Sept. 30, 1958 J. H. EMERSON 2,853,998

RESPIRATOR CASING AND METHODS OF PRODUCING THE SAME

Filed Feb. 28, 1955 2 Sheets-Sheet 1

Fig. 1.

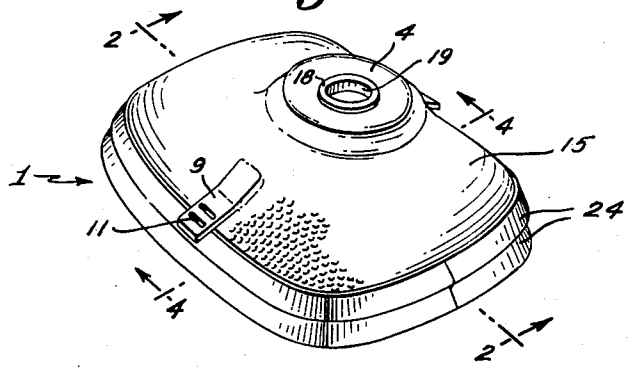

Fig. 3.

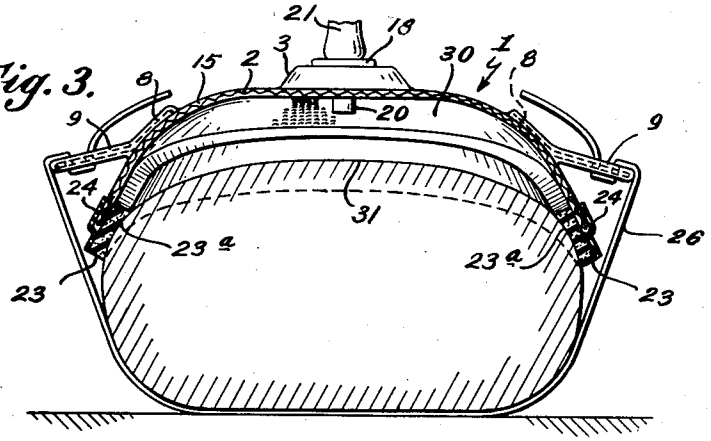

Fig. 2.

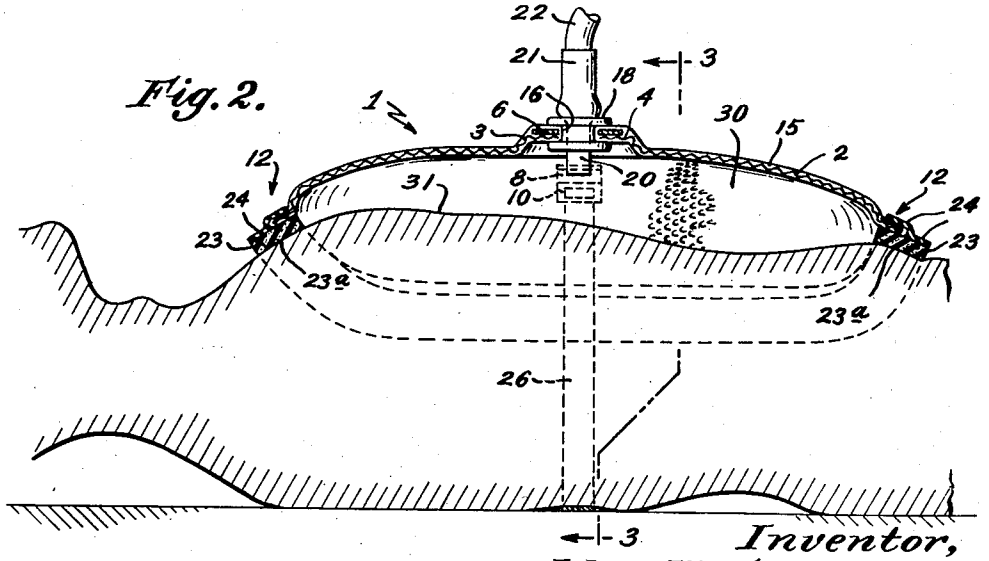

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Fig. 4.

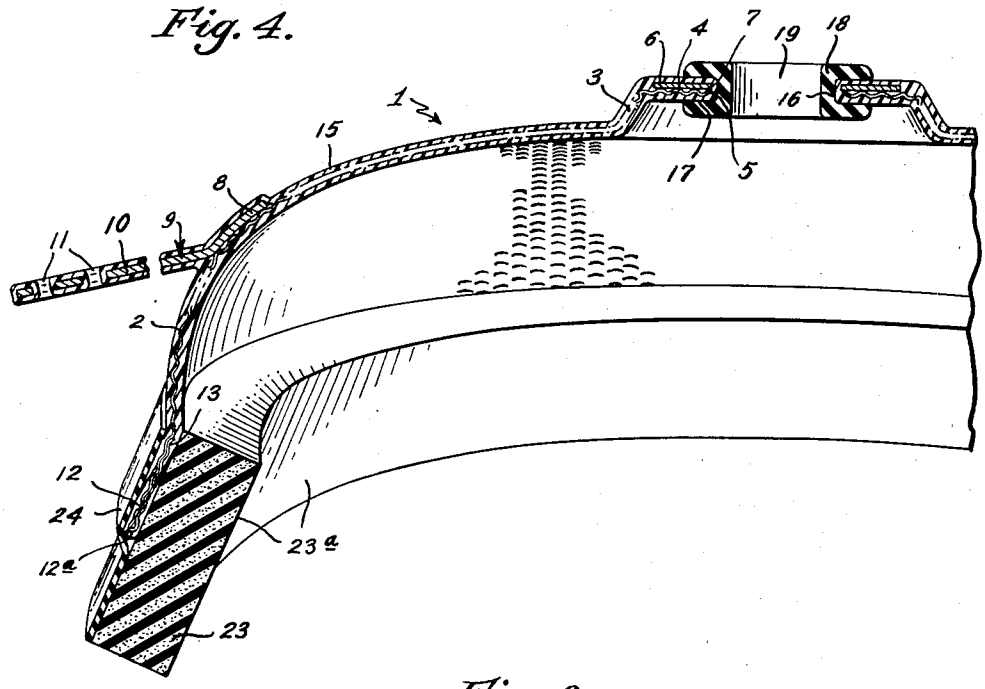
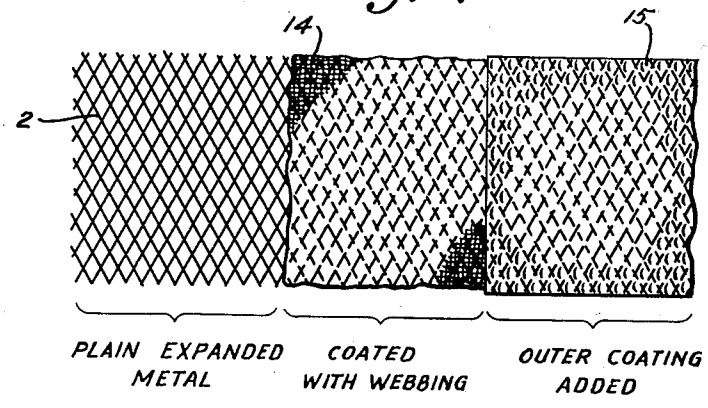


Fig. 6.



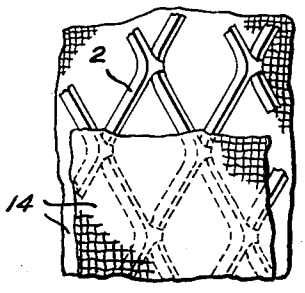


Fig. 5.

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United States Patent Office 2,853,998
Patented Sept. 30, 1958

2,853,998

RESPIRATOR CASING AND METHODS OF PRODUCING THE SAME

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Application February 28, 1955, Serial No. 491,124

17 Claims. (Cl. 128—30)

The present invention relates to respirator casings for inducing artificial respiration in a patient and to methods of producing such casings.

The present application is a continuation in part of application Serial No. 398,975 filed December 18, 1953. In that application there is described a portable respirator casing made up of substantially two parts: (1) a light troughlike cage adapted to be positioned over the patient's trunk with its edges resting against a support and (2) a sheet of flexible air-impervious material for placing over the cage with the forward and rear sides resting against the patient's body and the other tucked between the patient and the support. Ordinarily the application to, and removal from, the patient of this type of respirator requires an attendant.

One object of the present invention is to provide a simple, portable, low cost, rugged, tough, tear and scrape resistant, air impervious respirator casing which comprises a single integral unit which is so easily applied to and removed from the patient that the patient himself can apply and remove the same, which does not require any rigid or semi-rigid back support along the patient's back for supporting the same, the edges of which are adapted to be supported by the contours of the patient's body and form a substantially airtight seal therewith to provide a substantially airtight chamber, the boundaries of which are defined by the respirator casing and a minimum portion of the patient's anatomy, which does not necessarily form by itself or with a back support a chamber completely enclosing a portion of the patient's trunk, as in known chest respirators, and which consequently is smaller, less bulky, lighter and affords the patient greater convenience, comfort and freedom of movement than any chest respirator known heretofore.

A still further object is to provide such a single integral unit respirator which is so flexible that the edges can be easily shaped by hand to fit snugly enough against the contours of the bodies of patients having a variety of shapes thereof to form the above-mentioned substantially airtight contact therewith and hence the above-mentioned substantially airtight chamber but yet which is rigid enough to hold any shape into which it is formed.

Other and further objects and advantages of the present invention will be apparent from the following description and by reference to the accompanying drawings, wherein:

Fig. 1 is a perspective view of a chest respirator embodying the present invention;

Fig. 2 is a longitudinal section taken on the line 2—2 of the respirator of Fig. 1 with the respirator applied to a patient's chest;

Fig. 3 is a section taken along the line 3—3 of Fig. 2;

Fig. 4 is a portion of an enlarged section taken along the line 4—4 of Fig. 1;

Fig. 5 is a plan view of a segment of the web covered inner lattice frame of the respirator of Figs. 1 to 4 showing only a part of the web covering, one side of such segment and only a part of the web covering the other side thereof; and

Fig. 6 is a diagrammatic view of a segment of the respirator of Figs. 1 to 4 during the stages of manufacture thereof, showing the same before it was covered with a layer of webbing (left), after both sides thereof were covered with a layer of webbing (center) and the finished respirator after the web covered lattice frame was embedded in an air impervious layer of tough, flexible, air impervious material.

Referring to Figs. 1 to 5, the chest respirator casing 1 of the present invention comprises a trough-shaped frame 2 which has a greater length than width and which is comprised of a relatively thin, expanded metal which is flexible enough to be easily formed by hand into any desired shape but which is rigid enough to hold any shape into which it is formed. The top portion of frame 2 has an upward frusto-conical extension 3, the top 4 of which is horizontal (see Figs. 2 and 4). An aperture 5 extends vertically through horizontal portion 4. Welded to the top of horizontal portion 4 is a metal plate 6 having an aperture 7 (see Fig. 4) aligned with aperture 5.

End portions 8 (see Figs. 3 and 4) of two flat, metal ears 9 are welded to the sides of frame 2 as shown. Each end portion 8 of each ear 9 extends at an angle into portion 10 (see Fig. 4) which has two slots 11 passing therethrough.

Frame 2 has an outwardly flared portion 12 (see Figs. 2 and 4) along the bottom thereof, the lower edge of which turns inwardly at 12*a* and upwardly at 13 to form a reinforced edge. The entire frame has a layer of cheese cloth 14 (Fig. 5) or any other kind of flexible, light, porous web or mesh of a thread-like flexible fiber or filament covering both sides thereof. The cheese cloth 14 extends over and between the spaces formed by the strips of expanded metal of frame 2 (see Fig. 5), but does not extend over and between the apertures 5 and 7 of frame 2 and plate 6 respectively.

The cheese cloth covered frame 2, the ears 9 and the plate 6 are embedded in an air impervious layer 15 of a tough, flexible, air impervious, rubber-like material such as a plasticized vinyl chloride polymer or copolymer or a natural or artificial rubber. In the figures, such layer 15 is comprised of a high molecular weight plasticized vinyl chloride polymer. Although the layer 15 extends across and fills in the spaces between the metal strips of the expanded metal frame 2, it does not extend across the apertures 5 and 7, but merely covers the edges thereof to form an aperture 16 (see Fig. 4), the edges of which are received in a circumferential groove 17 of a rubber grommet 18 having a passage 19 which is adapted to receive the narrow portion 20 (Fig. 2) of a tube connector 21 to which is attached tube 22 leading to an alternating source of negative and atmospheric pressure, positive and atmospheric pressure, or negative and atmospheric pressure. However, the source of pressure, as well as the tubing 22, forms no part of applicant's present invention which is drawn to the respirator casing itself.

For the purpose of simplification, in the drawings the same numerals that are used to indicate particular portions of frame 2 and ears 9 are used to indicate such portions covered by the gauze 14 and/or embedded in layer 15.

A vinyl plastic or rubber cushioning and sealing pad 23 is attached to the embedded frame 2 along the lower edge thereof. The outer surface of the upper portion of such cushioning and sealing pad is glued to the inner surface of that portion of layer 15 in which portion 12 of frame 2 is embedded while the lower portion thereof

extends beyond the lower edge of embedded frame 2 as shown. Pad 23 is further secured to embedded frame 2 by means of a strip of tape 24 taped to the outer surface of the lower portion of pad 23 and to the outer surface of the layer 15 in which portion 12 of frame 2 is embedded. Removably attached to portion 10 of ears 9 (Figs. 2 and 3) by means of slots 11 is a strap 26 for strapping the respirator casing 1 to the patient's chest, as shown in Figs. 2 and 3.

Since the frame 2 is sufficiently flexible to be formed by hand into any shape desired and since the layer of material 15 in which it is embedded is flexible, the respirator 1 can be easily formed by hand into the shape shown in Figs. 2 and 3 so that the flat inner surface 23*a* of cushioning and sealing pad 23 will fit substantially along its entire width and length snugly and in a substantially airtight manner against the contours of the patient's body, as shown, when the casing is held firmly against such contours by strap 26 passing through slots 11 and around the patient's back as shown, whereby a substantially airtight chamber 30 is formed by the walls of the respirator casing 1 and portion 31 of the patient's body. Since frame 2 is sufficiently rigid to retain any shape into which it is formed, once respirator casing 1 has been formed by hand into the shape shown so that the above mentioned snug fit is obtained between the edges thereof and the contours of the patient's body, the respirator will retain such shape until it is deliberately twisted out of such shape by hand or by an instrument. Frame 2 lends sufficient rigidity to the casing to prevent it from being forced substantially out of shape either by the handling to which the respirator is ordinarily subjected while it is operably attached to the patient or by the changes of pressure which occur within chamber 30 during artificial respiration.

Cushioning and sealing pad 23 assures a snug, substantially airtight fit between the patient's body and the respirator and prevents the edges of the respirator casing from biting into the patient's body during the use thereof. Portion 12 of frame 2 is outwardly flared in order to permit a maximum amount of the broad surface 23*a* of cushioning and sealing pad 23 to fit as flush as possible against the patient's body so as to assure a substantially airtight as well as a comfortable fit between the edges of the respirator casing and the patient's body. The flare thereof may be adjusted by hand to assure in each instance that surface 23*a* will fit as flush as possible. The cushioning and sealing pad 23 is made from a very resilient and flexible vinyl plastic or rubber gasketing material so that it will easily take on the contour of the patient's body and fit snugly thereagainst in an airtight manner when the respirator is held firmly against the patient's body by means of strap 26 or by hand.

Although the frame 2 of the drawings is made of expanded metal, it can be made of any similar material or design so long as it is flexible enough to be formed easily by hand into any shape desired and at the same time is rigid enough to retain any shape into which it is formed. Chicken wire or any other similar wire mesh having these properties is suitable. A lattice shape is preferred because it makes possible a lighter respirator and permits the use of materials which in the form of a solid sheet would not be sufficiently flexible.

In manufacturing the respirator shown in the drawings, the expanded metal frame was formed in a known manner with an aperture 5 in the middle thereof and shaped by hand or otherwise into the desired shape. A small section of such expanded metal at this stage is shown diagrammatically on the left of Fig. 6. Plate 6 and ears 9 were then welded or attached in any other manner to the frame as shown. The lattice frame was then covered on both sides with a layer of light weight, porous cheese cloth so that the layers of cheese cloth extended over the spaces of the lattice frame but not over apertures 5 and 7. The two layers of cheese cloth were tacked together at a number of points therealong. The small section of the frame referred to above is shown diagrammatically at this stage in the middle of Fig. 6. The cheese cloth covered frame was then immersed in a bath of cream Chem-o-sol R3506 [trademark for a vinylchloride polymer plastisol (liquid dispersion of a high molecular weight vinyl chloride polymer resin in a liquid plasticizer) sold by Chemical Products Corporation] for a period of from four to ten minutes, it was then suspended over the tank and allowed to drain for from four to six hours, and it was then placed in a closed oven at 350° F. for a period of from ten to twenty minutes after which it was removed and cooled to room temperature. The liquid Chem-o-sol, which adheres to the cheese cloth covered frame from the immersion or dipping step, formed, during the heating and cooling steps a tough, flexible layer of plasticized vinyl chloride polymer in which the cheese cloth covered frame, plate 6 and ears 9 were embedded as shown. The segment referred to above at this stage is shown diagrammatically at the right of Fig. 6.

The layer of resin 15 adheres strongly to the frame 2 and fills up the spaces between the strips of metal thereof. It can be removed therefrom only with great difficulty.

The cheese cloth 14 is used to bridge the gaps between the strips of expanded metal so as to form a base therebetween to which the liquid plastisol can adhere. Consequently, a continuous air impervious layer 15 of plasticized vinyl chloride resin is formed which extends across and fills in such gaps so that the entire frame is embedded in such layer. If the cheese cloth is omitted, the liquid dispersion adheres only to the surfaces of the metal strips and when it is cured by heating each individual strip has a coating of resin therearound with gaps or spaces therebetween. Instead of cheese cloth, any light weight, porous web or mesh of fine fibers or thread-like filaments may be used so long as it bridges the gaps and consequently forms a base therebetween to which the dispersion can adhere and so long as it can be flexed freely. In fact, rubber can be sprayed over both sides of the frame in the form of thread-like filaments and in a known manner to form rubber "cobwebs" which adhere to the metal strips and extend over the gaps therebetween. The web should be porous and light weight so that the dispersion can pass therethrough and contact the metal strips during the dipping. It should be flexible so that it will not interfere with the flexibility of the casing.

Any flexible, tough, rubber-like resin, rubber or artificial rubber can be used instead of vinyl chloride polymers to form the outer layer of flexible material so long as it is flexible enough so that the final respirator casing can be formed easily by hand as set forth above and so long as it is gas impervious, tough and tear resistant. Resins formed from polymerizable, unsaturated compounds, and having such properties, such as vinyl resins and natural or artificial rubber are preferred, the most suitable being high molecular weight vinyl chloride polymers and copolymers.

The layer of flexible material may be applied in any liquid form, for example, as a solution of resin or rubber in an organic solvent, as a dispersion or emulsion in water or other liquids (latex) or as a dispersion in a liquid plasticizer for the resin (plastisol) as set forth above. When a thermoplastic resin or rubber solution or latex is used which has a solvent or carrier which must be driven off before the resin is cured, the adhered coating of liquid should be dried and then heated to cure the resin particles and cause them to fuse together into a continuous layer. Sheets of thermoplastic resinous material may be laid on either side of the frame 2 and then heated and pressed so as to fuse together and form a continuous layer in which the frame is embedded.

Any type of cushioning or sealing pad can be used so long as it is flexible enough and of a design to afford a

comfortable snug and airtight seal between the respirator casing and the contours of the patient's body. For example, an air filled, flexible, rubber tube of the type ordinarily used in oxygen masks is suitable. The particular flare of portion **12** of frame **2** depends on the type and shape of pad used and may be omitted entirely if the pad is designed and shaped to produce a comfortable airtight fit without it.

When the chest respirator casing of Figs. 1 to 5 is applied to the patient's chest, as shown, chamber **30** is sufficiently airtight to permit a negative pressure to be built up therein during operation of the respirator. As the negative pressure is built up in chamber **30** the edges of the respirator are sucked more tightly against the patient's body and consequently the seal between ring **23** and the patient's body becomes more airtight.

The respirator casing, when used as a chest respirator as in Figs. 1 to 5, is preferably of a size so that the edge toward the patient's head rests along the vicinity of the patient's collar bone, the edge toward the patient's feet rests on the lower part of his abdomen adjacent to his pubic bone and the side edges rest on the side of the patient's body under his arms.

Although in the drawings of Figs. 1 to 5 all the edges of the respirator lie against the patient's body so that no back support for the patient is needed to support the edges of the respirator as in prior art devices, it is apparent that the respirator of the present invention can be used with a back support, the extreme flexibility of such respirator being taken advantage of to obtain a snug, close fit between the patient's body and the respirator and the support and the respirator.

It is understood that any satisfactory means can be used to hold the respirator against the body besides the ears and strap as shown. In fact it can be held against the patient's body by the patient himself.

The particular manner in which the aperture in the top of the casing is formed may be varied in any manner desired.

The edges of the chest respirator coming in contact with the patient's body and the portions of the respirator adjacent thereto may be constructed in any manner desired so long as such edges are adapted to fit snugly against the patient's body without undue discomfort to the patient.

The terms "chest respirator" and "chest respirator casing" as used herein includes any respirator and respirator casing which enclose a sufficient portion of the trunk of a patient to induce artificial respiration in the patient.

Although the respirator casing of the present invention is most useful as a chest respirator, it can also be used as a resuscitator or face mask type respirator, it being understood that when it is so used the size and shape thereof should be such that it is adapted to fit over the mouth and nose or the mouth, nose and eyes of the patient. The terms "respirator" and "respirator casing," as used herein, include chest respirators and respirator casings and resuscitator or face mask type respirators and respirator casings.

Although the embedded lattice structure of the present invention has been described and shown in a respirator casing construction, it is apparent that it can be used for other purposes. When such a structure is used in a respirator casing of the type described and shown above, the frame **2** should be flexible enough to be readily formed by hand into any desired shape. However, other uses thereof might require lattice frame **2** to be much stiffer.

The respirator of the present invention comprises a single unit, extremely light respirator, which is so easy to apply to and remove from the patient that he can do it himself, which can be fitted to patients having a variety of chest and face sizes, which does not require a back support and which covers a minimum of body area, thereby permitting it to be less bulky and lighter than known chest respirators to afford the patient a maximum of convenience, comfort and freedom of movement.

While I have shown and described one embodiment of my invention, it is to be understood that this disclosure is for the purpose of illustration only and various changes and substitutions of equivalent elements may be made without departing from the spirit of the invention as set forth in the appended claims.

I claim:

1. A respirator casing comprising a concave shaped, air impervious cage which is sufficiently flexible to be formed by hand into any desired shape but which is sufficiently rigid to hold any shape into which it is formed, the edges of said cage being adapted to be formed by hand to fit snugly against selected contours of a patient's body in a substantially airtight manner to form a chamber around a portion of said body, said chamber being substantially airtight when said edges are held firmly against said contours, said cage having a passage extending therethrough adapted to provide communication between the interior and exterior of said chamber and comprising a light base shell which is sufficiently flexible to be formed by hand into a desired shape but which is rigid enough to hold any shape into which it is formed and which is lattice shaped, said shell being embedded in a gas impervious layer of a tough, flexible elastic, thermoplastic resin, said layer of resin extending across and filling the gaps of said lattice to form a continuous layer in which said lattice shaped shell is embedded.

2. A respirator casing comprising a concave shaped, air impervious cage which is sufficiently flexible to be formed by hand into any desired shape but which is sufficiently rigid to hold any shape into which it is formed, the edges of said cage being adapted to be formed by hand to fit snugly against selected contours of a patient's body in a substantially airtight manner to form a chamber around a portion of said body, said chamber being substantially airtight when said edges are held firmly against said contours, said cage having a passage extending therethrough adapted to provide communication between the interior and exterior of said chamber and comprising a light base shell which is sufficiently flexible to be formed by hand into a desired shape but which is rigid enough to hold any shape into which it is formed and which is lattice-shaped, said shell being embedded in a gas impervious layer of a tough, flexible material, said layer of flexible material extending across and filling the gaps of said lattice to form a continuous layer in which said lattice-shaped shell is embedded, said lattice-shaped shell being covered by a light, porous web of flexible, thread-like filaments which extends across the gaps thereof, said web covered lattice-shaped shell being embedded in said continuous layer of gas impervious, tough, flexible material which extends across and fills the gaps of said lattice-shaped shell.

3. A chest respirator casing comprising a trough-like, air impervious cage which is sufficiently flexible to be formed by hand into any desired shape but which is sufficiently rigid to hold any shape into which it is formed, the edges of said cage being adapted to be formed by hand to fit snugly against selected contours of a patient's trunk to form a chamber along at least a sufficient portion of said trunk to induce artificial respiration in the patient, said chamber being bounded by said cage and said portion and being substantially airtight against said contours, and said cage having a passage extending therethrough adapted to provide communication between the interior and the exterior of said chamber and comprising a light base shell which is sufficiently flexible to be formed by hand into any desired shape but which is rigid enough to hold any shape into which it is formed, said shell being embedded in a gas impervious layer of a tough, flexible elastic thermoplastic resin.

4. The respirator of claim 1 having a resilient, flexible cushioning and sealing means located along the edges

thereof for contacting said contours in a comfortable and airtight manner.

5. The respirator of claim 1 wherein said shell is lattice-shaped and said layer of flexible resin extends across and fills the gaps of said lattice-shaped shell to form a continuous layer in which said lattice-shaped shell is embedded.

6. A chest respirator casing comprising a trough-like, air impervious cage which is sufficiently flexible to be formed by hand into any desired shape but which is sufficiently rigid to hold any shape into which it is formed, the edges of said cage being adapted to be formed by hand to fit snugly against selected contours of a patient's trunk to form a chamber around at least a sufficient portion of said trunk to induce artificial respiration in the patient, said chamber being bounded by said cage and said portion and being substantially airtight against said contours, and said cage having a passage extending therethrough adapted to provide communication between the interior and the exterior of said chamber and comprising a light base shell which is sufficiently flexible to be formed by hand into any desired shape but which is rigid enough to hold any shape into which it is formed, said shell being embedded in a gas impervious layer of a tough, flexible material, said lattice-shaped shell is covered by a lightweight, porous, flexible web of material which extends across the gaps thereof, said web covered lattice-shaped shell being embedded in said continuous gas impervious layer of tough, flexible material, which extends across and fills the gaps of said lattice-shaped shell.

7. The respirator of claim 6 wherein said base shell is made from expanded metal and said web comprises a web of fine, flexible, thread-like filaments which extend over and between the gaps of the expanded metal.

8. The respirator of claim 7 wherein said lattice-shaped shell is folded over at its edges and said cage has a rim of resilient cushioning and sealing material along the edges thereof.

9. The respirator of claim 8 wherein said web comprises a thin gauze and said resilient material comprises a vinyl chloride resin.

10. A process for producing a respirator casing comprising forming a trough-shaped lattice which is sufficiently flexible to be formed by hand to any desired shape but which is rigid enough to hold any shape into which it is formed, said lattice having an enlarged aperture therethrough, applying over said lattice but not over said aperture a thin web of flexible thread-like filaments which extends across and between the gaps thereof and applying to and around said web covered lattice a continuous, gas impervious layer of a tough, flexible material in which said web covered lattice is embedded and which extends across and fills in the gaps of said lattice.

11. The process of claim 10 wherein said layer of flexible material is applied to and around said web covered lattice by dipping the same into said flexible material while it is in the form of a liquid and subsequently solidifying the coating of material which adheres to said web covered lattice.

12. A gas and liquid imprevious structure comprising a lattice-shaped frame, a light, porous web of thread-like filaments covering said lattice frame and extending across the gaps thereof, said web covered lattice frame being embedded in a continuous, gas and liquid impervious layer of a tough flexible material which extends across and fills the gaps of said lattice frame.

13. A method for producing a gas and liquid impermeable structure comprising covering a lattice or frame with a light, porous web of thread-like filaments and embedding said web covered lattice frame in a gas and liquid impervious layer of a tough, flexible material, which extends across and fills in the gaps of said frame.

14. The respirator of claim 1 wherein said resin comprises a vinyl resin.

15. The respirator of claim 14 wherein said resin comprises a solidified plastisol of a vinyl chloride polymer.

16. The respirator of claim 3 wherein said resin comprises a vinyl resin.

17. The respirator of claim 16 wherein said resin comprises a solidified plastisol of a vinyl chloride polymer.

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