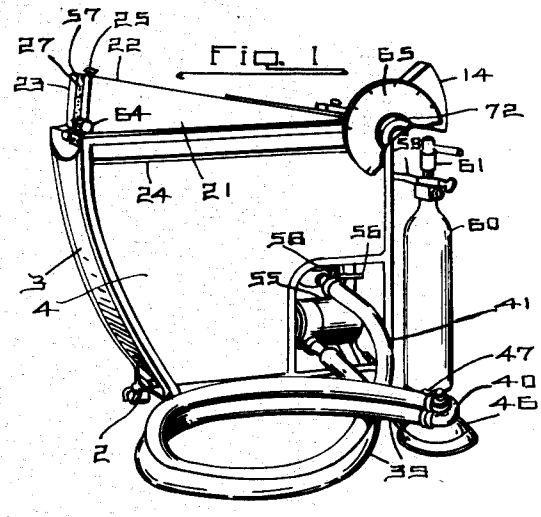
July 17, 1928. 1,677,147

E. I. McKESSON

GAS MEASURING

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Fig. 1



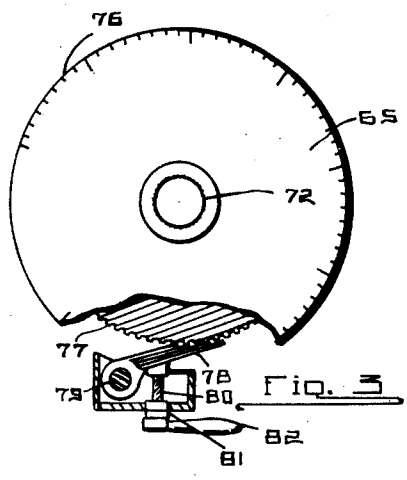
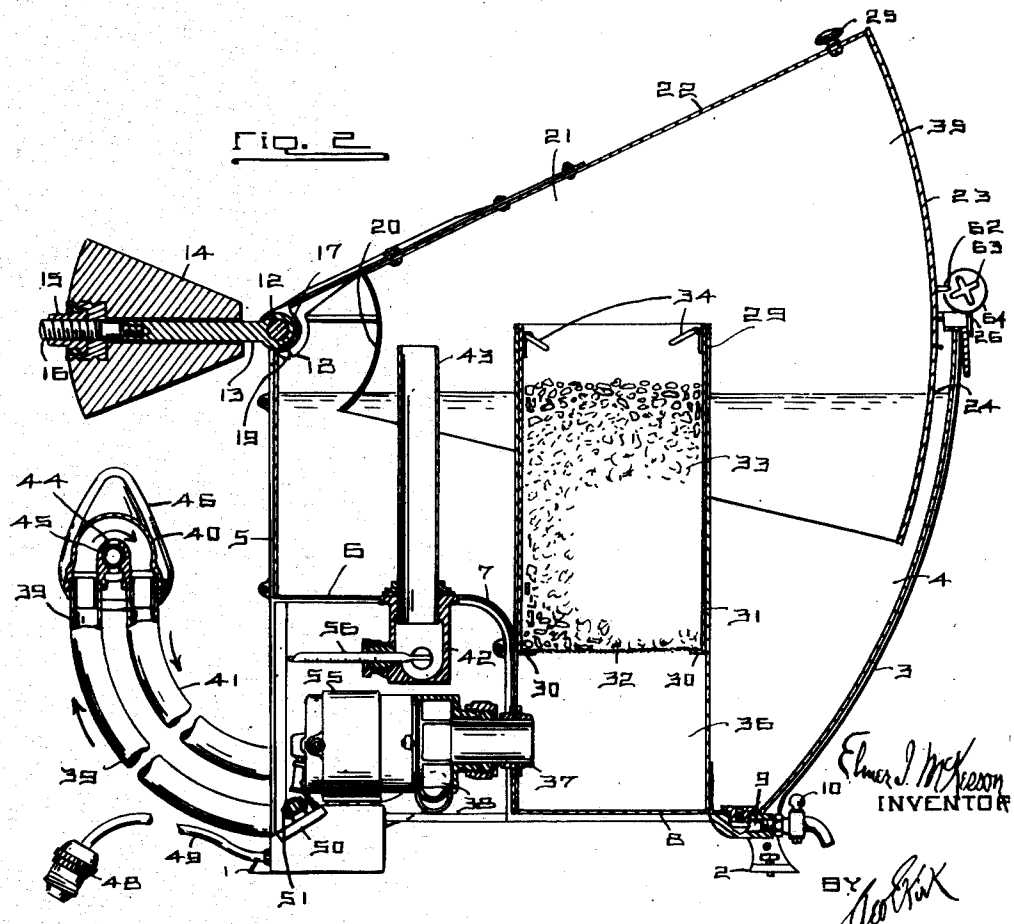


Fig. 3

Fig. 2



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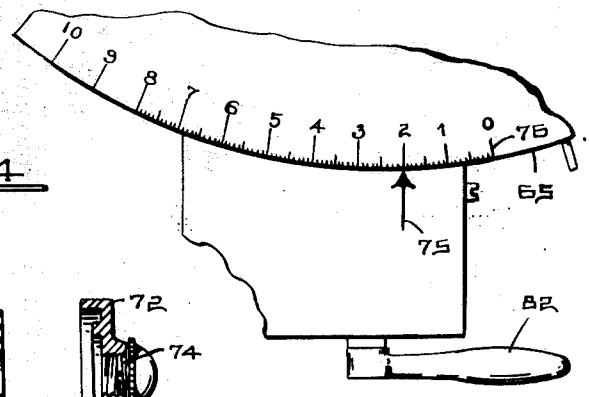


Fig. 5

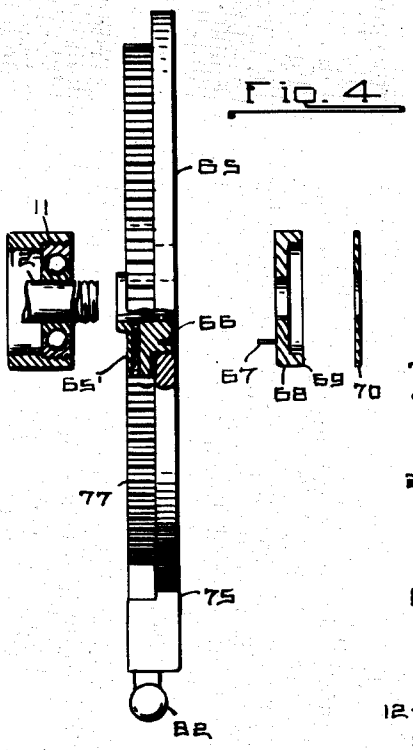


Fig. 4

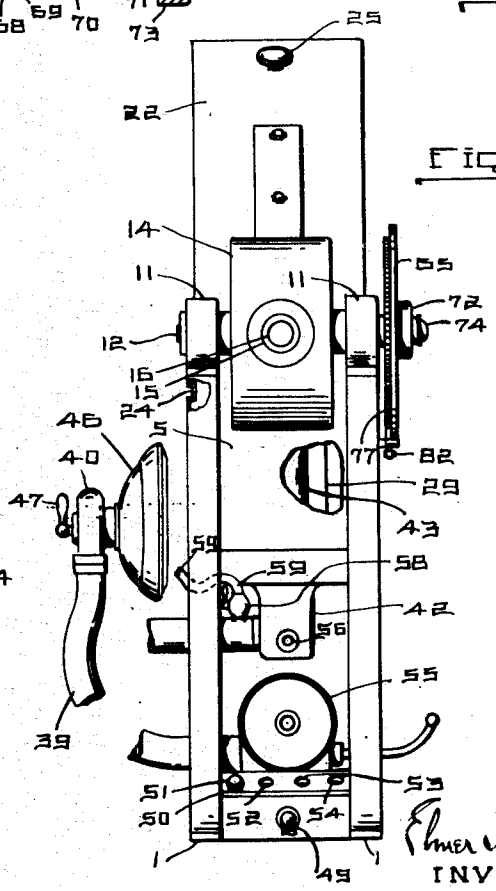


Fig. 7

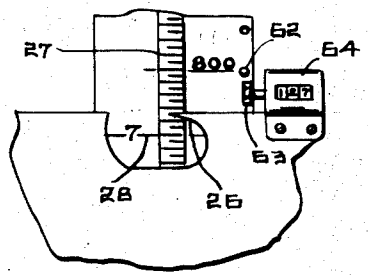


Fig. 6

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UNITED STATES PATENT OFFICE.

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GAS MEASURING.

Application filed October 10, 1921. Serial No. 506,584.

This invention relates to gas handling.

This invention has utility when incorporated in respiration mechanism, especially in the measuring of gas, and gas administration.

Referring to the drawings:

Fig. 1 is a perspective view of an embodiment of the invention in respiration mechanism especially adapted as a metabolism meter;

Fig. 2 is a vertical longitudinal section of the mechanism of Fig. 1;

Fig. 3 is a detail view of integrating volume measuring attachment for the mechanism;

Fig. 4 is a distributed view, parts being in section, of the volume integrating attachment and its mounting;

Fig. 5 is a fragmentary front view of this volume integrating attachment;

Fig. 6 is a front view of the direct reading scale feature of the mechanism at the float periphery, instead of at the float-axis, as is the integrating disk; and

Fig. 7 is an end view of the mechanism, parts being broken away.

Legs 1, 2, support a vessel or liquid carrying reservoir having a curved outwardly and upwardly extending forward end 3, from which extend rearwardly, parallel sides 4 to vertical rear end 5. This end 5 extends downward to an inwardly extending ledge or bottom portion 6 having a drop-off portion 7 to still lower main bottom portion 8. A duct 9 controlled by valve 10 may serve to draw off liquid from this vessel or reservoir.

Near the upper junction of the walls 4, 5, brackets 11 serve as pivot bearings for fulcrum pin or bearing 12. From this bearing pin 12 there extends outwardly away from the vessel or reservoir a stem 13 carrying a weight 14 adjustable along the stem 13 as shifted by nut 15 coacting with threaded portion 16 of the free end of this stem 13.

Loosely mounted on the bearing pin 12 is bracket member 17 having stop 18 swingable against stop 19 fast with the stem 13. This bracket member 17 carries a float chamber comprising an inner curved wall 20 from which outwardly extend parallel side walls 21, and top wall 22 to outer curved wall 23. The walls 20, 23, are concentric with each other and the reservoir wall 3, all having the common center of the axis of the shaft 12. The walls 23, 20, are somewhat narrower than the walls 5, 3, permitting some clearance of the float chamber as positively held against lateral shifting by the bearing 12 in the float oscillation into and out of the reservoir, in this pneumatic trough structure or constant pressure variable volume receiver or gasometer. A rib 24 is formed in the reservoir side walls 4 as a ready indication for water level maintenance in the normal operation of the mechanism as a pneumatic trough. The desired adjustment of the counterweight or counterpoise 14 is such as to neutralize the unbalancing tendencies which tend to arise by changes in the submergence of the walls of the float chamber. This is brought about by the disposal of the mass about the pivot bearing. This feature of constructing the counterpoise is had in order to maintain the float chamber against disturbance of internal pressure at different capacity positions thereof.

By grasping the handle 25 on the top 22 of the float, near the free end wall 23 thereof, this float may be swung on fulcrum bearing pin 12 as an axis back toward the counterpoise 14, to permit of ready inspection of the interior of the float chamber, and also general access to the entire reservoir interior. With the mechanism thus conveniently opened, the water may be supplied to the reservoir up to the gage mark 24, and the float readily swung toward the reservoir to have the stop 18 abut the stop 19. The nut 15 may then be adjusted to effect the shifting of the counterpoise 14 to balancing position with the float chamber. To readily check this position of true balancing, indicating means or pointer 26 carried by the reservoir wall 3 is overhanging adjacent a scale 27 carried by the wall 23 of the float. The pointer 26 is brought to 7 L. point 28 of this scale, so that there may be direct reading of capacity change therefrom, say in cubic centimeters, as disclosed by the graduations of the scale 27.

Inwardly from the side walls 4 and centrally of the liquid containing reservoir of the pneumatic trough, there is a seat 29 as a pocket extending upwardly above the water level line 24 to communicate with the float chamber interior. This seat 29 has a ledge 30 upon which is sustained removable chamber 31 having a perforate bottom 32. This chamber or vessel 31, 32, serves as a container for gas absorption means 33, as soda lime, when the gas to be absorbed is

carbon dioxid. With the float chamber swung back to open the reservoir, collapsible handles 34 of this soda lime vessel may be grasped and the vessel removed from its pocket 29, 30, for dumping out any spent granular material and the gas absorption chamber re-charged and readily replaced in the mechanism.

The float walls 20, 21, 22, 23, in the region above the liquid level gage 24, provide a chamber 35 for gas in communication through the coarse granular soda lime of the absorption chamber 31, 32, with sub-chamber 36, having duct 37 therefrom to rotary pump or gas impelling means 38 delivering gas to duct section 39 extending to the mask or inhaler by-pass section 40, having return duct section 41 extending to connection 42 below the bottom section 6, there communicating by way of upstanding duct section 43 with the chamber 35, thereby completing the gas circuit. This upstanding duct section 43, as well as the upstanding duct section or seat 29, so project up into the chamber 35 as to be above any normal liquid level in the reservoir 3, 4, 5, 6, 7, 8. Each of these upstanding duct sections 29, 43, is spaced by a considerable volume of jacketing water in the reservoir from the side walls of such reservoir.

Port 44 in by-pass 40 is in communication with passage 45 leading to face portion 46 of the mask or inhaler. In placing the inhaler in position for breathing by covering the nose and mouth passages, the inhaler may be manipulated by adjusting screw 47 so that the port 44 is fully closed, and the inhalations and exhalations are directly out of the passage 45 to the atmosphere.

In connecting up the mechanism for the forced circulation, when the one-way circulation is at a rate beyond mere check valve control, a convenient power source is electricity. A plug 48 may be connected for electric energy supply by way of cord 49 to switch board 50. Plug 51 from blank socket position, may be shifted into socket 52, when the current supply source is sixty cycle alternating electric current of 110 volts, and when the plug 51 is in socket 53 it is in on position when the current supply source is twenty-five cycle, 110 volt alternating electric current, while when in socket 54 universal direct current motor 55 will operate at similar speed to the former connections. In this last instance the current supply is 110 volts. The current supply as controlled by the plug switch 51 may operate the motor 55 for actuating the rotary pump or impeller means 38. It is contemplated the circulation rate in the gas circuit, as herein power operated, shall be continuous and in such volume that exhalations delivered by the inhaler 46 into the by-pass 40 shall travel by way of the duct section 41 to the float chamber 35, and that inhalations taken from the inhaler 46 shall be supplied by the duct section 39, with the carbon dioxid content largely if not entirely abstracted by the soda lime 33 in the gas absorption chamber 31, 32.

In order to minimize possible disturbance in volume calculations, as well as check thereon, a temperature indicator or thermometer 56 is disposed in the connection 42. This thermometer 56 as placed is located to disclose the circulated gas temperature, and any fluctuations therein are readily disclosed. In the operation of this pneumatic trough, there is no bubbling through the trapping liquid for the float. The liquid surface is accordingly quite. The passage 43 into the float and the passage 31 therefrom are so jacketed by the reservoir liquid as to approximate a uniform room temperature condition of the mechanism as at starting of the test. When completing a test, the circulation is maintained sufficiently long after the inhaler 46 is cut out, to allow the float chamber 35 to become quiet at a constant volume position, insuring that the total of carbon dioxid has been removed, and that the only gas remaining is oxygen, or possibly in addition thereto some nitrogen from the atmosphere which the inhaler holder had, or which may have been in the air passages to the lungs.

After the reservoir 3, 4, 5, 6, 7, 8, has been charged with water to liquid level rib or markers 24, and the mechanism is in leveled position as adjusted by the screws in the legs 2, the supply of gas may be introduced into the float chamber 35. The motor 55 may be operated to empty the chamber 35 before the duct sections 39, 41, are attached. This settling down of the float chamber may be to zero indication 57 on the scale 27. The ducts 39, 41, may be connected to the supply pump 38 and to the connection 42, and by way of valve 58, (Figs. 1, 7) now opened and in communication with the connection 42, the chamber 35 may be supplied with the gas for the test, as oxygen. A duct 59 connects the valve 58 with oxygen supply tank 60. valve 61 in which may be opened so that the flow of oxygen may lift the float, say until the scale 27 has 7 liter point 28 at the pointer 26. The design of the float and its counterpoise 14 are such that balanced condition exists at other points than this 7 liter position but this is a convenient volume with which to operate say on ten minute tests or less. It is important to check the exact time interval, and to have the period begin and end at the same phase in respiration cycle in order that there may not be disturbance of volume from such source. For standardizing with other tests, barometric reading should be taken into account, as well as temperature. To avoid computation the run-

ning of the motor 55 in balancing up complete absorption of the carbon dioxid may be continued not only until the position of the float is stable, but until the reading of the thermometer 56 returns to the point of starting. The circulation rate is maintained by the motor 55 as a stabilizing influence on the temperature in the gas circuit.

In the operation of the mechanism during respiration test, the float chamber shifts to breathe with the patient, for the supply drawn off by the motor or by a check valve system reduces the return volume to the chamber 35. There is accordingly at hand this shiftable means for readily checking up the number of respiration cycles of the test, data desirable in diagnosis and prognosis. The scale 27 has an adjustable pin 62 projecting to engage star wheel 63 operating integrating device or counter 64 carried by the reservoir housing adjacent the pointer 26. The position of the pin 62 may be such that at each dip of the float the star wheel 63 is given a shift for unit tally. By setting the counter 64 at zero at the commencement of test, its total is number of respirations during the test. Taking this figure as disclosed by the counter and dividing it by the number of minutes the test is conducted, and there is a quotient showing the number of respirations per minute.

The loss of volume of the gas in the float chamber at the termination of the test will disclose the volume of oxygen consumed by the one upon whom the test is made in the time interval. In the conduct of these tests for clinical purposes upon human beings, the quantity of oxygen absorbed represents a known amount of heat under certain diet conditions. The heat for carrying forward the digestive functions may be eliminated from the calculations by conducting the respiration test say some seventeen hours after food has been taken and after the one given the test has had a period of rest of say thirty minutes. Extensive measurements and tests have resulted in tabulation of the quantity of oxygen absorbed per hour per square meter of the body's surface. In clinical calorimetry as herein proposed for locating other energy or heat losses, the time for test may eliminate the digestive energy and physical fatigue; deduction upon basis of the physical measurements of the patient for heat losses through the skin then gives a basis for the net calory loss from what might otherwise be causes difficult to determine. Upon allowance of 10% for variation as the body radiation heat loss, in cases say of hyperthyroidism the oxygen consumption increase may run 50%, or even to 100% above normal; while for instance in hypothyroidism the oxygen consumption is below normal and to a marked percentage. The range of this mechanism has a large field of importance also in diseases of the heart and lungs, as in locating weaknesses and excitation of the former in abnormal or subnormal circulatory conditions, while checks upon the vital and tidal capacity of the latter may be had, say even during oxygen administration in cases of pneumonitis.

In furthering the field of this respiratory mechanism as a metabolism meter, there is advantage in integrating the inhalations. To this end the fulcrum pin or shaft 12 through the ball bearings of brackets 11, protrudes to have loosely mounted thereon disk 65. This disk 65 is loosely mounted on hub 65′ and has opening 66 to be engaged by pin 67 of collar 68 having outwardly extending annular flange 69 upon which is assembled thin flexible friction disk 70, flexed into desired clutch or holding relation by collar 71, of less diameter than the flange 69. This ring or collar 71 is carried by cap 72 having annular inwardly extending flange 73 extending over the flange 69 and serving to maintain the disk 70 housed. An adjusting screw 74 in a recess in the cap 72 limits the clamping adjustment effected by this cap 72 engaging the exteriorly threaded end of the shaft 12 in assembling the disk 70, collar 68, 69, and hub 65′ in friction gripping relation with the disk 65 so that these elements on the shaft 12, oscillate therewith. This outer member 72 may be so manipulated that the disk 65 is readily carried by the shaft 12 in the shaft movement with the float, or is as readily released therefrom, and this accomplished so delicately as not to disturb the gas handling. The disk 65 is balanced on the fulcrum 12.

A pointer 75, having Vernier graduations, serves as an indication means fixed with the liquid reservoir wall 4 in position as to scale 76 of graduations carried by the disk 65. A convenient arrangement of the scale graduations on a disk of about seven inch diameter is 37° in 100 c. c. steps for 8 liters, and from thence on with 1 liter markings giving a scale clearly with two ranges about the disk. The disk is readily adjusted to zero starting position at any position of the float, and so while the scale 27 on the float side 23 may disclose the volume to which the float chamber 35 is charged, this disk 65 may have its scale 76 give a direct reading after the test of the amount of oxygen consumed.

However, the scale 27 may be checked for the oxygen consumed, and the disk 65 total the amount of the tidal inhalations, thereby giving the ventilation for the interval of operation. On its inner or rear side the disk 65 has ratchet portion 77 against which may be shifted staggered spring pawls 78 of thin sheet steel pivotally mounted by bearing 79. The shifting of these pawls 78 is had by long pitch screw

80 as urged through fixed nut 81 by handle 82. Accordingly, with the handle 82 swung to the left, and the cap 72 adjusted into holding position, the pawls 78 are free of the disk wheel ratchet 77 and the disk 65 has full oscillations backward and forward similarly to the scale 27 on the float. However, with the handle 82 swung to the right, the disk 65 travels on the inhalation movement of the float, but is held by the pawls 78 during the exhalation or recover travel of the float. There is thus automatic summation of the total inhalation of the patient during the period of test.

The respiration mechanism has a direct field as a metabolism meter for determination of oxygen in clinical calorimetry tests. It is readily operable to ascertain the vital capacity of the patient by measuring the volume of a maximum inhalation, or the sum of a number of successive maximum inhalations from which a more accurate average is obtained. The checking of volume taken by inhalations over a period of time, gives figures for the ventilation of the patient, of importance in measuring dyspnœa. As the gas circuit is automatically purified in the rebreathing cycle, the apparatus is one which may be most economically used in cases of supplying oxygen in severe pneumonia cases. There is no waste of the oxygen. The carbon dioxid is removed, so from such source, there may be no deleterious effect upon the patient. The oxygen supply may be replenished as found desirable. The volume inhaled over different periods may be checked to note the degree of lung congestion, while the caloric condition or rate at which the oxygen is burned may serve as a further check upon the condition of the patient. There is no strain upon the patient in thus receiving the supply of oxygen in pneumonia cases, for the motor in the circuit places ample inhalation volume at all times at the inhaler 46.

The advantages to accrue from the respiration mechanism outside its resuscitation field, wherein measurements afford additional checking data for diagnosis and prognosis data, may be generally divided into external respiration field and internal respiration field. The external respiration measurements may be taken for vital capacity, tidal capacity, and minute volume of ventilation not only as general or clinical data, but as physical examination as well as physique tests for athletes, policemen, firemen, miners, military, naval and air service, as well as in peculiar vocational studies in connection with industrial or occupational fitness for duties. External respiration measurements are influenced by any diseases which interfere with the aeration of the lungs and blood, and those diseases which affect the movement of the blood which transports the gas to the body tissues: tuberculosis, pulmonary œdema, incompensation of the heart.

Internal respiration measurements involve metabolism, measurement of the oxygen consumed in a unit of time, taking into consideration the heat loss of the surface of the body. This oxygen consumption is affected by febrile diseases, as well as diseases resulting in subnormal temperature; hypo- and hyper-pituitarism, with possibilities for research extending into wider fields of usefulness.

What is claimed and it is desired to secure by Letters Patent is:

1. Respiration mechanism comprising an inhaler, duct sections to and from the inhaler, a gasometer connecting the ends of the duct sections remote from the inhaler, said gasometer including a liquid reservoir, a float providing a chamber above the liquid level in the reservoir into which chamber above the liquid level the ends of the duct sections project, a fulcrum mounting for the chamber permitting movement thereof as to the reservoir, and chamber operation disclosing means movable on a common axis with said fulcrum.

2. Respiration mechanism comprising a gasometer including a liquid reservoir, a float providing a chamber above the liquid level in said reservoir, a fulcrum mounting for the chamber, chamber depletion disclosing means coacting with said fulcrum, a duct extending to said chamber, a pocket centrally of said reservoir and independently of said duct, and a movable chamber provided with a perforate bottom, said chamber affording a receiver to be disposed in said pocket.

3. Respiration mechanism comprising a closed circuit, a housing in said circuit, a float providing a chamber, a fulcrum bearing mounting for the chamber, a movable measuring device element connected to said fulcrum, a pocket in said float chamber, and a gas absorption means container removably mounted in said pocket and transversely filling said pocket to insure maintenance of gas absorption means in said circuit.

4. An apparatus embodying a respiration closed circuit, a carbon-dioxid absorber in said circuit, a reserve variable capacity float reservoir providing ventilation measurement means, and a pivotally mounted counterpoise for the reservoir coacting to maintain constant pressure, said reservoir being operable by flow in said circuit, decreasing and increasing successively the capacity of said reservoir by varying its submergence, said counterpoise being mounted to compensate for said varying submergence.

5. Respiration mechanism including an oxygen reservoir of variable capacity, a fulcrum therefor, an oscillatory member on

said fulcrum, a carbon dioxid absorber for purifying the oxygen in said reservoir, a pivotally mounted counterpoise for the reservoir carried by said fulcrum and coacting to maintain constant pressure in the reservoir, and ventilation measuring means operable from said member as operated by the reservoir coacting through said fulcrum.

6. Respiration apparatus embodying a housing providing a fixed bearing, a rockable reservoir mounted by said bearing, ventilation measuring means for total tidal volume over an interval of time, said means being carried by the housing and operable from said bearing by said reservoir rockings, counting means for the inhalations during said interval of time as disclosed by the rockings of said reservoir on said bearing, and total oxygen consumption measuring means during said same interval of time disclosed by the position of said reservoir as to said housing.

7. A gas eliminator pocket, a closed circuit therefrom, a liquid reservoir into which the pocket and circuit separately extend and above which liquid reservoir the pocket and circuit communicate, a counterpoise, a float member, and a hinge providing a common axis mounting for the counterpoise and member, said member connecting the circuit and pocket and being swingable on its hinge mounting out of the reservoir and toward the counterpoise to permit charging access to said pocket.

8. A fixed bearing, a first chambered member providing a support for the bearing, a second relatively rockable member mounted on said bearing as an axis and movable in response to breathing, a gas eliminator for the carbon dioxid of the breathing, a first element fixed with the first member, a second element mounted on a common axis with the second member, a one-way clutch connection between the elements for causing the second member movements to progress said second element, and a counterpoise mounted coaxially with the second element and second member on said bearing and oppositely movable as to the second member in both directions and movable with the second element in the clutch driving thereof.

In witness whereof I affix my signature.

ELMER I. McKESSON.