March 5, 1940. C. V. PERRILL 2,192,799

BASAL METABOLISM MACHINE

Filed Dec. 28, 1937

Fig. 1.

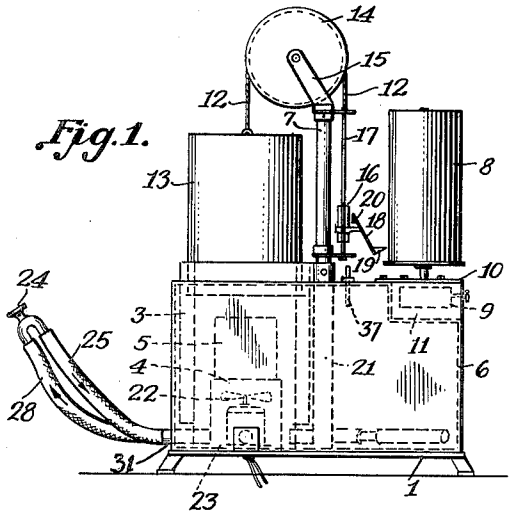


Fig. 3.

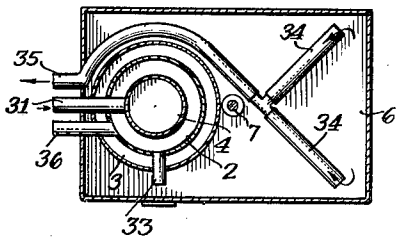


Fig. 4.

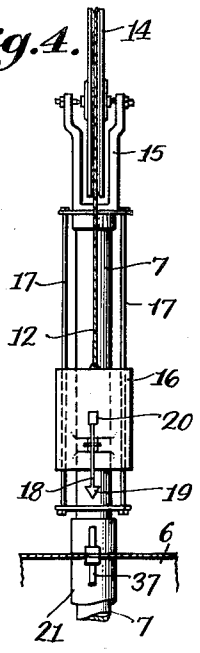


Fig. 2.

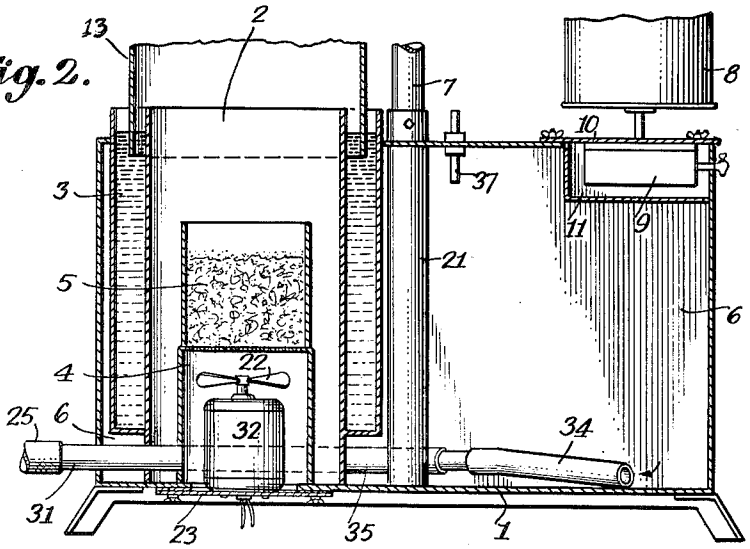
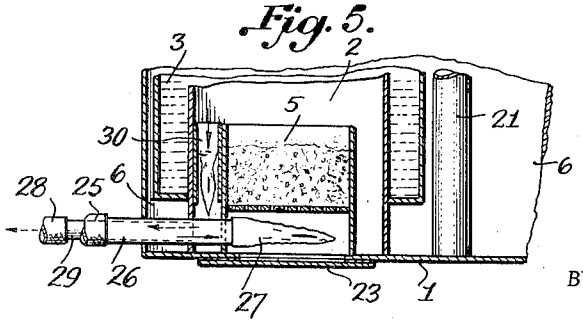


Fig. 5.



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BASAL METABOLISM MACHINE

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Application December 28, 1937, Serial No. 182,112

6 Claims. (Cl. 128—191)

My invention relates to improvements in a basal metabolism machine, an air metabolimeter, and it more especially consists of the features recited in the claims.

The purpose of my invention is to dispense with the complexity and cost of existing metabolism equipment in which special oxygen tanks are used. My simplified system is inexpensive, and simple to operate as I only make use of free air with its normal oxygen content of 21%. Actual demonstrations under careful controls have proved the efficacy of my basal metabolism machines which are available at remote places that cannot ordinarily be reached and supplied with the regular oxygen tank machines.

With these and other ends in view I illustrate in the accompanying drawing such instances of adaptation as will disclose the broad features of my invention without limiting myself to the specific details shown thereon and described herein.

Fig. 1 is a side elevation of an assembled machine.

Fig. 2 is a diagrammatic sectional elevation of Fig. 1.

Fig. 3 is a diagrammatic top plan view on a level of the fan motor, the top portions of Fig. 2 being omitted.

Fig. 4 is an enlarged diagrammatic elevation of the recording mechanism.

Fig. 5 is a detached diagrammatic view showing the relation of the inlets and outlets to and from the soda lime chamber in the absence of a fan.

In the use of my metabolism machine I may employ whatever alternatives or equivalents of structure that the exigencies of varying conditions may demand without departing from the broad spirit of the invention.

The machine may include any desired form of cabinet, supported on a suitable base. The device comprises a large air chamber, a kymograph, a spirometer, a circulating fan, a soda lime container, a mouth-piece and connecting tubes, and mechanism for recording the changing positions of the spirometer bell, on the kymograph drum, all without the use of oxygen tanks.

On a base 1 a spirometer chamber or well 2 is supported. This has a water or oil jacket enclosure 3. Below the chamber 2 a fan chamber 4 is positioned on the base 1 and above it there is a soda-lime container 5. The spirometer 2 is enclosed in a large air chamber 6. Between the air chamber 6 and the spirometer, a vertical tube 21 is secured to the walls of the air chamber. On top of the air chamber the kymograph drum 8 is positioned where it is connected to its driving clock 9.

The kymograph drum 8 has its spindle connected to the driving clock 9. The clock is supported from the underside of a removable plate 10. This plate covers an opening in the top wall of the air chamber 6. The clock is isolated at 11 from the air chamber by side walls connected to an enclosing bottom. These walls are secured to the underside of the top portion and the side of the air chamber 6.

If desired any standard kymograph movement on a tripod may be used by simply standing it on the top of the air chamber, though a more desirable position of the kymograph drum to the recording pen or stylus is secured by my arrangement. The distance between the standard 7 in the tube 21, on which the recording mechanism is supported and the axis of the kymograph drum is maintained at a definite dimension.

The spirometer bell 13 is supported by a cable 12 which passes over a grooved sheave 14 which has bearing in a bracket 15 that is supported on the upper end of the standard 7. The cable 12 is held taut by a lead counterweight 16. This has up and down movement between two guide bars 17 that are attached to the standard 7. To the counterweight 16, the recording arm 18 is pivoted. At one end this arm carries a recorder 19 which may be a stylus or a trough shaped pen. The other end of the arm 18 carries an adjustable counterweight 20 adapted to place the recorder under the desired tension against the drum.

The standard 7 passes through the tube 21 vertically across the air chamber 6. The fan chamber 4 encloses the fan 22. It is supported on a removable plate 23 and an air tight gasket so that it can be easily taken out of the chamber. The leading in wires are also sealed against air leakage.

The spirometer chamber 2 has an air connection 33 to the large air chamber 6 from which free air is inhaled by the patient through the tubes 34, 35 and the flexible tube 28 to the mouthpiece 24. The flexible tube 28 connects the mouthpiece to the cabinet and a separate flexible tube 25 connects the mouthpiece to the fan chamber 4 through the tube 31.

In case the metabolimeter is to be operated without fan circulation the exhalation tube 25, Fig. 5, connects with a horizontal tube 26 that passes through the wall of the air chamber and the wall of the chamber 5 in an air tight manner. The tube 26 has a flat rubber valve 27 which ter-

minates beneath the soda-lime container 5. The inhalation through the mouthpiece 24 is over a flexible tube 28 that is connected to a short tube 29 which passes through the air chamber wall in an air tight manner. A flat rubber valve 30 is placed in a down tube that connects the spirometer 2 to the short tube 29, as directed by the dotted arrow. The valves 27 and 30 only permit flow in one direction.

During fan operation exhaled air from the mouthpiece 24 passes through flexible tube 25 and a short tube 31 into the fan chamber 4, from where the fan 22, driven by a small six volt motor 32 moves the exhaled air upward through the soda lime in container 5 from where it passes into the spirometer chamber 2. It then descends and enters the air chamber 6 through a passageway 33 placed at any desired point. An incandescent lamp may be placed on the base within the air chamber 6 to provide a certain degree of initial heat if desired. The thermometer 37 is inserted into the air chamber 6 through any desired form of rubber plug.

The modification shown in Fig. 5 is only used when the device is operated without the fan motor. During inhalation air that has passed through the soda-lime container 5 into the spirometer chamber 2 passes through the flat rubber valve 30 into the tube 29 and the flexible tube 28 to the mouth piece 24. During exhalation the expelled air passes through the flexible tube 25, and short tube 26 to the flat rubber valve 27 which terminates beneath the soda-lime container 5. The valves 27 and 30 serve as ordinary check valves otherwise exhaled air would pass through tube 28 and tube 29 back into the spirometer chamber 2.

Inhaled air is taken from the air chamber 6 by plural inlets 34 connected by a single tube 35, which leads through the casing of the air chamber and is connected to the mouthpiece 24 by flexible tube 28. The tubes 31, 35 and 36 as they pass through the wall of the air chamber are sealed off to guard against leakage of air. The extra tube 36 leads from the spirometer chamber 2 to the outer air. It is plugged, excepting when a gas analysis is to be made.

I have found that in the use of free air as against conventional oxygen that the person under observation and taking the test does not manifest any oxygen want. It has been definitely shown that the oxygen tension of the air breathed can fall decidedly before any detrimental physiological changes can be noted. Authorities in the field of basal metabolism have found that the oxygen intake begins to fall only when the oxygen concentration in the air breathed is 14.8% or lower. It has been found in tests that have been made that the results of the test in which free air was used agreed to 1.8% with those in which oxygen was used. The air chamber is of sufficient capacity to provide the patient with fresh air for the entire six minute period of a test. I have further found that determinations of metabolism on a number of subjects gave results which varied by less than two percent from that obtained under exactly similar conditions with a standard oxygen machine. This slight variation is within the requirements of clinical calorimetry.

The capacity of my metabolism machine is one cubic foot (30 liters). This reduces the total capacity of my machine to a minimum, thus increasing its compactness, and portability. Any errors of gas volume changes are kept at a minimum, through the use of these safe dimensions, which were adopted only after extensive researches.

The soda lime container may be easily removed which makes it possible to obtain an accurate measure of the difference between the oxygen consumption and the carbon dioxide output of the patient breathing into the soda-lime container.

When this data is used in conjunction with the oxygen consumption rate as measured with the soda lime container, it is possible to calculate directly the respiratory quotient of the patient. This is possible only because the capacity of this machine is as great as 30 liters, a capacity not hitherto attained in portable machines. The oxygen consumption of the patient may be measured with increased accuracy because the gas breathed is not abnormally oxygen-rich. Hence, there is no tendency for an excessive oxygen absorption to take place into the body circulation, as would ordinarily exist in all conditions in which anoxemia or a tendency toward cyanosis is present.

The working capacity of the spirometer bell is gauged so as to maintain a ratio of 7% to 100% of the total gas in the metabolimeter. By means of this arrangement the subject will exhaust only about 7% of the gas in the system. By reason of this an automatic check is provided which prevents any test being carried beyond the safe limits within which the machine is designed. Through my elimination of the necessity for adding oxygen to the free air within the metabolimeter an accurate determination of the oxygen consumption of the subject is nevertheless possible without danger or discomfort due to oxygen want.

By securing the fan motor to a removable plate it is easily removed, plate and all, for adjustment, and repairs or for a quick and easy way of transforming the machine into a motorless model. The water jacket seal is placed almost entirely within the cabinet. This insures compactness, rigidity and it equalizes the temperature of the air surrounding it, thus maintaining a relatively constant temperature. The sheave supporting tube is supported within the tube that is attached to the bottom and at the top of the air chamber walls making it very rigid.

For ease in shipping etc., the supporting tube 7 is a separate piece, it passes into a tube 21. This tube may project above the chamber and it may have a set screw to hold the tube 7 and the sheave 14 in proper alignment with the bell 13 and the counterweight 16 of the recording mechanism. In addition the tube 7 may be supported at different heights as desired.

To insure that no oil spray or any products emanating from the running motor will contaminate the air from the air chamber which the subject is to breathe it is encased in its own housing. Air can be removed through the tube 36 for gas analysis while the other tubes are stoppered. When tubes 33 and 35 are stoppered the metabolimeter may be used in a manner similar to the conventional oxygen-using machines. Ordinarily the tube 36 remains stoppered and the others remain open. A complete circulation of the air is secured by dividing the tube 35 into two parts, 34, so that air enters at the far distant corners of the air chamber and thus the convection currents prevent any stratification of air within the system. The electric fan insures a continuous circulation of air when the machine is used without "Sadd" or other types of rubber valves,

by reason of this I eliminate the energy which the subject would otherwise have to expend in opening and closing mechanically operated valves. The valves 27 and 30 shown on Fig. 5 are thin rubber flaps united at their distal tips.

It will be apparent from the description that my machine can be inexpensively constructed, easily assembled, and serviced for repairs etc., conveniently transported and operated in remote places at small expense.

What I claim is:

1. In free-air basel metabolism machines a large fixed capacity air storage chamber with a capacity of approximately 30 liters, a spirometer, a soda-lime container, a mouth-piece, a flexible tube connecting the mouthpiece with the air chamber, a connection from the spirometer to the air chamber, a flexible tube connecting the mouth piece with the soda-lime container through a fan compartment, a connection from the fan compartment to the spirometer through the soda-lime container, an air circulating fan in the compartment, an adjustable standard, a sheave on the standard, a kymograph drum and a clock drive therefor, a gravity acting recording mechanism engaging the drum, and a cable on the sheave connected to the spirometer and the recording mechanism whereby a change in the vertical position of the spirometer bell is transmitted to and recorded on the kymograph.

2. In basal metabolism machines, a large capacity free-air storage chamber having a capacity of approximately 30 liters, a spirometer connected to the air chamber, an isolated fan compartment, a fan therein, a soda-lime container connected to and positioned between the fan compartment and the spirometer, a mouth piece, connections therefrom to the air chamber and separate connections therefrom to the fan compartment, and means for recording the differences in volume of air in the system.

3. In basal metabolism machines, a large capacity air storage chamber, a sealed off clock chamber and a sealed off fan compartment isolated from the air chamber, a spirometer connected to the fan compartment, a soda-lime container contained within the air chamber, a mouth piece, flexible connections therefrom leading separately to the air chamber and the fan compartment, a kymograph, a driving clock therefor said clock supported in the clock chamber, a fan in the fan compartment, a connection from the fan chamber to the soda-lime container, a connection from the latter to the spirometer and from the spirometer to the storage chamber, and means for recording variations in the volume of air in the various connections on the kymograph.

4. A basal free-air metabolism machine comprising a large capacity air chamber, a spirometer within the chamber, a connection therefrom communicating with the air chamber, a fan compartment connected to the spirometer also within but isolated from the chamber, a mouth piece, separate connections from the mouthpiece to the air chamber and the fan compartment, and means for recording the variable volumes of air passing through the mouthpiece without the use of oxygen tanks.

5. A basal free-air metabolism machine comprising a large capacity air chamber, a spirometer within the chamber, a connection therefrom communicating with the air chamber, a fan compartment connected to the spirometer also within but isolated from the air chamber, a mouthpiece, a separate connection from the mouthpiece to the air chamber such connection terminating in a plurality of inlets in the air chamber, a separate connection from the mouthpiece to the fan compartment, a separate outlet from the spirometer chamber to the outside of the air chamber adapted for separate gas analysis, and means for recording the variable directions of air movement through the mouthpiece without the use of oxygen tanks.

6. A basal free-air metabolism machine comprising a spirometer having a well, a large capacity air chamber, said spirometer well depending into the air chamber, an upwardly extending air tube within the spirometer, a connection from the spirometer to the air chamber, a soda lime container within the air tube, a fan chamber beneath the soda lime container isolated from the air chamber, a removable supporting plate for the fan, a mouthpiece, a connection therefrom terminating in spaced apart areas of the air chamber, another connection from the mouthpiece to the fan chamber, a connection from the fan chamber to the spirometer through the soda lime container and the air tube, and means for recording the variable volume of air in the spirometer.

CHARLES V. PERRILL.