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MEASURING APPARATUS FOR BASAL METABOLISM UNIT

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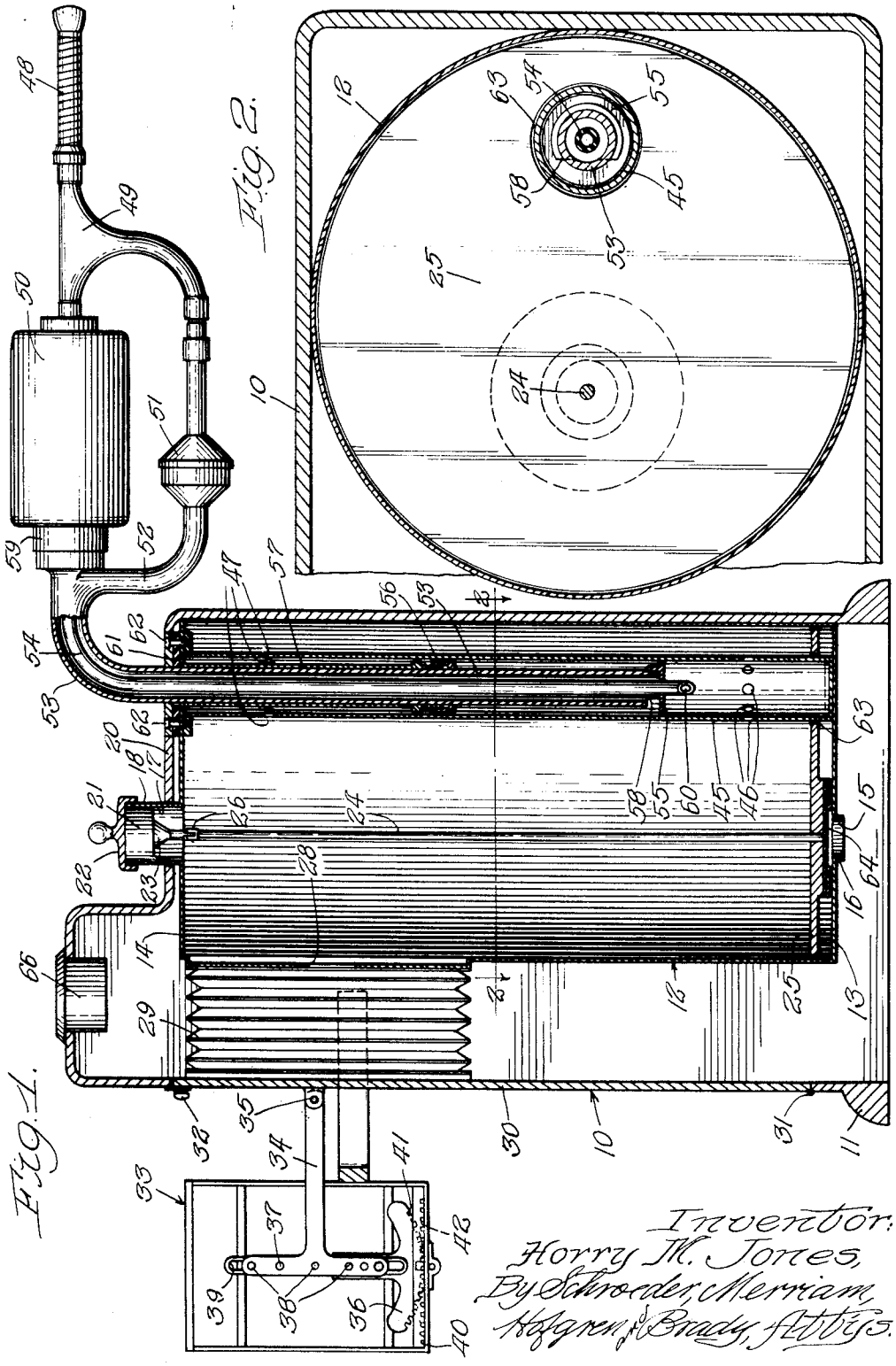


Fig. 1.

Fig. 2.

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MEASURING APPARATUS FOR BASAL METABOLISM UNIT

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6 Claims. (Cl. 128—2.07)

This invention relates to a basal metabolism testing apparatus as used by medical hospitals, clinics, and doctors of medicine, and more particularly to a device of such character operating with air to be breathed by a patient.

This application is a continuation-in-part of my copending application Serial No. 280,315 filed April 3, 1952.

A basal metabolism testing apparatus is used for determining several conditions of the human system which may be indicative of certain disorders. The apparatus determines the rate at which a human consumes oxygen. This rate is, in turn, indicative of the metabolism and its variation from normal may indicate certain pathological conditions. The present instrument is more fully described in my copending application and essentially includes a tank which is filled with ordinary atmospheric air. A patient breathes from the tank in a closed circuit consuming oxygen from the air contained within the tank. The amount of oxygen consumed is measured by means of a recording instrument which also records the time during which the volume of oxygen was consumed thus giving a direct reading of the metabolism rate which is expressed in terms of volume of oxygen per minute of time.

This invention is particularly concerned with the manner and means of maintaining a homogeneous mixture of air within the tank so that the patient may breathe air from the tank which contains a percentage of oxygen equal to the total percentage of oxygen within the closed system. In addition, an improvement in the recording mechanism will be described and hereafter claimed.

An exemplary embodiment of the invention is shown in the accompanying drawings illustrating an apparatus suitable for carrying out the principles of invention and in which:

Figure 1 is a vertical side elevational view partly in section of an apparatus including the invention herein and;

Figure 2 is a fragmentary horizontal cross sectional view through the tank of the apparatus taken substantially along line 2—2 in Figure 1.

The apparatus is housed in an appropriately attractive outer cabinet **10** which may be provided with a base roll **11** for supporting casters or other means necessary directly upon the floor of the hospital or other institution. This housing **10** has within it a tank **12** of cylindrical form having a bottom **13** and a top **14** forming a closed tank except for such openings as will be discussed. The tank has a volume sufficient to provide the necessary amount of oxygen that a patient may consume during a metabolism test. Ordinarily, atmospheric air will contain 20 to 21% oxygen and a person may breathe air comfortably for the short period of the test (10–15 mins.) with a percentage of oxygen as small as 10%. This criterion determines the size of the tank **12** and as most metabolism tests are conducted for a period not exceeding ten minutes it has been found that the volume of the tank can be conveniently about fifty to sixty liters.

The tank is provided with an opening **15** in its bottom formed by a nipple **16** welded or brazed in the bottom **13**. A top opening **17** is formed by a similar nipple **18** extending through the top **20** of the housing **10**. The opening **17** is closed by a resilient stopper **21** secured to an outer metallic cap **22**. The cap is also secured by means of a stud member **23** to a long slender rod **24** which carried a disk sweeping member **25** at its lower end. A lost motion link connection **26** is provided between the rod and the stud **23** so that the disk **25** may seat itself at the bottom of the tank and the stopper **21** may be tightly fitted into opening **17**. Thus, as the stopper may wear during repeated seatings, the lost motion connection will permit it to be fitted further into the opening thus still effecting a tight seal.

The sweep **25** is for the purpose of emptying the tank of stale or foul air and filling the tank with fresh air. It is only necessary to grasp the cap **22** and raise and lower the sweep within the tank to fill it with fresh air.

Near the top of the tank there is an opening **28** formed so as to be in communication with the rubber expansible bellows **29** attached at one end to the tank and at the other end to a hinged front panel **30** provided with hinges **31** at the bottom and a fastener **32** at the top. When the fastener is released the hinged front cover **30** may swing in and out toward the tank as the patient breathes therein and thus vary the volume of the trapped air without exerting an elevated pressure, to trace a graph on a paper record.

The movements of the bellows and hinged front panel are recorded by a clock mechanism generally indicated **33**.

A T-bar **34** is pivotally connected at **35** to the front cover **30** and is connected to a rocker arm **36** by means of a pin **37** placed in one of a number of openings **38** in the crosspiece of the T-bar **34**. The rocker arm is provided with a vertically extending slot **39** and an arcuate base which travels in a track **40** provided on the clock mechanism by placing the pin **37** in different ones of the openings **38** to vary the amplitude of the recording mechanism and rocker arm **36** to accommodate the differences between the depth of breathing of individuals. The pin extends into the slot **39** to rock the rocker arm in response to movement of the bellows. In order to insure that the rocker arm does not travel laterally a number of teeth **41** are placed on the bottom of the rocker arm to mesh with similar teeth **42** formed on the track **40**. The operation of the recording mechanism is more clearly described in my copending application identified above.

The apparatus by which the air within the tank **12** is maintained in a homogeneous mixture utilizes the breathing of the patient to effect a stirring of the air. In one side of the tank a stabilizer tube **45** extends from top to bottom of the tank and is secured in a fixed position. A plurality of openings **46** is provided near the lower end of tube **45** and similar openings **47** are provided at the upper end of the tube. These openings conduct inhalations and exhalations between the tank and the interior of the tube.

The patient is connected with the apparatus by a mouthpiece (not shown) and a flexible tube **48** connected into a Y **49**, one branch of which is connected with a soda lime cartridge **50** for removing carbon dioxide from the exhalations of the patient, the other branch being connected through a check valve **51** and branch line **52** to the interior of elevator tube **53**. The air that passes through the soda lime cartridge **50** passes inside a rubber tube **54** which carries only exhalations of the patient.

The tube members 53 and 54 which carry inhalations and exhalations respectively are so arranged that they discharge or open to the interior of the stabilizer tube **45** on opposite sides of a separator member **55** carried by the elevator tube **53**. Thus the inhalations and exhalations are conducted through separate chambers within the stabilizer tube and exit therefrom in different portions of the tank. In this way, the patient's breathing mixes the contents of the tank to maintain them homogeneous.

Some hospital beds are at different heights necessitating that the apparatus be elevated to the proper height to reach the patient. In the present invention this adjustment in height is accomplished by mounting the elevator tube **53** within the stabilizer tube so that it may be manually raised or lowered with relation to the cabinet **10** of the apparatus. A packing gland **56** supported on the end of a packing gland tube permits the elevator tube **53** to be raised or lowered within the stabilizer tube **45**. The separator tube **55** is mounted on the lower end of elevator tube **53** and is provided with a cut out portion **58** communicating with the interior of the ele-

vator tube. Thus air passes from the tank through the openings **47** and down between the packing gland tube **57** and stabilizer tube and through the opening provided by the cut out portion **58** into the elevator tube and thus on through the check valve **51** to the patient. The exhalations pass through a check valve **59** adjacent the soda lime cartridge and through the rubber tube **54** to an end opening **60** to the lower chamber within the stabilizer tube and below the separator **55**. This separator fits within the stabilizer tube rather closely to keep the upper and lower chambers separate while permitting the breathing tubes to be elevated through the packing gland **56**.

A rubber seal **61** is provided above the tank top **14** and secured to the cabinet **10** by a number of screws **62** so that no air can leak from the tank to the outside although the elevator tube **53** may be moved vertically. The sweep **25** is provided with an opening **63** which fits around the stabilizer tube loosely and will guide the sweep in its vertical movement through the tank. The bottom opening **15** is sealed by the sweep and particularly its soft sealing surface **64** on the bottom of the sweep.

It should be understood that the sweep **25** is used only to make sure that the tank contains a fresh charge of atmospheric air before a test is started. Other means may be employed without departing from the spirit or scope of the invention. An instrument **66** is included with the apparatus for determining the relative conditions of temperature, barometric pressure and aqueous tension as is more fully described in my copending application.

While we have discussed the use of the apparatus as applied to air, it is obvious that other gases may be employed if they contain oxygen which may be assimilated by a human and the apparatus could be used with a charge of oxygen enriched air. The primary convenience of the apparatus however is its adaptability for testing metabolism with the use only of atmospheric air avoiding the use of oxygen pumps etc. It is believed obvious that as the patient breathes into the apparatus of this invention the air is continuously mixed particularly since the bellows expands and contracts with the breathing and thus in effect pumps the air into and out of the tank aiding in the mixture.

While I have shown and described certain embodiments of my invention, it is to be understood that it is capable of many modifications. Changes, therefore, in the construction and arrangement may be made without departing from the spirit and scope of the invention as defined in the appended claims.

I claim:

1. In a basal metabolism testing apparatus having a tank for containing air to be breathed by a patient, apparatus for mixing the air within the tank; comprising, a plurality of nested tubes forming air passages between their walls, said tubes including an outer tube having open communication at its ends with opposite ends of the air tank, and inner tubes arranged to carry inhalations and exhalations respectively separate from each other, a separator member within the outer tube, one of the said inner tubes opening above the said separator member and the other of said tubes opening below the said separator member and both opening within the outer tube whereby patient's exhalations enter one end of the tank and inhalations are drawn from the opposite end of the tank to circulate air therewithin.

2. Apparatus as specified in claim 1 in which one of the inner tubes is slidably mounted within the outer tube so as to be movable therein, said inner and outer tubes extending to the exterior of said tank.

3. In a basal metabolism testing apparatus having a tank for containing a gas to be breathed by a patient, apparatus for mixing and circulating the gas within the tank during a test comprising, an elongated member forming a gas passage and having open communication at its ends with opposite ends of the tank, an inhalation conduit nested within said elongated member for carrying gas to the patient, said conduit having an opening intermediate the ends of said elongated member, a packing gland slidably supporting said inhalation conduit within said elongated member for adjustably positioning the height of the conduit relative to the testing apparatus, a separator secured to the lower end of said conduit and dividing said elongated member into upper and lower chambers each open to said tank, and an exhalation conduit loosely nested within said inhalation conduit and passing through said separator to open into the lower chamber whereby patient's exhalations enter the lower end of said tank and inhalations are drawn from the upper portion of the tank thus mixing the tank contents.

4. Apparatus as specified in claim 3 in which, the elongated member is cylindrical and is sealed at its opposite ends to the ends of the gas containing tank and said separator is provided with a lateral opening to admit inhalations to pass from the upper chamber into the lower end of said inhalation conduit.

5. In a basal metabolism testing apparatus having a tank for containing air to be breathed by a patient, means for maintaining the air as a homogeneous mixture during the test comprising a plurality of nested cylindrical conduits forming air passages therebetween, said conduits including an outer cylinder having open communication at its ends with opposite ends of the tank, and separator means within the outer cylinder with the inner conduits opening to opposite sides of the separator whereby inhalations and exhalations may be conducted from and to opposite ends of the tank to stir the tank contents.

6. In a basal metabolism testing apparatus having a tank for containing gas to be breathed by a patient, means for maintaining a homogeneous mixture of gas within the tank, comprising, a stabilizer tube extending between the ends of the tank and having open communication with the tank at each end thereof, a packing gland tube nested within the stabilizer tube and carrying a packing gland at a position intermediate the ends of the stabilizer tube, said packing gland tube and stabilizer tube forming an annular gas passage therebetween, an elevator tube nested within the packing gland tube and slidably extending through said packing gland and upwardly out of the tank to conduct gas drawn from the upper part of the tank to a patient, a separator member carried on the lower end of the elevator tube dividing the stabilizer tube into upper and lower chambers, and an inner tube nested within the elevator tube and extending through said separator to carry patient's exhalations to the lower part of the tank whereby patient's breathing circulates the gas within the tank.

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