Aug. 7, 1934. C. G. MUNTERS 1,969,621

HEAT INSULATION

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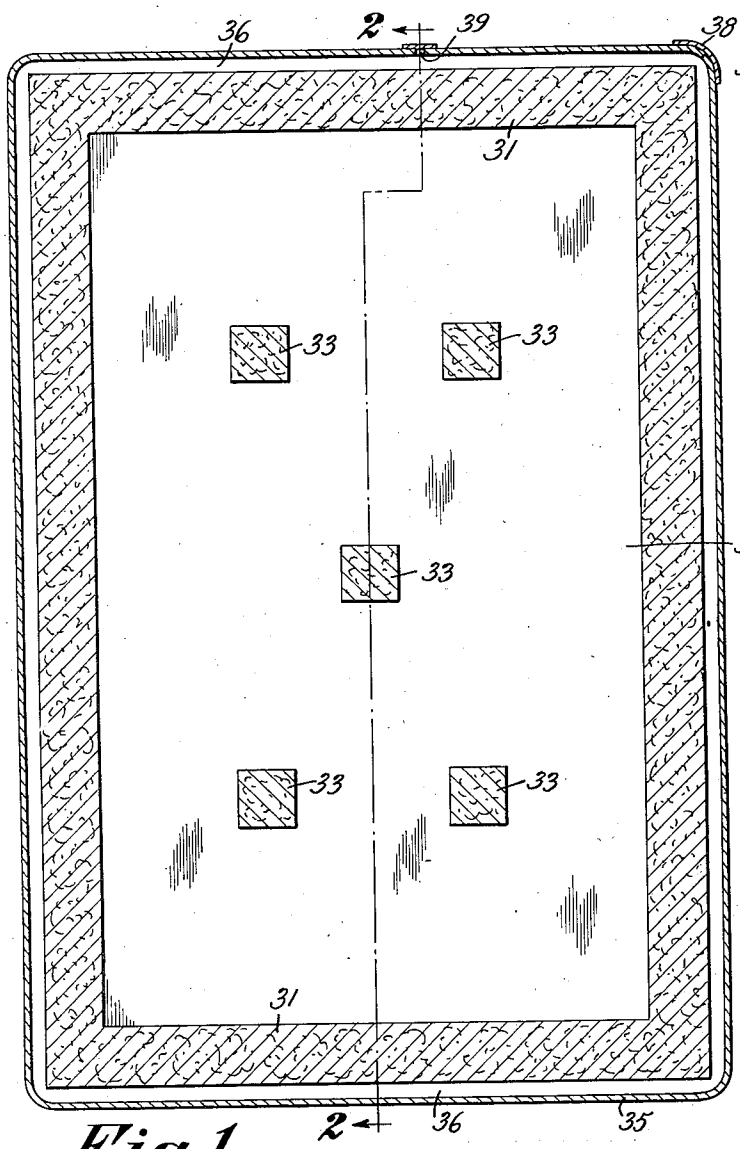


Fig. 1.

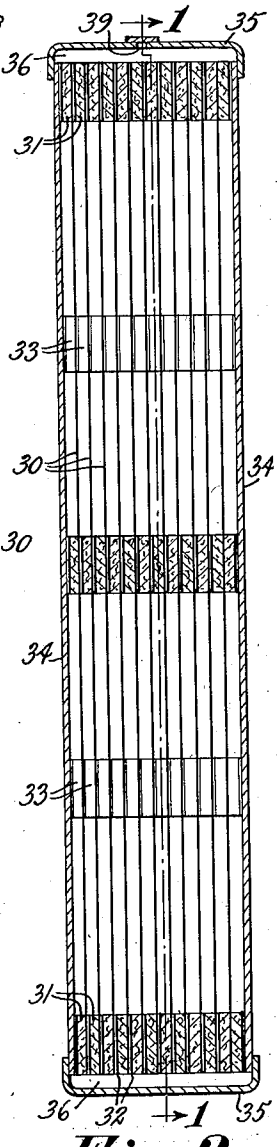


Fig. 2.

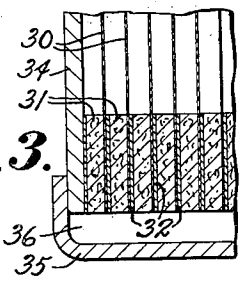


Fig. 3.

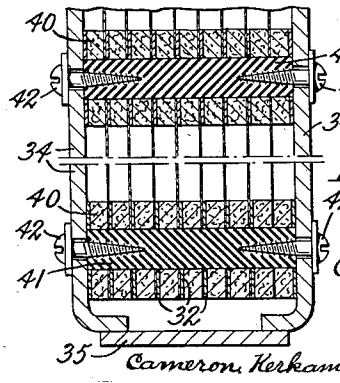


Fig. 4.

INVENTOR
Carl Georg Munters
BY
Cameron, Kerkam & Sutton ATTORNEYS

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HEAT INSULATION

Carl Georg Munters, Stockholm, Sweden

Application April 2, 1934, Serial No. 718,663
In Sweden March 3, 1931

7 Claims. (Cl. 154—45)

This application is in part a continuation of my copending application Serial No. 595,411 filed February 26, 1932.

My invention relates to insulation and more particularly to insulation of the character employing a relatively small amount of solid material arranged to form intervening spaces containing gaseous material.

It has heretofore been proposed to form insulation of sheets of solid material with intervening air spaces, said sheets in some instances being of metal foil, as aluminum foil, to provide surfaces having high heat-reflecting characteristics. If the layers of air are on the order of one centimeter in thickness in the direction of heat transfer, the air in said layers is substantially dead and so far as reducing heat transfer by convection maximum efficiency has been substantially obtained. It is known that certain gases have a lower heat conductivity than air and it might be expected that insulation of the character above referred to could be improved by replacing the air by such a gas of lower heat conductivity.

I have discovered, however, that such is not the case and the amount of heat transfer through insulation charged with a gas of lower heat conductivity may in fact be higher than that for the same insulation when charged with air. I have further discovered, on the other hand, that advantage may be taken of the lower heat conductivity of such gases in insulating structures of the type above referred to if the gas layers are made materially narrower than the critical spacing for preventing convection currents in intervening vertical layers of air, and although this involves an increase in the number of sheets or partitions, and thereby in the weight of solid material used, the total advantage derived from the use of the gas of lower heat conductivity results in insulation of materially higher efficiency than the best heretofore obtained by use of stagnant layers of air of whatever thickness.

In accordance with my discovery the number of layers into which the gas space is subdivided should be greater as the specific weight of the gas employed increases, to the end that convection currents within said gas layers may be reduced to a minimum. Therefore, in accordance with my invention, I provide a hermetically sealed enclosure which is charged with a suitable gas of lower heat conductivity than air at a corresponding temperature and pressure and the gas filled space is subdivided by partitions of sheet material which provide narrow gas spaces in the direction of heat transfer and which afford a minimum of conductive contacts or paths for conduction between said sheets or partitions. As compared with the spacing heretofore used when stagnant air has been employed, the thickness of the gas layers in the direction of heat transfer bears an inverse relation to the specific weight of the gas, whereby for a given total width of gas space in the direction of heat flow, the heavier the gas the greater the number of partitions or sheets which are employed. Whereas a spacing of one centimeter or more is suitable for sheets between air layers, for an insulation of average heat drop, the spacing according to the present invention will be less than one centimeter, and preferably not exceeding about 5 mm., and may be materially less than 5 mm.

Furthermore, to minimize heat transfer, some or all of the partitions or sheets may be provided with bright surfaces to reduce radiation, and the members of the insulation in the direction of heat flow are made of a material of low heat conductivity.

The invention will be further described in the following specification of illustrative embodiments, though it will be clear that the invention is not limited to the embodiments specifically disclosed.

Of the accompanying drawing, which forms a part of this specification:

Fig. 1 is a sectional view, taken on the line 1—1 of Fig. 2, through a slab of insulation embodying the invention;

Fig. 2 is a sectional view taken on the line 2—2 of Fig. 1;

Fig. 3 is a sectional view of part of the structure shown in Figs. 1 and 2, on enlarged scale; and

Fig. 4 is a sectional view of a modified structure.

The structure shown in Figs. 1, 2 and 3 comprises a hermetically sealed casing including side walls 34 and end or transverse walls 35. The slab is to act as a heat insulation between the spaces outside and adjacent walls 34. Consequently the line or direction of heat flow is perpendicular to the planes of walls 34. Walls or plates 34 may be corrugated or otherwise formed and are of such thickness as to give the insulating element sufficient strength and resistance to shocks. These walls may be made of aluminum, iron, or other gastight substance suitable for the purpose. The walls should be able to

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withstand pressure fluctuations of about 100 millimeters mercury due to variations in atmospheric pressure. The end walls 35 are made of material of low heat conductive capacity, such, for instance, as cellon (a mixture of acetocellulose and camphor or like plasticizers), celluloid, pollopas (an artificial mass obtained by condensation of urea or its derivatives and formaldehyde in the presence of bases) or the like, or a nickel-iron alloy, for example of 25–35% nickel. Walls 35, as shown in Figs. 2 and 3, are flanged over the walls 34 and, when using one or more of the non-metallic substances, are pasted thereto by a suitable kind of paste, which, for instance, may consist of a mixture of cellon and vinepas (polymeric vinylacetate) dissolved in acetone.

Within the casing or element are a plurality of thin partitions 30 of sheet material spaced by frames 31 of felt, porous paper composition or like material having low heat conductive capacity, which frames are made sufficiently rigid for handling during manufacture by means of similarly formed frames 32 of suitable material such as cardboard pasted to the felt or the like. The cardboard frames are also preferably pasted to the sheets 30. Sheet members 30 may be aluminum foils or the like. The sheets 30 are disposed transversely to the direction of flow of heat.

Within the frames 31 and between the sheet members are spacing members made of superimposed pieces of felt and cardboard pieces 33 similar to the material of parts 31 and 32.

At least every other partition 30 preferably has bright heat reflecting surfaces in order to counteract heat transmission through the element due to radiation. The other partitions may consist of paper or the like having less heat reflecting capacity, since their principal purpose is to provide such narrow gas layers as to substantially prevent movement of gas in the layers, and thus prevent heat transfer by convection.

The interior of the casing, and consequently the spaces between the partitions 30 of sheet material are filled with a gas having a lower coefficient of heat conductivity than air at corresponding pressure and temperature. The preferred gases are sulfur hexafluoride (SF_6); methyl chloride (CH_3Cl), dichlorodifluoromethane (CCl_2F_2); sulfuryl fluoride (SO_2F_2); methyl bromide (CH_3Br); and ethyliodide (C_2H_5I). All these gases are halogen compounds. Other suitable gases for certain insulations are compounds of sulphur such as sulphur dioxide (SO_2) and carbon disulphide (CS_2). A mixture of two or more of said gases may be used. The gas or gas mixture which is made use of should have a boiling point lower than the lowest temperature prevailing where the heat insulator is to be used. The gas chosen should be insoluble in the material of which the insulation is made and should not react with said material.

I have discovered that these heavy gases require a closer spacing than the critical spacing for air; and in general the spacing should be closer the heavier the gas. With the gases above mentioned, the distance between the partitions or foils is preferably less than 5 millimeters in order to prevent convection of the gas.

In order that the gas may enter all of the spaces between the partitions, the felt frames may be provided with small holes communicating with the narrow space 36 between the frames and the transverse walls 35. The transverse walls may be made of a single strip secured and made tight by an overlapping corner piece 38. A filling hole 39 is provided which may be closed by a cover pasted thereon.

When the insulation is made as shown in Figs. 1, 2, and 3, it is preferable, though not essential, to use a gas pressure approximately the same as but slightly below atmospheric pressure, since, in such case, the preponderance of pressure acting on the outside of the casing tends to maintain the separating members in place.

Fig. 4 shows a construction permitting a higher pressure to prevail inside the insulation than outside. In this embodiment, the partitions are spaced by means of ring elements 40 placed around pins 41 of a material of low heat conductivity, such, for instance, as bakelite, to which the outside walls or plates are secured by means of screws 42.

The gas may be introduced by evacuating and filling the insulation casing while wholly contained in a pressure vessel, so that the pressure inside and outside the insulation casing can be maintained the same.

In the foregoing, I have described an insulating unit in which some of the partitions have bright surfaces, as when using aluminum foil, backed or unbacked, or alternate foil and paper partitions. The invention may be carried out without the use of reflecting surfaces. For example, the partitions may be entirely of paper. In such case, the spacing should be still closer than hereinbefore indicated in order to obtain equivalent effect in preventing heat transfer by radiation. Paper may be used without special frame members by crumpling the paper so as to have a minimum contact. I have found an advantageous spacing of paper sheets to be about 0.6 millimeter. Non-conductive spacing pins may pass through the paper partitions.

What I claim is:

1. A heat insulating structure comprising exterior confining walls, a gas hermetically enclosed therein and having a lower heat conductivity than air at a corresponding pressure and temperature, and partitions formed of sheet material between said walls arranged transversely to the direction of heat transfer for counteracting heat transmission by radiation and convection, said partitions forming intervening gaseous layers materially narrower than the critical spacing for preventing convection currents in intervening vertical layers of air.

2. A heat insulating structure comprising exterior confining walls, a gas hermetically enclosed therein and having a lower heat conductivity than that of air at a corresponding pressure and temperature, said gas comprising a gaseous compound of the group including sulphur hexafluoride, methyl chloride, dichlorodifluoromethane, sulfuryl fluoride, methyl bromide and ethyliodide, and partitions formed of sheet material between said walls arranged transversely to the direction of heat transfer for counteracting heat transmission by radiation and convestion, said partitions forming intervening gaseous layers materially narrower than the critical spacing for preventing convection currents in intervening vertical layers of air.

3. A heat insulating structure comprising spaced walls to be maintained at different tem-

perature, other walls forming with the first mentioned walls a hermetically sealed casing, a gas in said casing heavier than air, and a plurality of partitions of sheet material per centimeter distance between the first-mentioned walls for dividing the gas into layers.

4. A heat insulating structure comprising exterior confining walls, a gas hermetically enclosed therein and having a lower heat conductivity than air at a corresponding pressure and temperature, and partitions formed of sheet material between said walls arranged transversely to the direction of heat transfer for counteracting heat transmission by radiation and convection, said partitions forming intervening gaseous layers having a thickness in the direction of heat transfer not greater than 5 millimeters.

5. A heat insulating structure comprising exterior confining walls, a gas hermetically enclosed therein and having a lower heat conductivity than that of air at a corresponding pressure and temperature, said gas comprising a gaseous compound of the group including sulphur dioxide and carbon bisulfide, and partitions formed of sheet material between said walls arranged transversely to the direction of heat transfer for counteracting heat transmission by radiation and convection, said partitions forming intervening gaseous layers materially narrower than the critical spacing for preventing convection currents in intervening vertical layers of air.

6. A heat insulating structure comprising exterior confining walls, a gas heremetically enclosed therein and having a lower heat conductivity than air at a corresponding pressure and temperature, partitions formed of sheet material between said walls arranged transversely to the direction of heat transfer for counteracting heat transmission by radiation and convection, and pressure resisting members of low heat conductivity passing through the partitions.

7. A heat insulating structure comprising exterior confining walls, a gas hermetically enclosed therein and having a lower heat conductivity than air at a corresponding pressure and temperature, and partitions formed of sheet material between said walls arranged transversely to the direction of heat transfer for counteracting heat transmission by radiation and convection, said partitions forming intervening gaseous layers whose thickness in the direction of heat transfer is less than one centimeter and of a thickness sufficient to substantially prevent convection currents in intervening vertical layers of the aforesaid gas.

CARL GEORG MUNTERS.