the upper and lower ends, separating at the lines *c c* and fixed together by the flanges *d d*; *e* and *f*, the upper and lower

pipes leading to and connecting the instrument with the boiler, *e* admitting the steam to act above the upper disk, and *f* admitting the boiling brine or water to act below the lower disk; *g*, the inner tube, weighted as before described at page 3, shot, by preference, being used for the purpose, or acted upon by a spring, and connecting the two diaphragms *i i* together; *k k*, spaces filled with water or other suitable fluid; *l*, shot or other weight, by which the inner tube is loaded until the standard pressure to act above the disk is obtained; *n n*, a disked rest upon which the lower disk is supported when the instrument is not in use; *o o*, ridge-and-valley gripe formed in the flange-joint for holding and tightening the elastic diaphragms to the required degree of tension; *p*, the rod or rack, which rises and falls with the varying pressure upon the instrument, and indicates the same, or which turns the pinions *r* upon the spindles *s* working through the stuffing-box *t*, and carrying and turning the hand or pointer *u* in front of the dial *v*, where the figures round the periphery indicate the degree of density or units of weight or pressure, as the case may be. *w* is a small screw-plug for charging the tube *e* with fluid when required.

Fig. 3 is an elevation, and Fig. 4 a plan at the line *c d*, Fig. 3, showing a scale-indicator and single-disk apparatus, in which the inner tube, *a*, is graduated by colored rings *b b* round the same, marking the degrees, or has one ring, *a'*, and a scale at the side or on the glass in front. An opening is made in the main tube, and in this opening a strong plate of glass, *c'*, is fitted and securely fixed; *d d*, a cushion of any suitable flexible material, upon which the glass is bedded; *b'' b''*, covering-plate fastened to the sides of the outer tube by screws. An opening is cut out of the middle of this plate, through which the glass and inner tube and indicator ring or rings can be seen by the observer. The inner tube is loaded and attached to the lower disk or diaphragm, as before described. When this kind of indicator is used the zero-point is placed level with the water in the boiler and forty inches (more or less) above the center of the lower diaphragm. It will be understood that a single-diaphragm instrument with a dial, or double-diaphragm apparatus with the tube-indicator, may be employed. In loading the inner tube, in all cases when the upper diaphragm is used, the superincumbent upper column, *x y*, Figs. 1 and 2, must be allowed for.

Fig. 5 is a plan view of a corrugated disk, a section of which is shown across the center thereof, *a b*.

Modification of indicator-dial.—Figs. 6 and 7, Drawing B: In this case the hand or pointer is worked by levers, and one diaphragm only is to be used. *a* is the inner tube or rod, as before; *b*, a short connecting-rod, attached at one end to the top of the tube and at the other to the end of a crank-lever, *c*, fixed upon the spindle *d*, which carries the pointer *e*. The spindle *d* works through the dial-plate *f*, and as the inner tube or weighted rod, as the case may be, rises and falls, the pointer is moved to the right or left. If desired, the sectional dial *g* may be increased to any extent from that here shown (or less) up to a complete circle, as shown by the dotted lines, and the same kind of lever action be made available. The sectional dial can be also placed so that the hand and zero-point may be horizontal, or, in fact, in any required position. *h* is a perforated plate, in the center of which is a bearing or hole to receive and carry the end of the spindle *d* of the indicator.

The combined salinometer and hydrometer.—Fig. 8, Drawing C, shows a front elevation, Fig. 9 a side view, and Fig. 10 a plan view, of one of these apparatus. *a* is the main outer tube of the salinometer, as before described; *b*, the salinometer-dial; *c*, the hydrometer-scale; *d*, the working-surface level of the water in the boiler; *e e*, a glass-inclosed opening in the main pipe *a*, through which glass the surface of the water can be seen. This pipe *e* is open to the boiler, so that the steam which presses upon the surface of the salt-water in the boiler also presses upon the saltless or distilled water in the salinometer, the two surfaces of which it is desired to maintain at the same or at some known relative level. I should here state that I deem it important to keep the salt-water out of the salinometer-pipe above the lower diaphragm. In order to accomplish this and thus render the salinometer capable of indicating the salinity of the brine more accurately, and at the same time operate as a hydrometer, I connect the boiler and pipe *e'* by means of the pipes *g* and *h*, upon which latter pipes I place the intercepting-reservoir *i*. This reservoir is made to separate and fit together at the joint *j*, and is divided internally into two compartments (as is the case in the salinometer-globes) by a flexible diaphragm of india-rubber, *k*. The pipe *g* and the compartment *k'* are charged with cold water up to the level of the top of the globes before the apparatus is attached to the boiler, and in charging the salinometer-tube with distilled water the pipe *h* and the compartment k^2 are also filled. Now, in this condition, the apparatus being supposed to be attached to the boiler and the latter to be in operation, then (the water being at the working-level *d d*,) the column of brine L L' will be balanced by the column of fresh water L^2 L^3, or nearly so, the relative levels of the two surfaces varying a little more or less, according as the salinity (and consequently the weight) of the boiler-column is increased or diminished. This difference in level, however, will only be caused by the difference in weight of the two short columns L L' and L^2 L^3, a little more or less—a variation which, in practice, will be scarcely appreciable. To give an example of the action of this part of the improved apparatus, I will suppose that the boiler-column is

suddenly lowered. Then the salinometer-column will press upon the diaphragm in the intercepting-reservoir, which will yield until an equilibrium of the two columns is obtained. Again, I will suppose that the water in the salinometer-tube *e* is accumulating from the condensation of the steam. Now, it is obvious that without some compensating medium this column will increase until the condensed water rises therein to the elbow above, when it will flow over into the boiler. As soon as this column exceeds in weight the column of brine in the boiler it will cause the diaphragm to yield in the contrary direction to that before stated until the equilibrium is again thereby effected, and thus their respective columns become self-adjusting. *m* is a small tap for letting off the distilled water occasionally.

Another mode of combining the two instruments in one apparatus is also shown upon Drawing D. Fig. 11 is a front view, Fig. 12 a section, and Fig. 13 a plan at E F, Figs. 11 and 12. *a* is the main tube of the salinometer, as before; *b*, the inner tube, which rises and falls and works the salinometer-dial *c*. *c'* is a hydrometer-scale, having a glass-inclosed opening, *e e*, through which the surface of the water can be seen. *f* is a water-tight compartment immediately behind the glass, open at the top, and charged with water up to the line *x x*, or water-surface in the boiler. *g g'* is a siphon, the two limbs of which dip to the level of the bottom of the scale, the action of which siphon is as follows: As the water in the boiler rises and falls the water flows from *g* to *g'*, and vice versa. The inclosure *f* may be carried up above the elbow, as shown at *f'*, in order to prevent the water in the main tube from flowing over it at any time into the siphon or hydrometer portion of the tube.

Drawing E shows another modification of this combined apparatus. Fig. 14 is a front view, Fig. 15 a section, and Fig. 16 a plan at G H. The general construction is the same as that shown on Drawing D. *a* is the main tube; *b*, the inner tube, which rises and falls as the weight of the brine increases or diminishes; *c*, the siphon, one limb of which dips into a well-hole, *d*, in the rising and falling tube. *e e* are openings in the tube, connecting the well-hole *d* therein with the outer tube, *a*, so that as the water therein rises or falls it may be acted upon by the siphon, and the surface thereby regulated by the surface of the water in the boiler.

Drawing F shows a modification of the salinometer represented at Figs. 6 and 7, Drawing B, Fig. 17 being a perspective elevation, and Fig. 18 a sectional view. Fig. 19, Drawing C, shows a front elevation of the single-diaphragm salinometer last explained, and Fig. 20 a similar instrument with a short inner and main tube, intended to operate as a hydrometer, to be fixed to the boiler at the side of the said salinometer, as here shown, and to be used in conjunction therewith, the two dials being fixed at the same level and the respective instruments graduated and adjusted, so that as the salinometer indicates the degrees of salinity the hydrometer indicates the height of the water in the boiler. The black hands, as here shown, indicate saltless water, the red hands 3° of salinity.

What I claim, and desire to secure by Letters Patent, is—

1. The salinometer formed with an outer tube and a flexible diaphragm, upon which diaphragm rests a weighted tube balancing a given column of fluid of a known density, so as to indicate varying pressures of the saline column, substantially as specified.

2. In combination with the salinometer, fitted and acting as specified, the hydrometer, applied and acting as set forth.

P. B. O'NEILL.

Witnesses:

WILLIAM BULL,
Civil Engineer, 1 *Quality Court*, *Chancery Lane*, *London*.

ARTHUR CHABOT,
129 *Camberwell Road*, *Surrey*.