(No Model.) 3 Sheets—Sheet 1.

J. JACKSON.

HYDROSTATIC WEIGHING MACHINE.

No. 507,009. Patented Oct. 17, 1893.

Fig. 1.

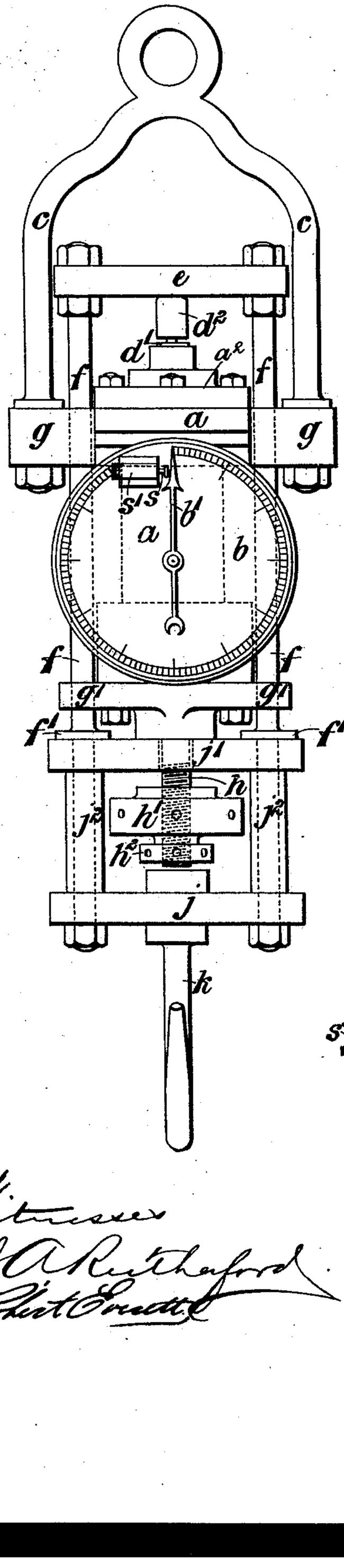


Fig. 7.

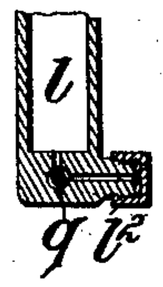


Fig. 9.

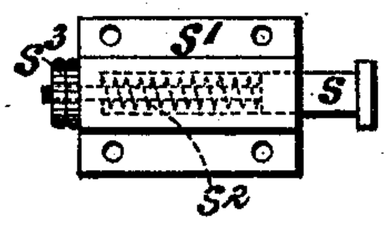
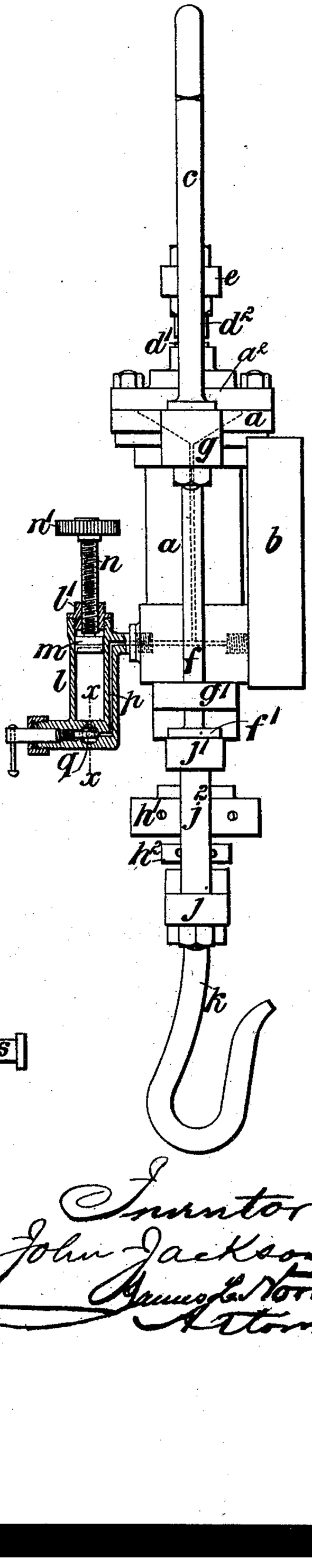


Fig. 2.



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By Munn & Co. Norris
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(No Model.) 3 Sheets—Sheet 2.

J. JACKSON.

HYDROSTATIC WEIGHING MACHINE.

No. 507,009. Patented Oct. 17, 1893.

Fig. 3.

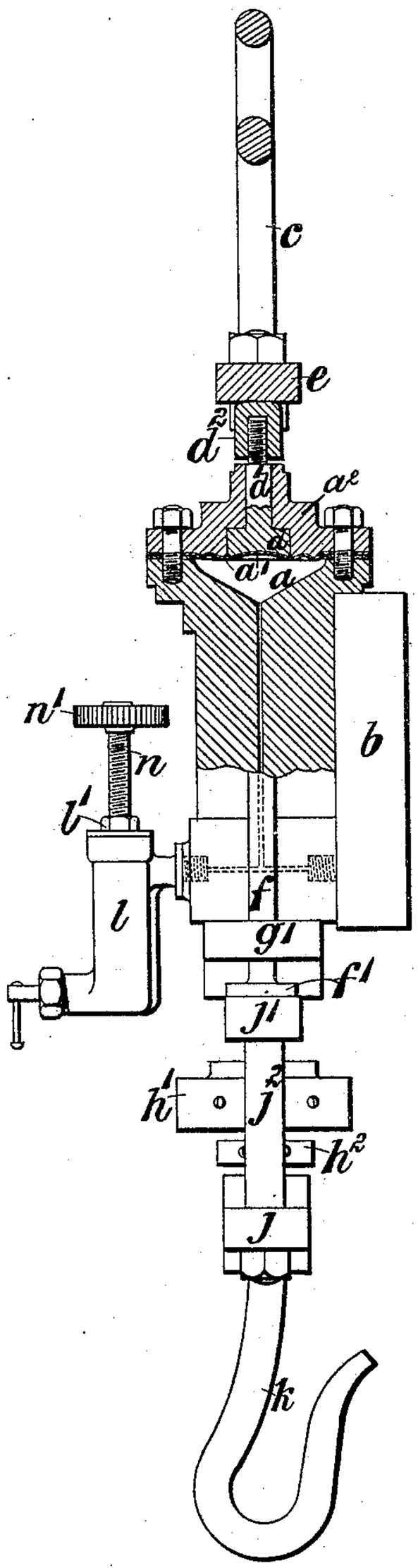
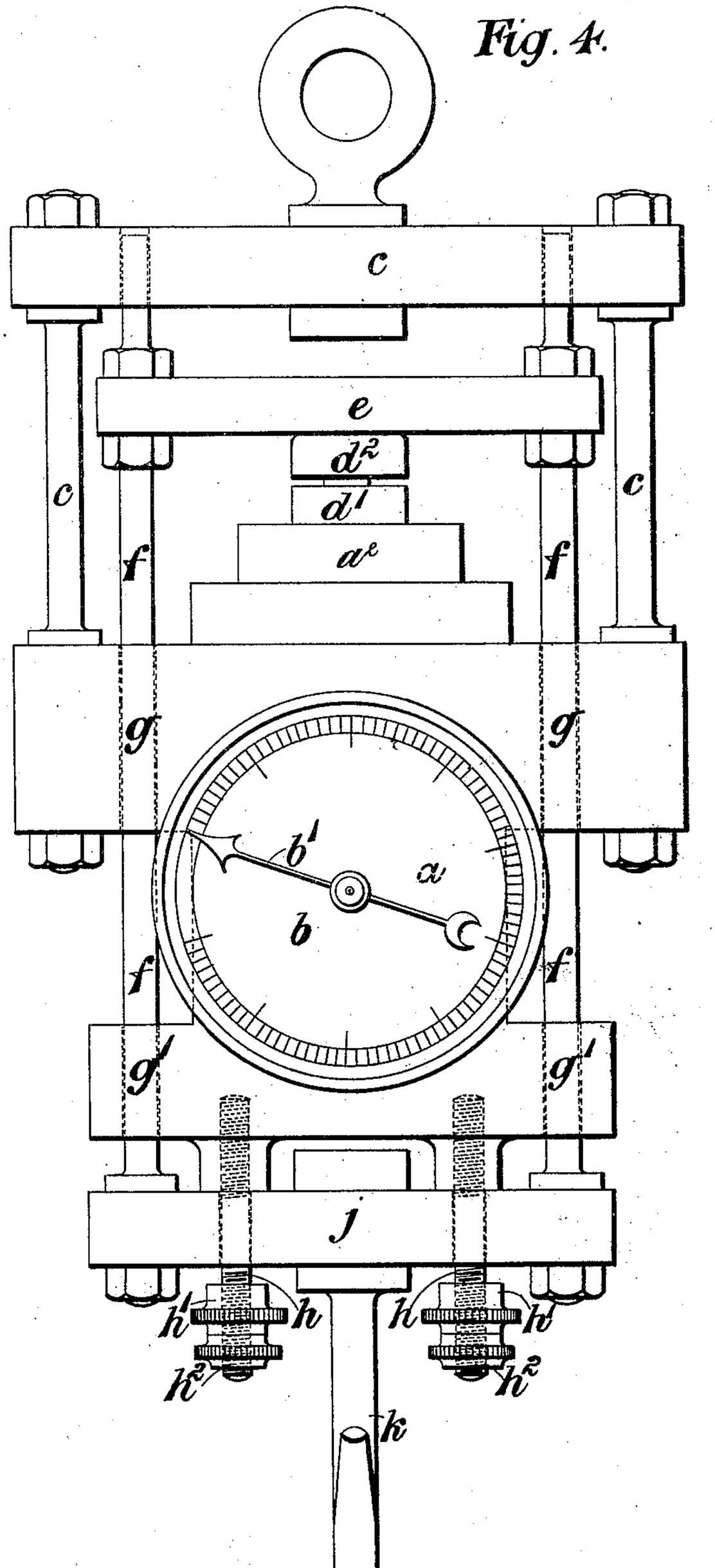


Fig. 4.



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(No Model.) 3 Sheets—Sheet 3.

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HYDROSTATIC WEIGHING MACHINE.

No. 507,009. Patented Oct. 17, 1893.

Fig. 5.

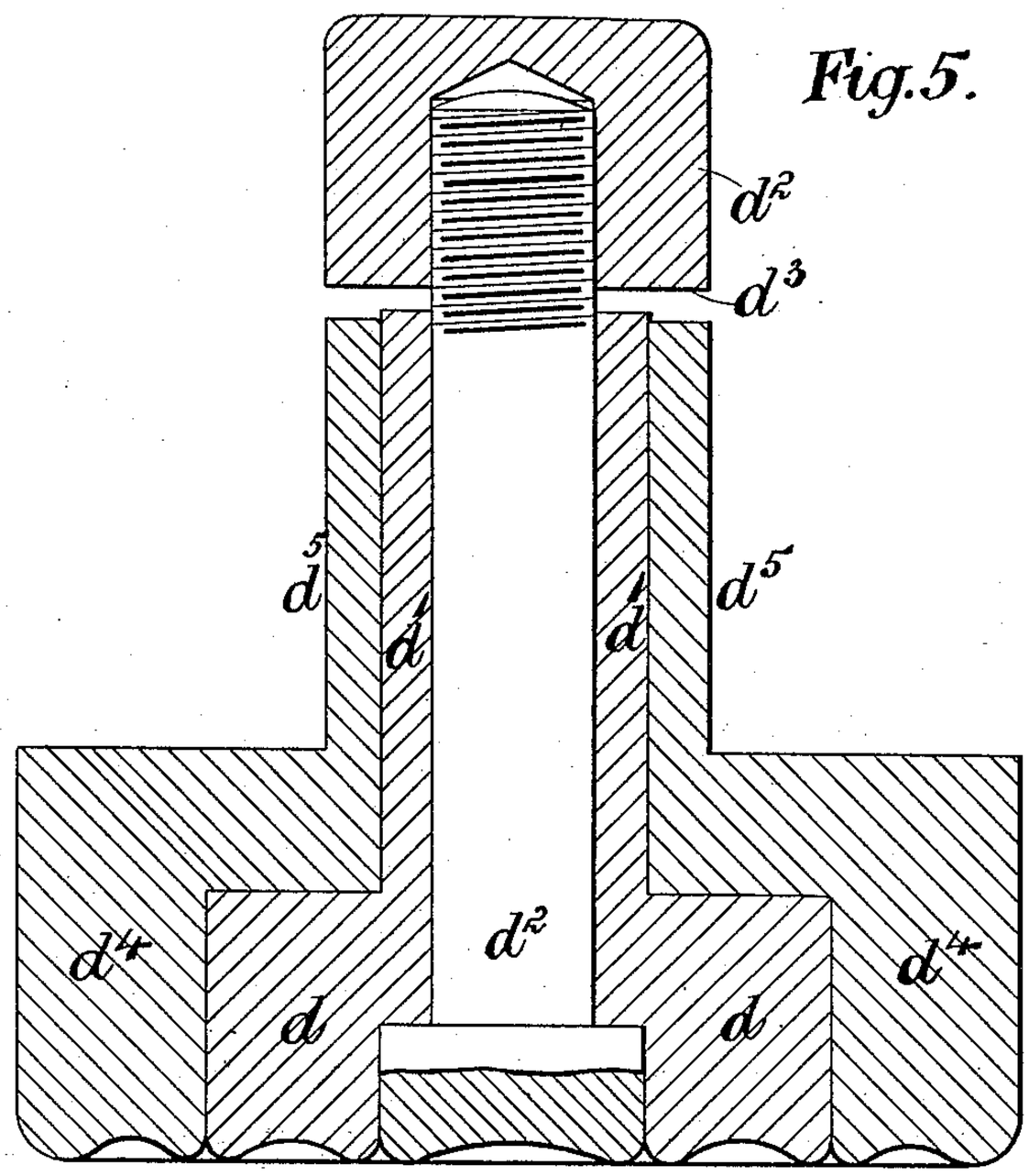


Fig. 8.

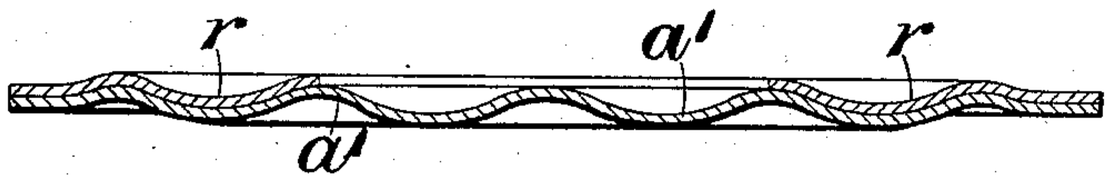
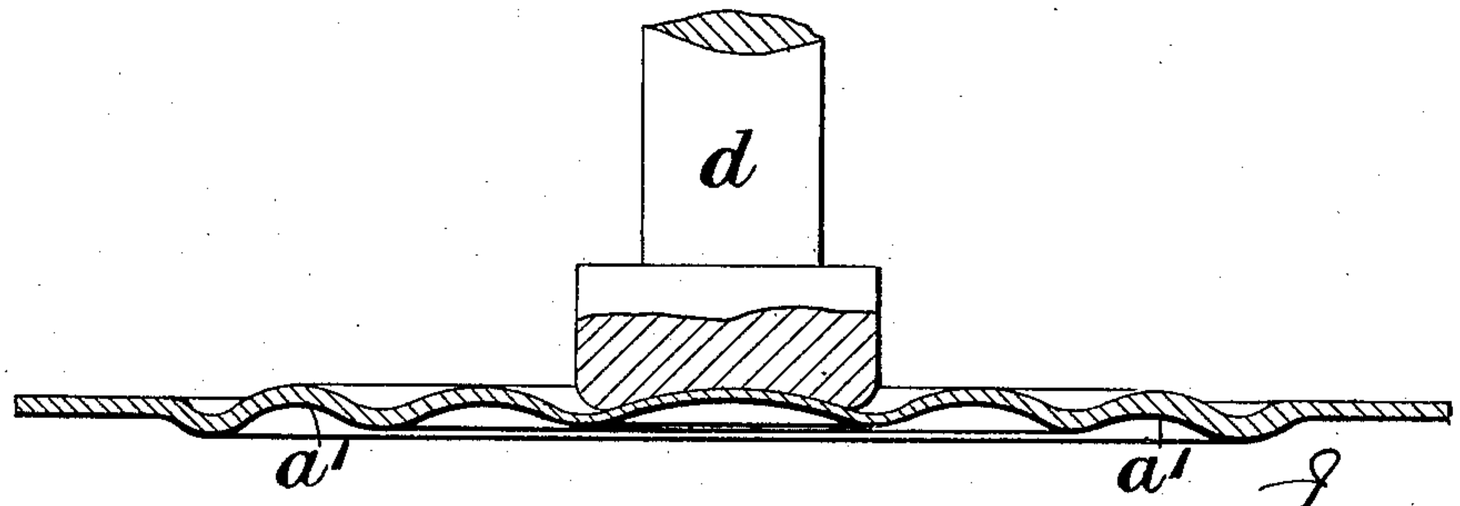


Fig. 6.



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UNITED STATES PATENT OFFICE.

JOHN JACKSON, OF LONDON, ENGLAND, ASSIGNOR OF ONE-HALF TO EDWIN ALFRED HOAD, OF SAME PLACE.

HYDROSTATIC WEIGHING-MACHINE.

SPECIFICATION forming part of Letters Patent No. 507,009, dated October 17, 1893.

Application filed August 25, 1892. Serial No. 444,110. (No model.) Patented in England April 14, 1891, No. 6,338, November 30, 1891, No. 20,880, and May 7, 1892, No. 8,715.

To all whom it may concern:

Be it known that I, JOHN JACKSON, engineer, a subject of the Queen of Great Britain, residing at London, England, have invented certain new and useful Improvements in Hydrostatic Weighing-Machines, Weigh-Bridges, and the Like, (for which the following Letters Patent in England have been obtained, viz: No. 20,880, dated November 30, 1891; No. 6,338, dated April 14, 1891, and No. 8,715, dated May 7, 1892,) of which the following is a specification, reference being had to the accompanying drawings.

My invention relates to hydrostatic weighing-machines, weigh-bridges, and the like, and is designed to simplify and improve the construction of the same. Heretofore it has been usual to construct such weighing-machines with a piston or plunger to which the load is to be applied and which is arranged to move up and down in a cylinder containing glycerine or other suitable liquid in the space between the said piston or plunger and the bottom of the said cylinder, this space being in communication with a pressure-gage for indicating the weight of the load. Weighing-machines constructed in this manner are objectionable by reason of the difficulty of keeping them tight and preventing leakage, and also by reason of the fact that the devices employed to form fluid-tight joints between the relatively movable parts of the machine, cause more or less friction, which interferes with the proper working of the machine and consequently impairs the accuracy of its indications. Such friction is more especially objectionable because it prevents the return of the parts to the proper position to accurately record the weight of the load, should they be moved beyond this position by any shock or jerk due to the too sudden application of the load.

Now according to my present invention I obviate the defects and inconveniences above mentioned, by inclosing the liquid in a hermetically sealed vessel or box of peculiar construction which is in communication with a suitable pressure-gage. This vessel or box is constructed with one or more elastic or resilient metal diaphragms so arranged as to be forced inward to a greater or less extent by pressure applied thereto externally by the load; the liquid contained in the said vessel or box is thus subjected to a corresponding pressure, which is transmitted to the said gage; the said diaphragms, moreover, react or spring back to their original position when the load is removed. I am thus enabled to dispense with the piston or plunger hitherto employed, and also with the cup-leathers or similar devices heretofore used for making fluid-tight joints between the relatively movable parts of the machine. The said closed vessel or box is combined with suitable devices through the medium of which the pressure due to the weight of the load will be transmitted to the elastic or resilient metal diaphragm or diaphragms. It may be advantageous in some cases, to provide for the connection of the said closed vessel or box with a small accumulator or pump, whereby liquid may be forced into the said vessel or box until the latter is completely filled, or until an initial pressure is set up therein. This accumulator or pump may be used from time to time, if required, to introduce more liquid into the said vessel and thus insure the proper action of the machine.

When a heavy load is suddenly applied to a weighing-machine of the kind or class above referred to, it subjects the pressure-gage to undue stress and is apt to thus injuriously affect the same so as to impair its action or the accuracy of its indications. The index or pointer of the pressure-gage is in this manner frequently moved through an angle far greater than is necessary, and has to return through a considerable fraction of this angle in order to accurately indicate the weight of the load. In some of the hydrostatic weighing-machines heretofore constructed, such excessive movement of the weighing-mechanism presents the further disadvantage that, by reason of the friction, the moving parts cannot return to the proper position, and the weight of the load is consequently inaccurately recorded by the gage. I obviate these defects by the employment of one or more rigid supports, the position of which can be regulated in such a manner that they will

sustrain any excessive stress due to the too sudden application of the load, the downward force exerted by the load being resisted by the said support or supports when the index or pointer of the pressure-gage has been moved through the required angle, or, if desired, through an angle slightly greater than that required to indicate the weight of the load; such excessive stress will, therefore, not be exerted upon the weighing-mechanism. In this manner I provide for regulating or determining the maximum stress to which the weighing-mechanism shall at any time be subjected. For instance, if the machine is adapted for weighing loads up to say five tons, the said supports are so arranged that they will protect the weighing mechanism against any stress greater than that due to a weight of five tons, and, when the machine is required for loads of a lesser weight, the said supports can, if desired, be so adjusted as to relieve the weighing-mechanism from any stress greater than that due to such lesser weight. This part of my said invention is very advantageously applicable to machines to be suspended from a crane-chain for the purpose of weighing loads lifted by the crane. My said invention is, however, also applicable to weigh-bridges and other forms of weighing-machines.

The accuracy of hydrostatic weighing-machines is liable to be impaired by the expansion and contraction of the liquid therein, due to changes in the temperature of the same, the said machines, when affected by such changes of temperature, indicating either more or less than the actual weight of any load applied thereto, according to whether the liquid is expanded or contracted. To obviate this defect or inconvenience I provide suitable means for compensating for such expansion and contraction of the liquid. I find it advantageous for this purpose to combine, with the weighing-machine, means whereby the cubic capacity of the space in which the liquid is inclosed may be varied at will.

In weighing-machines of the kind or class above referred to, it is desirable in order to obtain the requisite strength and elasticity or resiliency of the diaphragm, that the outer portion of the latter should be stiffer than the central portion thereof. To attain this result I find it advantageous to combine, with the diaphragm, a strengthening ring or annular piece the external diameter of which is approximately equal to the diameter of the diaphragm, and the internal diameter of which is such as to leave a suitable area of the central portion of the said diaphragm unsupported by the said ring or annular piece. I have found, moreover, that, when the machine is provided with a pressure-gage of the usual construction in which the movement of the needle or pointer is arrested, on its return to zero, by a fixed pin or stud, the said needle or pointer is liable to injury should the load on the machine be suddenly removed, the said needle or pointer, in such case, striking the fixed pin or stud with great force. To obviate the liability to injury in this manner I provide the gage with a suitable spring or cushion so arranged that the needle or pointer, when it returns with undesirable rapidity, will move back beyond the zero and will act upon the said spring or cushion, and the latter, by its reaction, will then move the needle or pointer forward to zero. The shock or concussion to which the needle or pointer is subjected will thus be diminished sufficiently to avoid injury to the said needle or pointer.

In the accompanying drawings, I have shown how my said invention may be conveniently and advantageously carried into practice.

Figure 1 is a front elevation, and Fig. 2 a side elevation, partly in vertical section, of one form of my improved weighing-machine adapted to be suspended from a crane-chain or from a fixed hook or the like. Fig. 3 is a side elevation partly in vertical section of the said machine. Fig. 4 is a front elevation of another form or modification of the said machine. Fig. 5 is a vertical central section, drawn to an enlarged scale, illustrating another modification of my invention, and Fig. 6 is a sectional elevation, also drawn to an enlarged scale, illustrating a further modification of my said invention. Fig. 7 is a section on the line x, x Fig. 2, showing a detail of construction. Fig. 8 is a vertical central section drawn to an enlarged scale, showing an elastic or resilient metal diaphragm and a strengthening ring combined therewith, and Fig. 9 is a front elevation, also drawn to an enlarged scale, illustrating one form of my cushion for the pointer of the gage.

Like letters indicate corresponding parts throughout the drawings.

a indicates the hermetically sealed vessel or box in which the glycerine or other liquid is contained. b is the pressure-gage which communicates with the said vessel through a suitable passage.

The vessel or box a is closed at its upper end by means of an elastic or resilient metal diaphragm a'. The said vessel or box is provided with a suitable loop or frame c whereby it may be conveniently suspended from a crane-chain or from a fixed hoop or the like. A disk d of metal or other suitable material is placed upon the diaphragm a', and is provided with a rod or stem d' and another rod d^2 is screwed into the said stem d. The disk d and rod d' work in a hole in a cover a^2 which is secured to the box a over the diaphragm a' and bears against the portion of the said diaphragm around the said disk d. The said rod d^2 is arranged beneath a cross-bar e firmly connected to two side rods f working in guides g, g' on the body of the machine. The rods f are firmly secured at their lower

ends in a cross-bar j provided with a hook k or other suitable device for supporting the body or object to be weighed.

When a load is suspended from the hook k, the weight of the said load acts, through the medium of the cross-bar j, the side rods f, the cross-bar e, and the rods d', d^2 and disk d, upon the diaphragm a' and thus subjects the liquid in the vessel or box a to more or less pressure, according to the weight of the said load. This pressure is communicated to the gage b, which is thus caused to indicate such weight.

In the arrangement shown in Figs. 1 and 2, the lower ends of the rods f are firmly secured in a frame which consists of an upper cross-bar j', a lower cross-bar j and two sleeves or distance-pieces j^2 arranged between the said cross-bars. A screw-stud h is firmly secured in the under side of the body of the machine and extends through a hole in the cross-bar j', and a screw-threaded rigid support or nut h' is fitted upon the said screw-stud below the said cross-bar, a lock-nut h^2 being also fitted upon the said stud h. The rods f are provided with collars f' which bear against the upper surface of the cross-bar j'.

To prevent injury to the machine by any excessive shock or jerk that may be caused by the sudden lifting of the load by the crane, the nut h' is so adjusted that, when the rods f are pulled down a short distance farther than is necessary to cause the gage to indicate the weight of the load, the cross-bar j' will rest upon the said nut h', and any extra stress which would otherwise be put upon the diaphragm and transmitted to the gage is applied through the said nut to the screw-stud h and communicated through this stud and through the body of the machine to the upper loop c. The weighing-mechanism has, therefore, to withstand only the pressure required to indicate the weight of the load, or a slightly greater pressure, according to the adjustment of the nut h'.

By screwing up the nut h' a sufficient distance upon the stud h the weight of the load suspended from the hook k may be removed from the weighing-mechanism if desired. Or the load may be lifted while the nut h' is in position to sustain the weight thereof, and the said nut be then turned down to allow the weight to act gradually upon the weighing-mechanism.

In cases where it is desired simply to protect the weighing-mechanism against injury by stresses greater than that due to the weight of the maximum load for which the machine is constructed, a collar or other suitable support fixed upon the stud h at the required distance below the cross-bar j' can be substituted for the aforesaid adjustable nut.

It is obvious that if desired, interchangeable cotter-washers or other suitable supports can be used in place of the adjustable nut h'.

In the arrangement shown in Fig. 4, two studs h are secured in the body of the machine and extend through holes in the cross-bar j; and suitable supporting nuts h' and lock-nuts h^2 are fitted upon the said studs, below the said cross-bar j, so that, when the index or pointer of the gage has been moved through the desired angle by the downward movement of the cross-bar j and the parts which move therewith, the said cross-bar j will rest upon the supporting nuts h'.

In the modification of my invention illustrated in Fig. 5, the rod d^2 is formed in two parts which are united by means of a screw-thread. The lower part of the said rod d^2 extends through the hollow or tubular stem d' of the annular piece or disk d and bears at its lower end against the center of the aforesaid diaphragm. The said rod d^2 is formed with a shoulder d^3 adapted to bear against the upper end of the stem d' when the said rod has been moved downward through a predetermined distance. To provide for varying this distance as may be required, I find it advantageous to make the rod d^2 in two parts united by a screw-thread as shown, so that they can be adjusted relatively to each other, or so that they can be detached to permit the insertion between the stem d' and the shoulder d^3, of one or more washers of greater or less thickness for the purpose of regulating or determining the distance through which the rod d^2 must be moved before its shoulder d^3 will act upon the stem d' and depress the annular piece or disk d. By this arrangement of the annular piece or disk d and the central rod d^2 in combination with the diaphragm, the requisite pressure can be applied to the surface of the liquid in the closed vessel or box without subjecting the diaphragm to undue stress, the rod d^2 first acting upon the center of the diaphragm, and pressing it inward more or less according to the relative adjustment of the two parts of the said rod, and the shoulder d^3 then acting upon the stem d' so that pressure is applied to the diaphragm both through the said disk d and through the rod d^2.

I sometimes combine with the annular piece or disk d and rod d^2 another annular piece or disk d^4 surrounding the disk d and also adapted to bear upon the diaphragm. The disk d^4 is provided with a hollow or tubular stem d^5 through which extends the stem d' of the disk d. The parts are so arranged that when a load is applied to the machine, the rod d^2 will be depressed and will act upon the diaphragm, and after the said rod has moved downward through a predetermined distance, its shoulder d^3 will act upon the stem d' and depress the disk d; moreover, when this disk and the rod d^2 have been moved downward through a predetermined distance, the said shoulder d^3 will act upon the stem d^5, and the three parts d, d^2, d^4 will be pressed downward upon the diaphragm. If desired the device which acts directly upon the diaphragm may be formed of a larger number of pieces, so as to render its action

upon the diaphragm still more gradual, suitable means being provided, if deemed advantageous, for permitting relative adjustment of the said pieces for the purpose above specified. Or the said device may consist of a single piece of any suitable shape.

According to a further modification of my said invention, I make the elastic or resilient metal diaphragm comparatively thin at the central portion thereof, and gradually increasing in thickness from the said central portion to its circumference, as shown, for example, in Fig. 6. In this case, I can use a single rod *d* arranged to bear against the central portion of the said diaphragm the outer portion thereof being sufficiently strong to resist the internal pressure without extrinsic support.

In machines for weighing very heavy loads, if only a single diaphragm were employed, it might be necessary in order to give the said diaphragm the requisite strength, to make it of such thickness that its elasticity or resiliency would be impaired. In some instances therefore, instead of using only a single diaphragm, I provide for obtaining the requisite strength and elasticity or resiliency by employing two or more elastic or resilient metal diaphragms arranged one above another.

In Fig. 8 is shown a device for strengthening or supporting the diaphragm while preserving the requisite elasticity or resiliency of the same. *a'* is the corrugated diaphragm, and *r* is a correspondingly corrugated ring or annular piece of metal, which is placed over the said diaphragm and secured therewith between the top of the vessel or box *a* and the holding down flange attached thereto.

Referring again to Figs. 1 and 2 *l* is a cylindrical chamber provided with a piston *m* which is attached to an adjusting screw *n* extending through a tapped hole in the cylinder cover *l'* and provided with a milled wheel *n'* to facilitate its adjustment. The said cylinder *l* communicates with the interior of the vessel or box *a* by means of a pipe or passage *p* provided with an adjustable stop-valve *q*, and both the vessel or box *a* and the cylinder *l* are to be filled with liquid.

To compensate for changes of volume of the liquid due to variations of temperature, the valve *q* is opened and the piston *m* is then moved or adjusted by means of the screw *n* either downward or upward, according to whether expansion or contraction of the liquid has been caused by the variation of temperature until the pointer of the gage is brought to zero. The valve *q* being then tightly closed, the machine is ready for weighing accurately the loads placed thereon.

The vessel or box *a* is filled with liquid before closing it. The regulating cylinder *l* may be charged with liquid by screwing the piston *m* down to the end of the stroke or movement connecting the said cylinder through the nipple l^2 Fig. 7, with a receptacle containing the liquid, and then raising the piston and thus drawing the liquid into the said cylinder, the passage through the nipple l^2 being then closed by screwing a cap or cover upon the said nipple. A suitable valve may, if necessary, be provided for permitting the escape of air from the said vessel or box *a*.

The device shown in the drawings for diminishing the shock or concussion imparted to the needle or pointer of the gage on its return to zero, comprises a small plunger *s* fitted to slide in a casing *s'* in which is inclosed a weak spiral spring s^2 bearing at one end against the said casing and at its other end against a shoulder on the said plunger *s* so that it tends to push the latter out of the said casing. The said plunger is retained in the casing *s'* by the lock-nuts s^3.

As may be seen in Fig. 1, the pointer *b'* of the gage, when at zero, is just clear of the spring plunger *s*. If the said pointer, after it has been turned to any point of the graduated dial, should from any cause be allowed to return too suddenly to zero, it will strike the plunger *s* and more or less compress the spring s^2, the said pointer moving back a short distance beyond the zero; the spring s^2 will then, by its reaction, move the said pointer forward to the zero. The pointer will thus be returned to zero without injurious shock or concussion.

The construction and arrangement of my improved apparatus will necessarily be somewhat varied according to the kind or class of weighing-machine to which my improvements are applied. In the case of a weigh-bridge, for instance, I find it advantageous to provide the platform which receives the load, with two or more vertical guide-pins and to employ interchangeable slotted washers or cotter-washers of different thicknesses which can be fitted and secured in place upon the said guide-pins, so as to serve as supports for the said platform. The stress to which the weighing-mechanism is to be subjected is varied, in this case, by removing the washers and replacing them with washers of geater or less thickness as required. Or I make the said guide-pins with screw-threaded portions on which are fitted adjustable supports or nuts adapted to sustain the weight of the load when the said platform has been moved downward thereby through the required distance to record the weight of the load on the pressure-gage. Or I provide other suitable means for varying or regulating the stress to which the weighing-mechanism can be subjected.

It will be seen that, in my improved weighing-machine, the pressure is imparted to the liquid by the forcing inward to a greater or less extent of one or more elastic or resilient diaphragms forming parts of the closed vessel or box, and which spring back to their original position on the removal of the load instead of by the movement of a piston or plunger in a cylinder, as in the hydrostatic

weighing-machines heretofore employed. There is therefore, in my apparatus no appreciable amount of friction and at the same time there is less liability to leakage than in the machines heretofore employed.

What I claim is—

1. The combination of a hermetically closed vessel or box, one of the inclosing surfaces of which consists of an unperforated elastic or resilient metal diaphragm, a cover having a hole through the same and secured to the said box so that it bears against the diaphragm, a rod or plunger extending through the said cover and bearing against the said diaphragm, connecting devices through which the load to be weighed acts upon the said rod or plunger, and a pressure gage connected with the said vessel or box, substantially as hereinbefore described and for the purpose specified.

2. The combination with the closed vessel or box and the elastic or resilient metal diaphragm between the body of the box and its cover, of a plunger consisting of parts or pieces working one within another and arranged to act in succession upon the said diaphragm, and adjusting devices for varying the relative movement of the said parts or pieces, substantially as and for the purposes above specified.

3. The combination, with the vessel or box a and the cross bar j, of adjustable supports h' beneath the said cross-bar adapted to resist or sustain any excessive force due to the too sudden application of the load, substantially as and for the purposes above specified.

4. The combination, with the closed vessel or box provided with the elastic diaphragm and the cylinder connected with the said vessel or box by a pipe or passage controlled by a valve, of an adjustable piston fitting the said cylinder, substantially as, and for the purpose, above specified.

5. The combination, with the dial of the gage and the index or pointer, of the casing s' attached to the said dial, the plunger s in the said casing and the spring s^2 for returning the said plunger to its normal position, substantially as, and for the purpose, above specified.

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