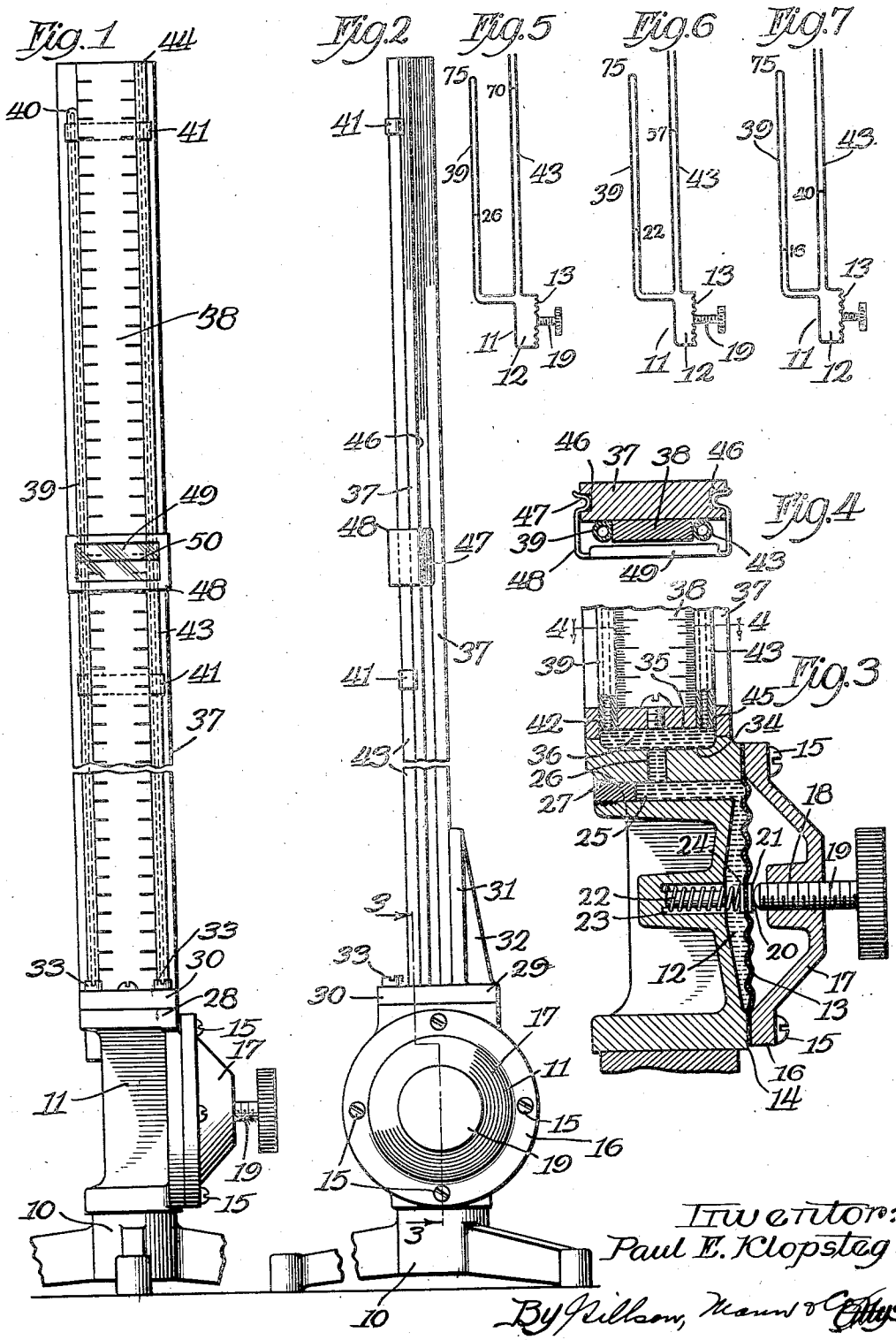
July 11, 1933. P. E. KLOPSTEG 1,917,846

GAS PRESSURE APPARATUS

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GAS PRESSURE APPARATUS

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Fig. 8

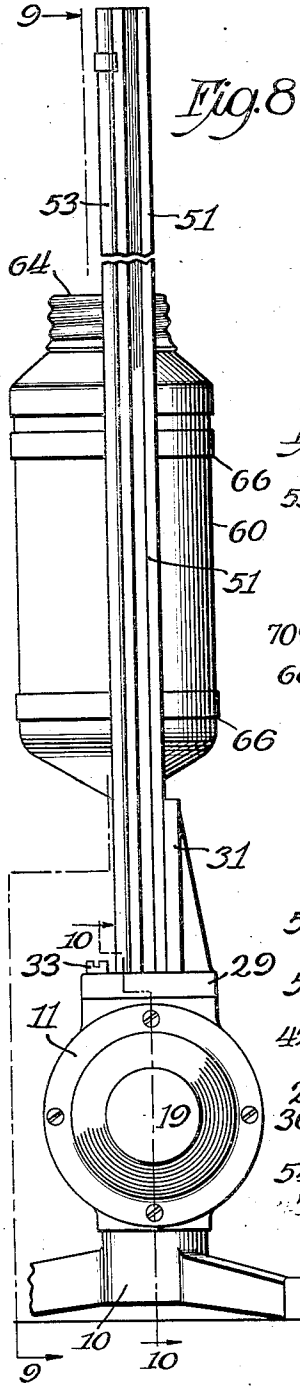


Fig. 11

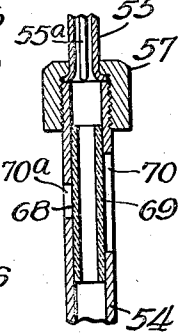


Fig. 9

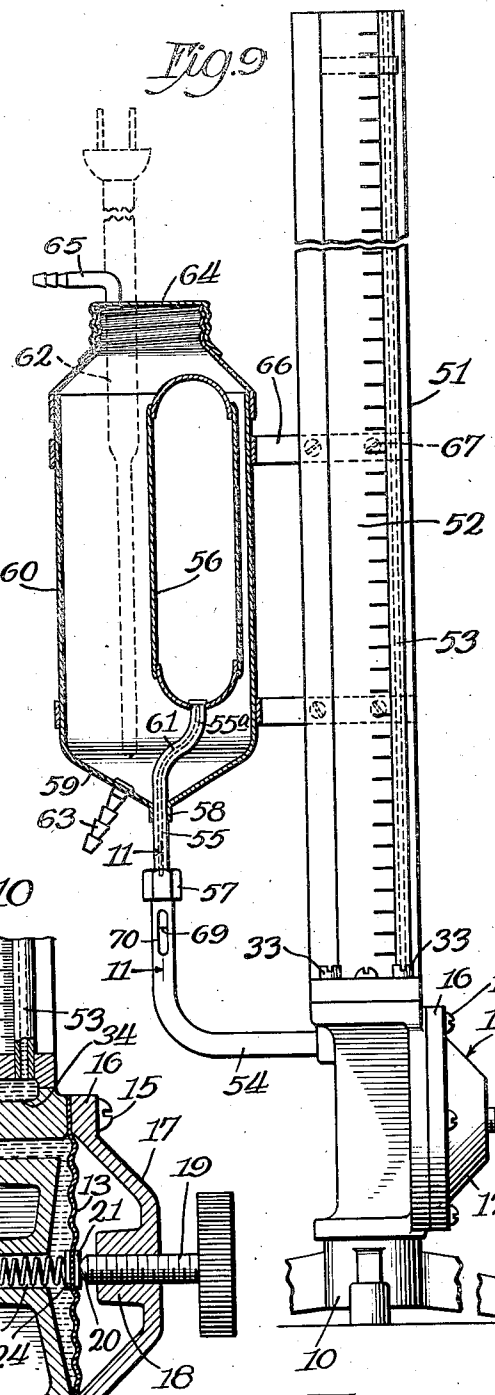
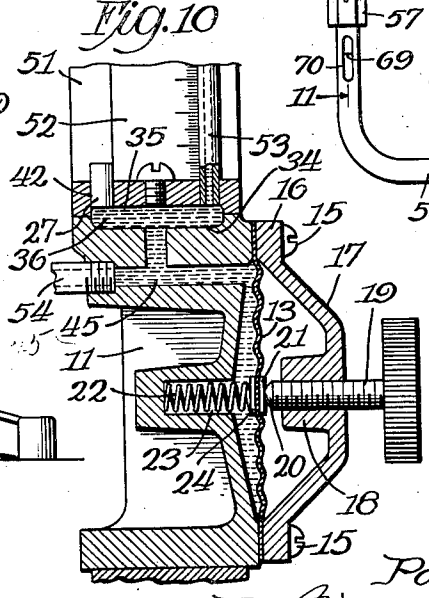


Fig. 10



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UNITED STATES PATENT OFFICE

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GAS PRESSURE APPARATUS

Application filed May 11, 1929. Serial No. 362,343.

This invention relates to gas pressure apparatus and has, among its principal objects, to provide devices especially suited for Boyle's law and Charles' law demonstrations with which the average student can easily obtain the necessary data, and which will withstand the mishandling to be expected from students; that can be easily stored and maintained; that will give results sufficiently close to theoretical laws to be convincing; and that will be free from difficult adjustments and manipulations, thereby giving the student more time for productive work and permitting a larger number of students to handle the apparatus within a given period.

Further objects and advantages of the invention will be revealed as the disclosure proceeds and the description is read in connection with the accompanying drawings, in which

Fig. 1 is a front elevation of the preferred form of the device for use in connection with Boyle's law demonstrations, the intermediate portion and the two legs of the tripod being broken away;

Fig. 2 is a side elevation of the same, looking from the right in Fig. 1;

Fig. 3 is an enlarged sectional view taken on the line 3—3 of Fig. 2;

Fig. 4 is a transverse sectional view taken on the line 4—4 of Fig. 3;

Figs. 5, 6 and 7 are similar diagrammatic views illustrating the mercury heights in the two arms of the J-tube, corresponding to different pressures of the gas under treatment;

Fig. 8 (Sheet 2) is a side elevation corresponding to Fig. 2 (Sheet 1) of a modified form especially adapted for Charles' law demonstrations;

Fig. 9 is a front elevation with the bulb and enclosing vessel in section on the line 9—9 of Fig. 8;

Fig. 10 is an enlarged sectional view on the line 10—10 of Fig. 8, and corresponding to Fig. 3; and

Fig. 11 is an enlarged sectional view of a portion of the volume arm illustrating the preferred manner of providing a visible volume limit in a metallic tube.

But these specific illustrations and the corresponding description are used here solely for the purpose of disclosure and it is realized that the substance of the invention may be embodied in other forms and put to other uses, and it is intended that all such changes shall be covered by the claims.

Boyle's law device (Sheet 1)

The base of the device shown in Fig. 1 is a cast iron tripod 10 of familiar form. Upon this is mounted a cistern body, generally indicated by 11, also of cast iron or other non-corrosive material, and having therein a mercury chamber 12 open at one side which is closed by a diaphragm 13 clamped and shellacked to a ground surface 14 on the body by screws 15 and a base flange 16 of a cap 17. The central portion of this cap is thickened and threaded at 18 to receive a screw 19, having a ball point 20 to cooperate with the wear plate 21 at the center of the diaphragm on the outside. The natural resiliency of the diaphragm is augmented by a spring 22 seated in an annular pocket 23 in the cistern body and bearing against a wear plate 24 at the center of the diaphragm on the inner side.

Adjacent to the upper end of the mercury chamber the cistern body is drilled horizontally at 25 and vertically at 26 to form a passage communicating with the cistern; and in this preferred form 25 extends from side to side of the cistern body, one end or outlet being closed by a plug 27.

At the top the cistern body is provided with a flange 28 which forms a seat for a column bracket 29, including a base flange 30 and a vertical arm 31 reenforced by a gusset 32. The adjacent surface of the flanges 28 and 30 are ground and shellacked so that when clamped together by the screws 33 they form a mercury-tight joint.

The intermediate portions of the adjacent surfaces of the flanges 28 and 30 are grooved, as indicated at 34 and 35, which grooves cooperate to form a passage 36.

An upright wooden column 37 is screwed to the arm 31, and a scale bar 38 is secured on the front of the column. On the left of the scale bar a glass tube 39, having its upper end 40 closed, is made fast by suitable clips 41,

and its lower end is cemented in a bore or outlet 42 communicating with one end of the passage 36. On the right of the scale bar, and secured by the same, or similar clips 41, is a glass tube 43 having its upper end 44 open, and its lower end cemented in a bore or outlet 45 communicating with the opposite end of the passage 36. The two glass tubes in conjunction with the passage 36, form a J-passage, of which the tube 39 is the short, or volume arm, and the tube 43 is the long, or manometer arm. The joints between tubes 39 and 43 and the bores 42 and 45 must, of course, be mercury-tight, which may be insured by using a secret preparation known in the trade as de Kotinsky cement.

It will, of course, be understood that any other suitable means may be employed for making a mercury tight seal between the tubes 39 and 43 and the bores 42 and 45, respectively.

The scale bar is graduated in any suitable units, that illustrated being in centimeters and corresponding to about eighty centimeters in length.

The sides of the column 37 are grooved at 46 to receive resilient fingers 47 of a frame 48 equipped with a crystal 49 and a hair line 50, to facilitate reading the height of the mercury in the two arms of the tubes.

The apparatus constructed and assembled substantially as shown in Figs. 1 to 4 may be filled at the factory and received by the purchaser ready for use. The escape of mercury during handling and shipping may be effectually prevented by winding a little cotton on a wire inserted in the manometer tube 44. The wire should, of course, project beyond the tube in order that the cotton may be readily extracted when the apparatus is to be put in use.

It will be clear that turning the screw 19 to deflect the diaphragm 13 to the left in Fig. 3 will cause mercury to flow from the cistern chamber 12 through the passage formed by the drillings 25 and 26 to the J-passage; that turning the screw in the reverse direction to relax the diaphragm will permit a flow in the opposite direction, and that in each case the mercury will assume elevations in the respective arms 39 and 43, in accordance with Boyle's law.

Readings may be taken for successively decreasing volumes, as illustrated by 70, 57 and 40 (Figs. 5, 6 and 7), or for successively increasing volumes, or, for better accuracy, readings may be taken both ways.

Charles' law device (Sheet 2)

The tripod base 10, the cistern body 11 with appurtenances including the bracket 29 may be, and preferably are, identical with those described in the Boyle's law device illustrated in Sheet 1, with the single exception that the plug 27 is removed from the bore 25 and inserted in the bore 42.

The column 37 is replaced by a similar column 51, equipped with a suitable scale bar 52, and a glass tube 53, corresponding to the tube 43, on Sheet 1, in structure and function.

The volume arm of the J-passage in this instance preferably includes a heavy steel tube 54 threaded into the bore 25, a lighter steel tube 55 and a steel bulb 56. The tube 54 is bent at right-angles and is joined to the tube 55 by a coupling 57 just above which the tube 55 extends through and is soldered to the neck 58 in the bottom 59 of a copper vessel 60, which encloses the bulb 56, and is adapted to be filled with a cooling or heating fluid, as occasion may require.

The pipe 55 is bent laterally at 61 in order to place the bulb 56 at one side of the vessel 60 and thereby provide space for an electrical heating device 62, or for ice, or other things used in changing the temperature of the gas within the bulb 56. The vessel 60 is provided with a hose nipple 63 in the bottom, and with a screw cap 64 also provided with a hose nipple 65. It is supported by clamps 66 attached to the column 37 at 67.

A glass tube 68 provided with an etched mark 69 is inserted in and cemented to the upper end of the tube 54, and a portion of the wall of that tube is cut away at 70 to make a short length of the glass tube, including the mark 69, visible, and this result is promoted by an oppositely disposed opening, or window 70^a.

All the volumetric content of the tubes 54, 55 and 56, above the mark 69, becomes the constant volume chamber for the gas to be studied. A bent rod 55^a in the tube 55 reduces its volumetric capacity without materially affecting free passage through the tube.

In use, after the gas in bulb 56 has been brought to a selected temperature, the screw 19 is adjusted to bring the mercury to the line 69 in the tube 54, when the mercury elevations in the two arms are read on the scale 52. In the case of the volume arm this is facilitated by a small triangle, or the like, held with the edge over the line 69, and extending across the scale 52.

The temperature of the gas in the bulb 56 is then changed by any suitable means, another adjustment of the mercury made, and other readings taken from the scale.

The metal wall of the bulb assists in bringing the contained gas to the temperature of the surrounding medium with little or no more lag than is to be found in the thermometer, hence, no error of consequence is committed.

For high temperature readings the vessel 60 may be wrapped with suitable insulating material to reduce the loss by radiation and convection.

If the method of two fixed points is to be used the screw cap 64 is equipped with a steam gasket and steam is introduced through suitable holes applied to the nipples 63 and 65 for the high point; and for the low point the hose nipple 63 is closed with a short piece of hose and a clamp, and the vessel is filled with ice.

It will be readily noted that all rubber connections, common to apparatus heretofore used, have been eliminated, and the contamination of mercury by sulphide formation thereby obviated. Mercury comes in contact with metal or glass alone, and leakage is almost entirely eliminated. Both the devices may be easily and quickly prepared for shipping with appropriate quantity of mercury contained, and as easily and quickly prepared for use upon receipt. They are compact, comparatively unbreakable, and, therefore, simplify the storage problem and reduce the upkeep due to mishandling.

The mercury levels are easily adjusted with great precision by manipulating the screw which is convenient to the hand of the operator facing the scale. For convenience this motion may be designated as micrometric, though, of course, it is not to be construed within the strict meaning of that term as applied to optical and similar apparatus. About forty threads to the inch on the screw 19 gives all the precision required for ordinary purposes.

I claim as my invention:

1. In a device of the class described, tubular means including a closed volume arm, an open manometer arm, said arms being structurally separate, a metallic cistern closed except for a passage directly connecting with said means and forming a connection between said arms, and micrometric means for varying the capacity of the cistern.

2. In a device of the class described, a cistern body having a fluid chamber on one side thereof, with a resilient diaphragm wall, means for flexing said diaphragm wall to vary the fluid capacity of the chamber, and resilient means for engaging the inner side of said diaphragm for holding the same in continuous engagement with said first-named means.

3. In a device of the class described, a cistern member having a cistern therein, a passage formed in said member connecting with the cistern, tubes for indicating the liquid levels opening into said passage, a diaphragm closing said cistern and forming a flexible wall therefor, a guide pin extending along the axis of the cistern normal to said diaphragm, a helical spring for pressing said diaphragm outwardly, a micrometric screw in substantial alignment with said pin and bearing upon the outer side of said diaphragm to deflect the diaphragm against the pressure of the spring and the pressure of the liquid contained in said cistern.

4. An apparatus capable of demonstrating both Boyle's law and the law of Charles, comprising a vertical scale and a cistern body, said body being provided with passages communicating with two outlets adapted to allow the insertion of closed volume arms therein, one of said outlets being provided in the upper face of said cistern body whereby a closed volume arm may be attached parallel to said scale and form with said apparatus a Boyle's law device, the other of said outlets being provided in the rear face of said cistern body, whereby a closed volume arm bearing a considerably enlarged volume chamber may be attached to said apparatus and form therewith a law of Charles device, and means for closing either one or the other of said openings.

5. In a device of the class described, a metallic cistern body having a storage chamber therein and having a passage connecting the chamber with two outlets, a metallic diaphragm closing the chamber, means for flexing the diaphragm to vary the capacity of the chamber, and a pair of rigid tubular members mounted one in each of said outlets, one of said members being closed to form a volume arm, and the other being open to form a manometer arm.

6. In a device of the class described, a metallic base provided with a recess in one of its faces to receive a fluid and having passages connecting the recess with two outlets, a rigid open manometer arm mounted in one of the outlets, a rigid volume arm mounted in the other outlet, a metallic bulb on the end of the volume arm, heat interchange means enclosing the bulb, a closure for the recess movable relative to the base to change the volumetric capacity of the recess and force fluid into said arms.

7. In a device of the class described, a metallic base provided with a recess in one of its faces to receive a fluid and having passages connecting the recess with two outlets to thereby form a passage through the base, a rigid open manometer arm mounted in one of the outlets, a rigid volume arm mounted in the other outlet, a metallic bulb on the end of the volume arm, a vessel enclosing the bulb, a metallic diaphragm closing the recess, and means for flexing the diaphragm to force fluid into said arms and compress a gas in the bulb.

8. In a device of the class described, a body made of material that will not chemically attack or contaminate mercury and having a recess in one of its faces for receiving a fluid and a passage for connecting the recess to two outlets, an upright column rising from the body, a scale on the front of the column, a rigid manometer tube mounted in one of the outlets and supported by the column, a rigid

closed volume tube mounted in the other outlet, a bulb on the end of the volume tube, a vessel enclosing the bulb for varying the temperature of the bulb, and a diaphragm closing the recess and adapted to be flexed for varying the fluid capacity of the recess.

9. In a device of the class described, a cast metal base provided with a recess in one of its faces and having a horizontal passage communicating with the recess a vertical passage communicating with the horizontal passage and a second horizontal passage adapted to connect with two outlets, a closure for the recess movable relative to the base to change the volumetric capacity of the recess, and micrometric means for moving the closure.

10. In a device of the class described, a cast metal base provided with a recess in one of its faces for receiving a fluid, said base also being provided with two outlets and drilled horizontal and vertical passages connecting the recess with the two outlets, rigid tubes mounted one in each of said outlets, a closure for the recess movable relative to the base to change the volumetric capacity of the recess, and micrometric means for moving said closure, said base being cast in a single piece.

11. In a device of the class described, a base made of material that will not chemically attack or contaminate mercury and being provided with a recess in one of its faces to receive a fluid and having passages connecting the recess with two outlets to thereby form a passage through the base connecting the two outlets to each other and to the recess, a closure for the recess movable relative to the base to change the volumetric capacity of the recess, and micrometric means for moving the closure.

In testimony whereof I affix my signature.

PAUL E. KLOPSTEG.