Jan. 20, 1959 JOHN JEN-CHU CHU 2,869,537

PNEUMATIC PRESSURE RESPIRATORY VEST

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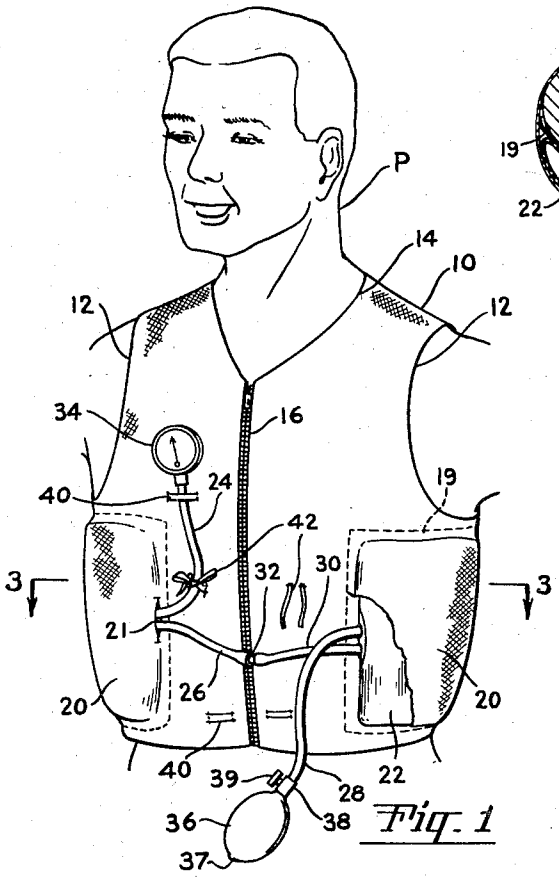

Fig. 1

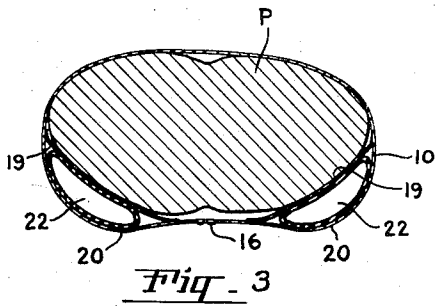

Fig. 3

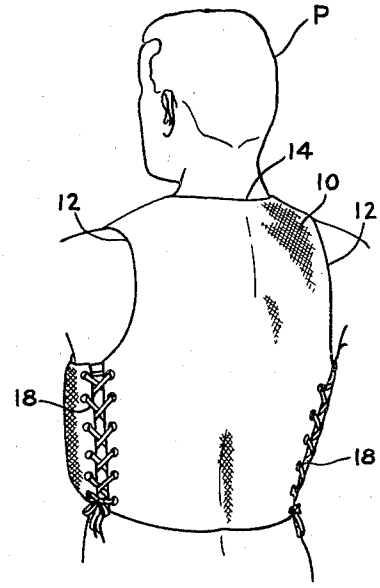

Fig. 2

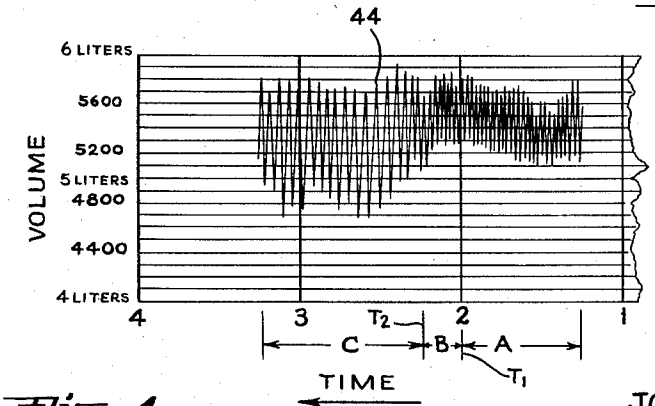

Fig. 4

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PNEUMATIC PRESSURE RESPIRATORY VEST

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2 Claims. (Cl. 128—27)

This invention relates to a new method of treatment and to a device in the general form of a vest for assisting natural respiration in patients suffering from certain respiratory ailments, as distinguished from pressure breathing devices for producing artificial respiration.

Many patients with chronic pulmonary diseases exhibit a tendency toward developing chronic pulmonary emphysema. This condition may be described as simply over-distension of the lung tissues. In advanced stage, it causes the patient severe shortness of breath and eventually leads to serious pulmonocardiac complications. In such condition the lungs have a high resting expiratory level whereby at the end of expiration they contain an abnormally large amount of residual air which the patient cannot expel. When the lungs remain thus distended at the end of expiration it follows that the volume of inspiration is necessarily reduced to a subnormal value. Such patients, therefore, experience shallow breathing wherein the exchange of air is inadequate. At some point in the development of this condition, the patient finds that he can no longer obtain enough fresh air by natural breathing and must resort to some form of artificial aid.

The aid heretofore employed by such patients has been some kind of pressure breathing or artificial respiratory device employing a mechanical pump for forcing air into and out of the patient's lungs as a supplement to the natural breathing efforts. Conventional artificial respiratory apparatus, however, has many limitations whereby such apparatus cannot be made available to all patients who might be benefitted thereby. The apparatus is costly to build, its use usually requires an attendant and it usually requires an electric power supply. The common and successful types of such devices are quite bulky and require the patient to be taken out of bed and placed bodily in the apparatus. Even portable artificial respiration devices seriously encumber the patient and impose severe limitations upon any activity in which he may wish to indulge.

It is, therefore, the general object of the present invention to provide a new and improved method of treatment and a relatively simple and inexpensive device to assist the respiration of such patients without entailing the numerous disadvantages and limitations of the conventional artificial respiratory machines.

A further object is to provide a method and device to assist natural respiration rather than produce artificial respiration.

A further object is to increase the tidal volume without resorting to pressure breathing.

Other objects are to provide a respiratory device of the type described which can be applied and manipulated by the patient himself and which will permit the patient to walk and move about in a normal manner without imposing any limitations on any activities of which he is capable.

As a departure from the theory of operation of conventional artificial respiratory devices, the present invention provides an aid to natural respiration without employing power-operated mechanism to produce a breathing rhythm. Applicant has found that some tuberculosis patients with advanced chronic pulmonary emphysema experience the greater difficulty in the expiratory stage by not expelling enough volume of air during the respiratory cycle. This is due to the prolonged over-distension of the lungs, plus air-way obstructions, which make it difficult for the contraction of lungs and thoracic cage sufficiently to produce a normal expiration. It follows, of course, that without a normal volume of expiration there cannot be a normal volume of inspiration whereby, if the expiration can be improved, the inspiratory effort will be much improved.

For a reliable and more detailed explanation of the breathing problem in chronic pulmonary emphysema patients, reference is made to "Chronic Pulmonary Emphysema" by Maurice S. Segal and M. J. Dulfano, published by Grime & Stratton, N. Y., copyright, 1953, Library of Congress Catalog Card No. 53-9299.

Based on the foregoing reasoning, the present device comprises a vest which is laced or otherwise fitted snugly to the patient while he is in relaxed condition. The vest contains inflatable air bags overlying the lower part of the thoracic cage where the maximum expansion and contraction of the thoracic cage occurs in breathing. Upon inflating the air bags in the vest, the thoracic cage and the lungs therewithin are compressed to some extent thereby reducing the over-distension of the lungs and volume of residual air contained therein, especially at the end of the expiratory stage, and the respiratory cycle is modified to a lower resting expiratory level. Contrary to what might be expected, such flexible compression does not impair the inspiration. The patient is benefitted by immediate relief of dyspnea and less muscular exertion during respiration, and in many instances, the displacement volume in each respiratory cycle is found to be increased. This is proved by pulmonary function tests, and also by observing the fact that bed-ridden patients by using the device can get up and walk and engage in other activities which they had been forced to discontinue due to severe dyspnea.

In most cases patients can put the vest on and adjust it without assistance. They may then inflate it to the pressure from time to time as they may find desirable by experience. Thus, with the assistance of the present device, patients in such condition not only experience a considerable degree of relief but also are made ambulatory so that they can resume a more normal life. This device does not effect a cure but it does make it easier for the patient to endure an incurable condition.

The invention will be better understood and additional objects and advantages will become apparent from the following description taken in connection with the accompanying drawings which illustrate a preferred form of the invention. It is to be understood, however, that the invention may take other forms, and that all such

modifications and variations within the scope of the appended claims which will occur to persons skilled in the art are included in the invention.

In the drawings:

Figure 1 is a front perspective view of the present respiratory vest applied to a patient;

Figure 2 is a back view of the vest also applied to a patient;

Figure 3 is a cross sectional view taken on the line 3—3 of Figure 1; and

Figure 4 is a graph illustrating tidal volume and respiratory rate of a patient with and without the present vest.

Referring specifically to the drawings, the numeral 10 designates, generally, the respiratory vest of this invention, and, as seen in Figures 1 and 2, the vest is adapted to be worn on the upper trunk portion of a patient P. A preferred form thereof comprises a garment made from a rugged and durable flexible but substantially non-stretchable fabric having arm openings 12 and a neck opening 14. The vest has a slide fastener 16 at the front and has side laces 18 which provide a size adjustment to properly fit the vest on a patient, a proper fit being one wherein the vest fits the patient closely or snugly at least in those areas of the rib cage which have maximum contraction and expansion during respiration.

The vest is provided at the lower portion thereof with a pair of side pockets 20, each having a small lateral opening 21, and each supporting therein an inflatable rubber bag 22. Pockets 20 are located in predetermined positions so as to overlie the lower costal region in an area extending partially in front and partially around the sides of the patient. Preferably, the pockets 20 are formed by stitching around all four sides of a pair of rectangular patches 19 applied to the inside of the vest and having sufficient fullness of material so that the pockets will tend to bulge inwardly rather than outwardly when bags 22 are inflated. Outward expansion is restrained by hoop tension in the vest when the latter is securely and snugly fastened on a patient before the bags are inflated. Openings 21 are formed in the vest itself within the pocket area.

One of the air bags 22 has a pair of hoses or tubes 24 and 26 and the other air bag has a pair of hoses or tubes 28 and 30 projecting from the pocket openings 21. The two air bags are connected together by hoses 26 and 30 coupled by means of a suitable detachable coupling 32. Hose 24 leads to an air pressure gauge 34 and hose 28 leads to an air bulb 36 of a well-known type capable of operating as a pump upon repeated squeezing thereof. Bulb 36 is equipped with inlet and outlet check valves 37 and 38 and a manual relief valve 39 which may be opened to deflate the air bags 22.

By the arrangement shown, when the bulb 36 is operated as a pump, both bags are inflated and the pressure existing in the bags is indicated on the pressure gauge 34. Suitable loops 40 and tie strings 42 are provided on the vest for anchoring the hoses, the pressure gauge 34 and bulb 36 at convenient locations.

As best seen in Figure 1 and as explained hereinbefore, the pockets 20 and the inflatable air bags 22 overlie the lower costal region and, more specifically, are preferably engageable with the rib cage at lateral or side areas and in anterior or frontal areas. Such position of the air bags is shown in the sectional view of Figure 3. With the air bags inflated, the thoracic cage, as well as the lungs, are compressed somewhat to reduce the abnormal distension which is characteristic of the patients referred to. The volume of residual air in the lungs is reduced whereby the resting expiratory level is lowered. It is found that such restriction greatly increases the tidal volume and greatly reduces the respiratory rate.

To illustrate the effectiveness of the present vest, there is shown in Figure 4 a true reproduction of a kymographic reading or graph taken on a Collins respirometer (13.5 liter) showing respiration of a typical patient in an advanced stage of pulmonary emphysema. This patient was a man seventy years old, weighing 147 pounds and five feet eight inches in height. The graph plots volume against time, the time being designated by minutes and the volume being designated by liters, the graph paper running under the stylus from left to right at constant speed. The vertical length of the stylus excursions measures tidal volume and their frequency across the graph indicates the respiratory rate. The lower end of each excursion indicates the resting expiratory level in relative scale value with respect to the other excursions.

Following the stylus markings 44 from right to left, the graph illustrates the effectiveness of the present vest in slowing down the high respiratory rate and in increasing the very small tidal volume. This graph comprises a continuous reading for about two minutes with no changes made in any condition except that after a short interval the air bags 22 were inflated. The horizontal distance, designated by the letter A, represents an interval of steady breathing before inflation and illustrates the tidal volume, resting expiratory level and frequency of respiration with the air bags deflated. Thereupon, at the time T_1, operation of the hand pump was started and continued for an interval B. The desired pressure was attained and the pumping stopped at time T_2. The horizontal distance on the graph designated by the letter C illustrates the changes in these values which were then registered for one minute with the vest inflated.

Upon comparison of the two parts A and C of the reading, it will be seen that the respiratory rate without the assistance of the inflated bags is approximately double and the tidal volume roughly half that observed after inflation. With the vest inflated, the tidal volume increased from 500 cc. to 900 cc. and the respiratory rate decreased from 34 to 17. The resting expiratory level decreased from a scale value of around 5200 to around 4800, a reduction of 400 cc. in residual volume, which improvement in ventilation, or air exchange, has proved to be very beneficial to the feeling of well-being of an emphysematous patient.

The respirometer measures the volumes of gas flowing into and out of the patient's lungs whereby, in a continuous recording starting before inflation of the vest, the increase in tidal volume and reduction in residual volume are graphically indicated in terms of volumetric quantities.

With the improvement in respiration brought about by the present vest, bedridden patients have become ambulatory and, due to its simplicity of operation and handleability, patients may be capable of applying and supervising the function of this respiration aid without assistance. The air bags may be inflated to a desired pressure as indicated on the gauge 34, check valve 38 holding the pressure until it is released by valve 39. If desired, the gauge 34 may be omitted and the air bags merely inflated to a pressure found most helpful to the patient.

To remove the vest, after deflating the air bags, the slide fastener 16 is opened and the coupling 32 between the tubes 26 and 30 disconnected whereby the vest may then be slipped over the arms. If desired, the slide fastener may be provided at the back whereby the vest may be taken off without disconnecting the tubes 26 and 30. The air bags are readily removable from the pocket openings 21 for cleaning the vest.

Having now described my invention and in what manner the same may be used, what I claim as new and desire to protect by Letters Patent is:

1. A device for assisting natural respiration in a pulmonary emphysematous patient comprising a flexible vest, pockets inside of said vest in opposite lower side portions thereof, said pockets being closed at their top edges and having restricted openings at their front edges in the outside of the vest, inflatable air bags insertable into and removable from said pockets through said open-

ings, and tubes from the respective bags extending through said openings and detachably connected together exteriorly of the vest.

2. A device for assisting natural respiration in a pulmonary emphysematous patient comprising a flexible vest of substantially inelastic fabric material, adjustment means for fitting the vest snugly to the patient, a pair of patch pockets on the inside of said vest in the opposite lower side portions thereof, said pockets being closed on all sides except for a restricted opening at one edge of each pocket, inflatable air bags insertable into and removable from said pockets through said openings, said pockets having sufficient fullness of material to cause them to bulge inwardly instead of outwardly when the air bags are inflated in said pockets with the vest fitted on a patient, a tube interconnecting said air bags exteriorly of the vest, and means for inflating said air bags.

References Cited in the file of this patent

UNITED STATES PATENTS

665,260	Ostermeyer	Jan. 1, 1901
1,623,993	Anderson	Apr. 12, 1927

FOREIGN PATENTS

853,465	France	Dec. 7, 1939