March 18, 1947. C. G. MUNTERS 2,417,435

HEAT INSULATION

Filed Jan. 6, 1944

Fig. 1.

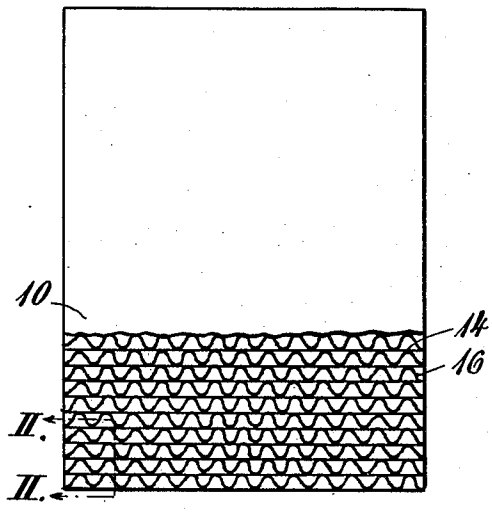
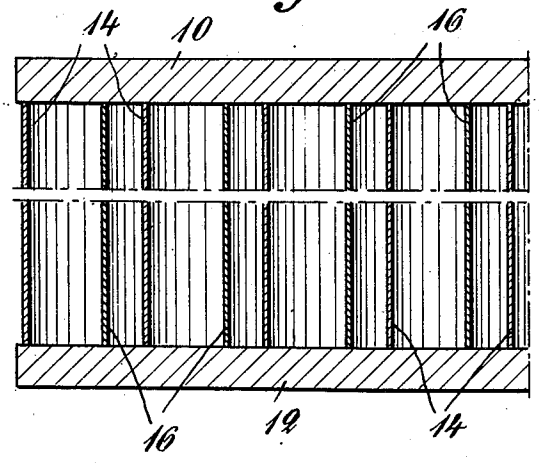


Fig. 2.



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HEAT INSULATION

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My invention relates to heat insulations of the multilayer type comprising sheets of poor heat conductivity, in the first place paper. More particularly, the invention relates to heat insulations of the multilayer type, in which the sheets are corrugated, entirely or in part, with the corrugations extending perpendicularly or substantially perpendicularly to surfacing boards or plates secured to the insulation.

As is well known, the heat transmission through insulation can take place in three different ways, that is, through conduction in the solid and gaseous substance of the insulation, through convection of the gaseous substance and, finally, through radiation. Multilayer insulations are particularly advantageous relative to the first factor because the solid substance need only constitute a very small portion of the total volume of the insulation, the remaining volume being occupied by a gas, such as the air which has a low coefficient of heat conductivity, relatively to the solid substance. Convection in the gas is avoided by the sheets being spaced apart a distance falling below a certain limit. Foils of bright metal are capable of limiting the heat transmission through radiation to a very great extent.

However, in the Patent No. 2 098,193, issued November 2, 1937, it is shown that the radiation also can be greatly reduced in such insulations that consist of sheets which are not bright, such as paper sheets, if the spacing of the sheets is less than 1.2 millimeters and preferably as low as .5 millimeter. In this known type of insulation, the foils are arranged parallel to the outer plane of the insulation or, in other words, perpendicularly to the direction of the heat flow through the insulation as installed. The transmission of heat by radiation is diminished effectively by the heat, on its way through the insulation, meeting the great number of sheets closely spaced to each other.

In multilayer insulations of the type above mentioned, wherein the sheets extend parallel to the direction of heat flow, interruption of the passage of radiant heat obviously cannot be obtained as in the known type of insulation just mentioned. The corrugations form open passages or tubes in the transverse direction of the insulation, and the main portion of the volume of the insulation consequently consists of the gas in these passages, which does not form any bar whatever to heat radiation.

Now, I have discovered that the spacing of the sheets nevertheless also in this case has an influence on the quantity of heat transferred by radiation through the insulation. It was found that in two insulations containing the same part by volume or weight of solid substance, such as paper, a considerably better heat insulating characteristic could be obtained by reducing, in the one case, the thickness of the sheets and by instead introducing a correspondingly greater number of sheets evenly distributed over the plane of the insulation. Inasmuch as the conduction in the solid and gaseous substances must thus be of the same magnitude in the two insulations, and inasmuch as the spacing of foils was kept within limits where convection is out of the question, the improvement obtained must have resulted from a decreased heat transfer by radiation in the insulation having the closer spacing of sheets. The explanation of this phenomenon is relatively complicated and can be reduced from the space angle over which the radiation takes place from a certain point, and which is the reason that the sheets, in spite of their direction coinciding with that of the flow of heat through the insulation, can be caused to serve as effective radiation absorbers. It should be pointed out that such an improvement is not obtainable if, instead, the insulation were conceived as built up from bright and perfectly reflecting foils.

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A multilayer insulation with sheets in the transverse direction thereof has, in comparison with the insulation according to the Patent No. 2,098,193, a greater heat conduction in the solid sheet substance, inasmuch as this substance so to say short-circuits the two external sides of the insulation. However, the cross extending sheets impart to the insulation a considerably better strength and rigidness, and this type of insulation is for this reason particularly suited for use in building panels and the like of the prefabricated type. For example, such panels may be used for the erecting of walls or floorings in buildings.

The invention has for its object to provide a multilayer insulation from a material of poor heat conductivity disposed in an edgewise arrangement, said insulation combining an exceedingly good strength and rigidness with a low coefficient of heat transmission and a low weight.

Further objects and advantages of the invention will be apparent from the following description considered in connection with the accompanying drawing which forms part of this specification, and of which:

Fig. 1 is a view of a heat insulating unit made in accordance with the invention, parts of the

unit being broken away. Fig. 2 is a more or less diagrammatic sectional view on the line II—II of Fig. 1 and on a considerably enlarged scale.

In the drawing, 10 and 12 designate two comparatively rigid and hard boards or plates of suitable, preferably non-metallic material, such as fibre mass, pasteboard or the like. The multilayer insulation is arranged between said boards or plate members. It is preferably composed of alternating plane and corrugated paper sheets 14 and 16, respectively. These sheets extend, like the corrugations, at least approximately at right angles to the plane of the boards 10 and 12. The sheets 14 and 16 are connected with one another by means of a suitable adhesive, such as water-glass, at the ridges of the corrugations. Furthermore, the boards 10 and 12 are rigidly connected with the sheets 14 and 16 by pasting.

As a measure of the number of sheets it is suitable to indicate the average spacing thereof, that is to say the number of sheets for a certain length. Consequently, if the spacing between two plane layers 14 is 4 millimeters, for example, the average spacing will by the presence of the intermediate corrugated sheet 16 amount to 2 millimeters. The average spacing between the sheets is kept, according to the invention, between the limits of .5 to 3 millimeters. The thickness of the sheets is preferably indicated by weight. I have found that the individual sheets for obtaining a favourable result should have a weight between 20 and 60 grams per square meter. A certain, although less valuable improvement is still obtainable at 80 grams per square meter. On the other hand, the total weight of the solid sheet material in the insulation plays an important part. The sheet material in the multilayer insulation should thus have a weight below 60 kilograms per cubic meter with a lower limit of about 10 kilograms per cubic meter.

An insulation was built up from paper sheets having a weight of 80 grams per square meter and with an average spacing of 4 millimeters between the sheets, that is to say above the limit value indicated above. The insulation value was found to be 0.07 kcal/m/h/° C., interpreted as kilogram calories per meter per hour per ° C. At the same time another insulation was made, wherein the weight of the paper sheets was one fourth of the previous weight, that is to say 20 grams per square meter, and wherein the average spacing was likewise reduced to one fourth, that is to say 1 millimeter between the sheets. In the latter case, the number of sheets was obviously four times as great as in the first instance, by reason of which the total paper weight was the same, that is to say 24 kilograms per cubic meter. The coefficient of heat transmission of the insulation with the closer spacing between the sheets was found to amount to only 0.04 kcal/m/h/° C. The coefficient of heat transfer in the first instance is consequently no less than 75 per cent greater than in the latter instance. The heat conduction through the air and the sheet material must be the same in both cases. With the sheet spacings used and with the insulation otherwise constructed as indicated, no convection can occur in the air body of the insulation. The great improvement is thus wholly to be attributed to the reduced radiation in connection with the closer spacing of the sheets, in spite of the fact that the interior of the insulation has all over its surface passages extending therethrough, in which the air cannot offer any resistance to the radiation.

With the same quantity by weight of sheet material but with a paper weight of 40 grams per square meter and an average spacing of 2 millimeters, a coefficient of heat transmission of 0.05 kcal/m/h/° C. was obtained. In this case, the coefficient of heat transmission is thus 25 per cent higher for the insulation having an average spacing of 4 millimeters between the sheets.

An insulation made within the limits above-mentioned has exceedingly good strength properties combined with a low coefficient of heat transmission, a low total weight and a low manufacturing cost in consequence thereof.

The multilayer insulation may be divided into a number of layers parallel to the surface extension of the insulating unit with the aid of paper layers which will then be disposed at right angles to the direction of the heat flow, whereby the strength of the insulation is augmented. On the other hand, no appreciable improvement in regard to the insulating qualities will be obtained thereby. It is understood that if the radiation shall be broken by means of such layers, then it is necessary, as will appear from the Patent No. 2,098,193, that the spacing of these layers be diminished to such an extent that the structure of the insulation with sheets in a cross-extending arrangement can be maintained no longer.

The insulation may be impregnated with or contain substances making it waterproof and fire resistant. The impregnation is then effected before the boards 10 and 12 are pasted thereon and while the interior of the insulation is still readily accessible to the impregnating liquid. If the sheets obtain an increased rigidness through the quantity of solid substance added by the impregnation, it will be found advantageous to keep the paper weight per surface unit as the lower limit values as per above.

While a more or less specific embodiment of the invention has been shown, it is to be understood that the same is for purpose of illustration only, and that the invention is not to be limited thereby, but its scope is to be determined by the appended claims viewed in the light of the prior art.

What I claim is:

1. Heat insulating material comprising spaced substantially parallel plate members, structure disposed between said plate members and secured thereto, said structure comprising a plurality of sheets extending between said plate members transversely thereof and spacing means disposed between said sheets, said spacing means being constructed and arranged to form elongated air chambers between and substantially parallel to said sheets and transversely of said plates, heat transfer being in a path transversely of said plates and parallel to said sheets, the mass of said sheets and said spacing means being less than 60 kilograms per cubic meter and greater than 10 kilograms per cubic meter whereby heat transfer by conduction is held to a minimum, the average spacing between said sheets being maintained within the limits of .5 to 3 millimeters thus fixing the cross-sectional dimension of the said chambers transversely of said sheets at a value determined to be optimum for holding the transfer of heat due to radiation to a minimum.

2. Heat insulating material comprising spaced substantially parallel plate members, structure disposed between said plate members and secured thereto, said structure comprising a plurality of sheets extending between said plate members transversely thereof and spacing means disposed

between said sheets, said spacing means being constructed and arranged to form elongated air chambers between and substantially parallel to said sheets and transversely of said plates, heat transfer being in a path transversely of said plates and parallel to said sheets, the mass of a unit volume of said sheets and said spacing means being less than 60 kilograms per cubic meter and greater than 10 kilograms per cubic meter whereby heat transfer by conduction is held to a minimum, the thickness of said sheets and the material forming said spacing means as defined by the weight thereof being less than 60 grams per square meter and greater than 20 grams per square meter, the average spacing between said sheets being determined by the mass of said unit volume and the thickness of said sheets and said spacing means, said spacing being a value determined to be optimum for holding the transfer of heat due to radiation to a minimum.

3. Heat insulating material comprising spaced substantially parallel plate members, structure disposed between said plate members and secured thereto, said structure comprising a plurality of sheets extending transversely between said plate members and spacing means between said sheets, said spacing means being constructed and arranged to form elongated air chambers between said sheets substantially parallel thereto and transversely of said plates, heat transfer through said material being in a path transversely of said plates and substantially parallel to said sheets, the thickness of said sheets and the material forming said spacing means as defined by the weight thereof being less than 60 grams per square meter and greater than 20 grams per square meter, the average spacing between said sheets being less than 3 mm. and greater than .5 mm., thus fixing the cross sectional dimension of the said chambers transversely of said sheets at a value determined to be optimum for holding the transfer of heat due to radiation to a minimum.

4. Heat insulating material comprising spaced substantially parallel plate members, structure disposed between said plate members and secured thereto, said structure comprising a plurality of relatively flat sheets extending between said plate members substantially perpendicular thereto, spacing means comprising corrugated sheets formed of material like that of the relatively flat sheets disposed between said relatively flat sheets, the corrugations forming elongated air chambers between and substantially parallel to said relatively flat sheets and transversely of said plates, heat transfer through said material being in a path transversely of said plates and parallel to said relatively flat sheets, the mass of said relatively flat sheets and said spacing means being less than 60 kilograms per cubic meter and greater than 10 kilograms per cubic meter, whereby heat transfer by conduction is held to a minimum, the average spacing between said relatively flat sheets being less than 3 mm. and greater than .5 mm., thus fixing the cross sectional dimension of said chambers transversely of said plain sheets at a value determined to be optimum for holding the transfer of heat due to radiation to a minimum.

CARL GEORG MUNTERS.

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