April 21, 1964 J. J. ANDERSON, JR 3,130,112

THERMAL INSULATING ASSEMBLY

Filed March 30, 1961 2 Sheets-Sheet 1

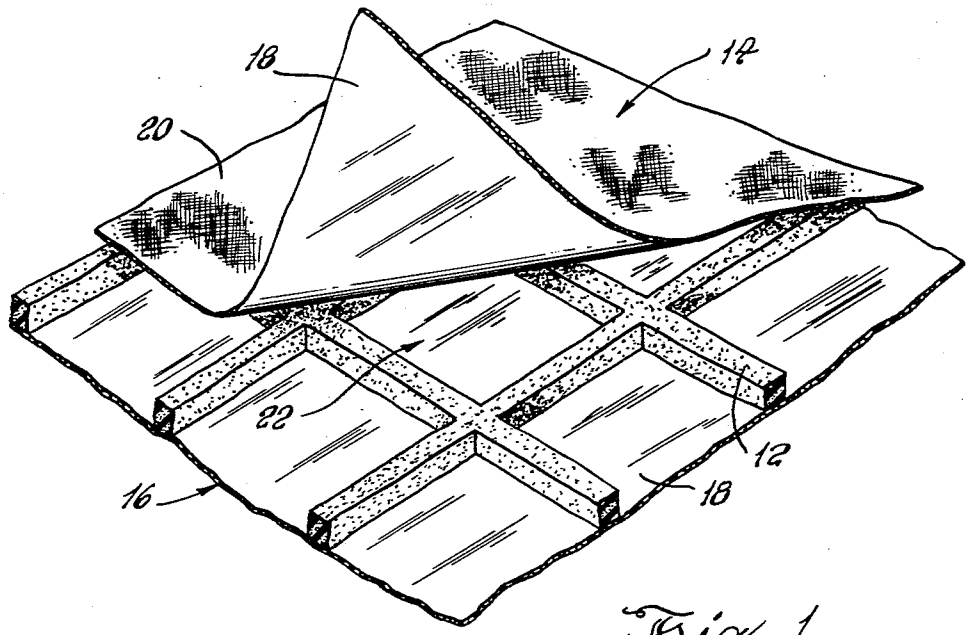


Fig. 1

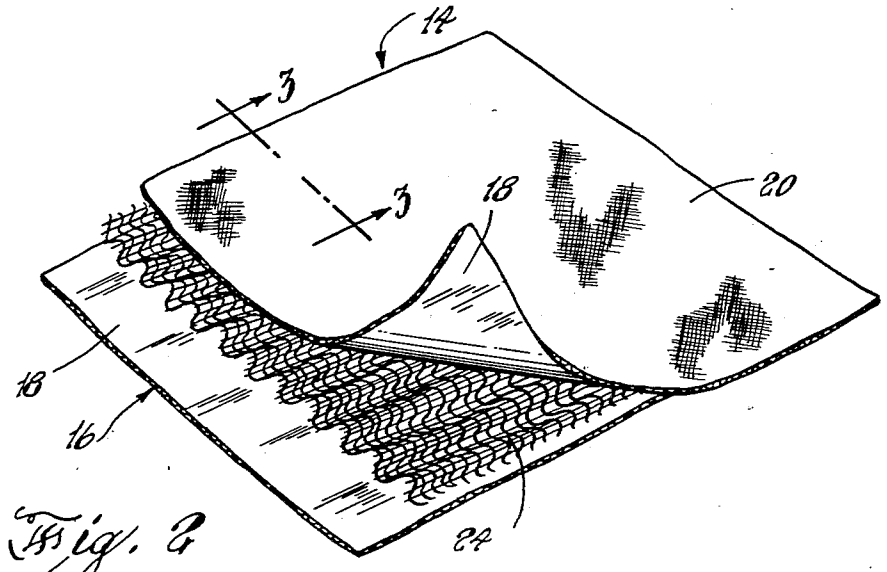


Fig. 2

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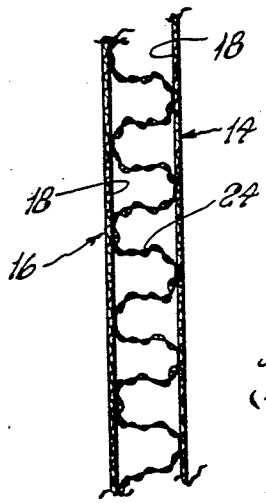
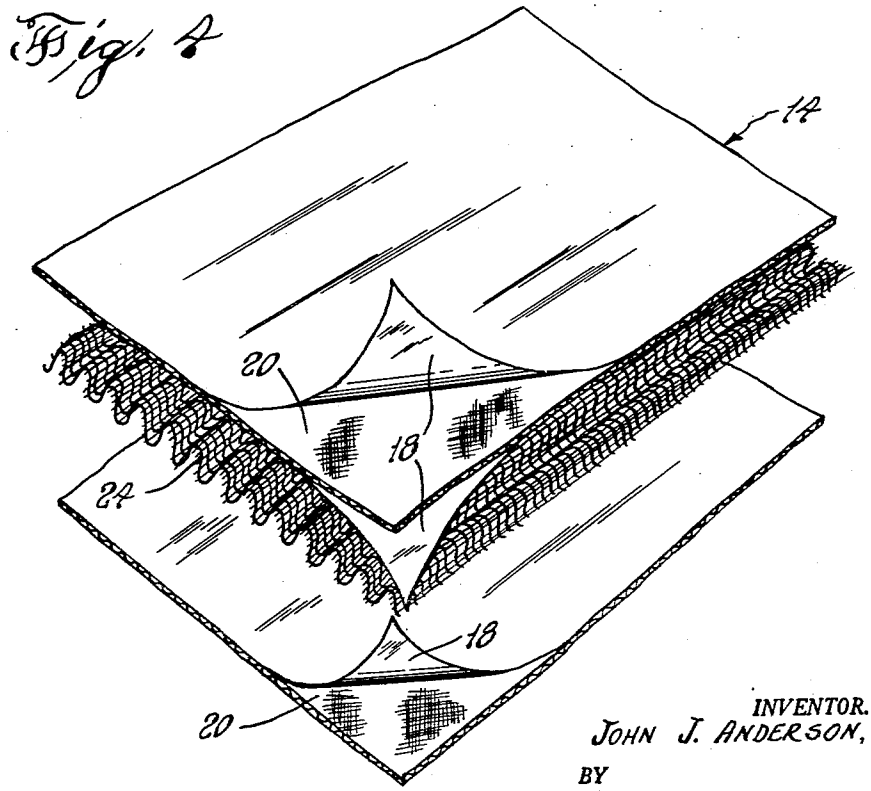


Fig. 3

Fig. 4



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THERMAL INSULATING ASSEMBLY

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4 Claims. (Cl. 161—89)
(Granted under Title 35, U.S. Code (1952), sec. 266)

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

This invention relates to thermal insulation and especially to a reflective-type, flexible, thermal insulating assembly.

The need for an efficient, low-weight, flexible, thermal insulating material has become acute in recent years as the exploration of the frigid regions of the earth and of space has intensified. Men sent up miles above the earth in the open gondolas of balloons must be protected against the severe extremes of temperature and radiative energy which are encountered there.

The present invention provides a thermal insulating assembly which greatly reduces the exchange of heat energy between the two regions that it separates. A typical embodiment of the invention comprises a pair of spaced, heat-reflective sheets, each sheet being formed of a backing, or base, coated on one side with a coating of low-emissivity, high-reflectance material. The sheets are placed so that the coatings face each other. The coated backings are separated from each other by a spacer of low thermal conductivity, the spacer material being perforated to provide a structure which is open and permits the maximum free void across which the opposed coatings can "see" each other.

An object of this invention is to provide efficient thermal insulation.

Another object is to provide an efficient thermal insulating material having the characteristics of low weight and flexibility.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

FIG. 1 is a representation of a section of a thermal insulating assembly fabricated in accordance with the invention and utilizing a spacer material of perforated low-density, flexible, organic polymeric foam;

FIG. 2 is a representation of a section of a thermal insulating assembly fabricated in accordance with the invention and utilizing a spacer material consisting of an open meshwork of monofilament fiber;

FIG. 3 is a cross-section of the spacer material used in the thermal insulating assembly shown in FIG. 2; and

FIG. 4 is an exploded view of a modification of the invention which is particularly useful in very high-altitude balloon work.

FIG. 1 shows a broken portion of thermal insulating assembly, or material, comprising a spacer **12** which separates an upper sheet **14** and a lower sheet **16**. The upper sheet **14** is folded back to show that the sheet consists of a coating **18** on a backing, or base, **20**. The lower sheet **16** also consists of a coating **18** on a backing **20** (not visible). The two coatings **18** face each other.

The backing may consist of any strong fabric which is impermeable to moisture, such as a close-knit, neoprene-coated nylon or Dacron cloth. The coating **18** is a thin film of material, such as aluminum, which has a low emissivity (high reflectance) in the far infra-red regions of the electromagnetic spectrum. The film may be

deposited directly on the fabric or may be a very thin lamination which is pasted to the fabric. Any other method providing a firm adhesion and flexibility may be used. The spacer material may be low-density, lightweight, low-thermal-conductivity material, such a polyurethane foam, with open areas **22** as shown. The spacer should have a high resiliency and sufficient compressional resistance to prevent the opposing metallic surfaces **18** from contacting each other when loaded with pressures in the order of 1 to 2 pounds per square inch.

Spacer materials can be of a woven or knit fibrous material having the necessary thickness (e.g., approximately one-quarter of an inch) and open structure. A woven material **24** fabricated from a stiff synthetic monofilament fiber, such as polyethylene or polypropylene, is shown in FIG. 2. The corrugated nature of the spacer material geometry is illustrated in FIG. 3.

A modification of the invention, which is particularly useful in high-altitude balloon work (at approximately 100,000 feet) where the balloonist is in an open gondola exposed to the direct rays of the sun, is shown in FIG. 4. Here the outer surface of the upper sheet **14** is given a coating **18** of low-emissivity material, such as aluminum, in addition to the coatings on the opposing surfaces of the upper and lower backings **20**. This outer coating of aluminum is particularly useful in reflecting a large amount of the incident solar energy which is quite strong at these altitudes. The insulating assembly thus acts not only to reduce the amount of body-heat loss to the surrounding medium, but reflects a large portion of externally impinging radiation which would act to burn the skin body areas presented to direct sunlight.

Heat transfer across an insulating assembly such as shown in the drawing takes place by a combination of conduction, convection, and radiation when atmospheric gasses are present between the opposing metal surface. The metallized opposing surfaces of the two outer sheets significantly reduce heat transfer by radiation provided that the metallic surfaces have very low emissivity and provided that the two surfaces can "see" each other. This is the reason the spacer material in FIG. 1, which consists of solid foam, contains excised areas **22**.

Heat transfer by conduction across the air space is relatively low since air has a low coefficient of heat transfer. There will be some heat transfer by convection.

Heat transfer by conduction through the spacer material itself is minimized by the use of a material with low thermal conductivity and small cross-sectional area between the two sheets. It is therefore advantageous to make excised portions of the foam spacer as large as possible relative to the sheet-separating portions. The limitation in the size of the excised areas is imposed by the necessity of keeping the metallic surfaces of the sheets from contacting each other.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

I claim:

A light weight garment for protection against extremes in temperature

comprising

a first and second flexible, impermeable neoprene coated nylon fabric,

a low density, flexible, compressive resistant organic polymeric spacer of low thermal conductivity intermediate said first and second fabric,

said spacer being a mesh, whereby the area of the contiguous faces of said fabrics that

abuts said spacer is substantially less than the total area of each of said faces of fabrics,

said first and second fabrics having a flexible, heat radiation reflective metallic surface on each of the faces of said fabric contiguous said spacer, and

said metallic surface having a low infra-red radiation emissivity.

2. The garment of claim 1 wherein said metallic surface is aluminum.

3. The garment of claim 2 wherein said spacer is polyethylene foam.

4. The garment of claim 2 wherein said spacer is a stiff monofilament fibrous mesh of polyethylene.

References Cited in the file of this patent

UNITED STATES PATENTS

1,956,323	Gregg	Apr. 24, 1934
2,389,579	Reynolds	Nov. 20, 1945
2,540,331	Hlavaty	Feb. 6, 1951
2,695,744	Gattuso	Nov. 20, 1954
2,697,679	Zimarik	Dec. 21, 1954
2,766,164	Salem	Oct. 9, 1956
2,858,881	Newall et al.	Nov. 4, 1958