Nov. 7, 1933. E. DYCKERHOFF 1,934,174

HEAT INSULATION FOR AIR SPACES

Original Filed April 30, 1926

Fig. 1.

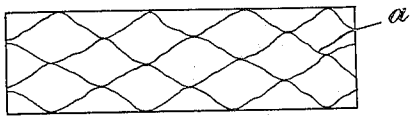


Fig. 2.

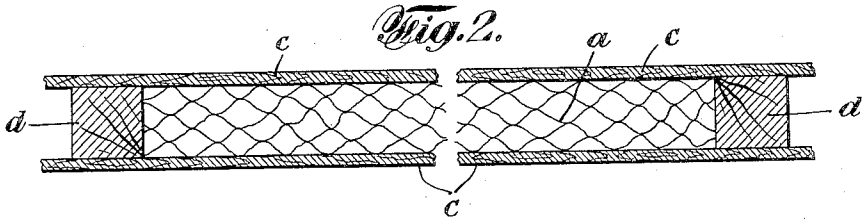


Fig. 3.

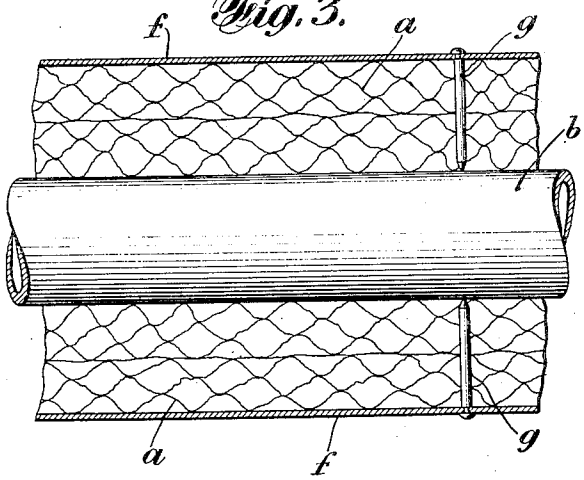


Fig. 4.

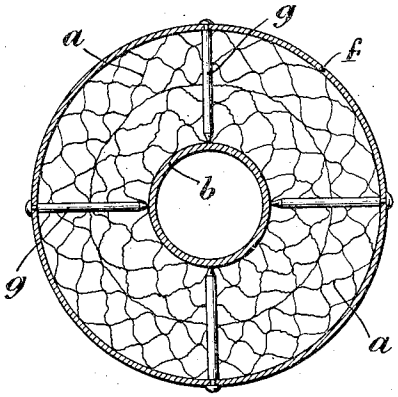
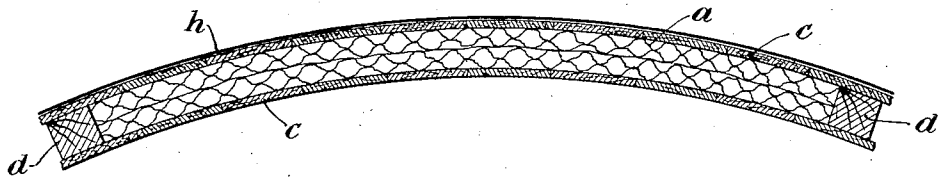


Fig. 5.



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HEAT INSULATION FOR AIR SPACES

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Continuation of application Serial No. 105,753, April 30, 1926, and in Germany November 23, 1925. This application March 6, 1933. Serial No. 659,806

12 Claims. (Cl. 154—28)

This application is a continuation of application Ser. No. 105,753, filed on April 30, 1926, by me, together with Ernst Schmidt, and is a continuation in part of my earlier application, Ser. No. 442,219, filed April 7, 1930.

In Schmidt application, Ser. No. 635,263, filed Sept. 28, 1932, issued as Patent No. 1,890,418, there is described and claimed the invention of using sheets having thin heat reflective metal surfaces spaced apart to form air layers, as a heat insulation. This application relates to a specific form of that invention, in which the sheets are formed of metal foil and the means for holding the sheets in spaced relation is formed from the sheets themselves. Despite the fact that metal usable for the foil, such as aluminum, has great conductivity for heat, I have discovered that if the foil used is very thin the amount of heat conducted through the points of contact necessary to keep the sheets spaced will be very small, particularly where there is a substantial average spacing of the sheets. The foil employed for this purpose may be less than .02 mm. and may even be as thin as .005 mm., or thinner if obtainable, but foil even of this thin, tissue, paper-like nature has sufficient rigidity relative to its weight so that a very small number of points of contact will be sufficient to keep two sheets in proper spaced relation provided they are protected against outside pressures.

The means for spacing the insulated sheets may be formed of the sheets themselves in any desired manner, such as by stamping and subsequently bending the sheets, and the insulating sheets thus formed may either be applied immediately to the member to be insulated or used to form insulating plates. I have found however that the most efficient way of forming the necessary projections on the sheets is to give them a crumpling which will make the sheets uneven. This crumpling should be such that when the sheets are laid together they will have a substantial average spacing which may be, for example, in the order of about 1 cm., though this may be increased or decreased somewhat as circumstances demand, but ordinarily will be between .5 cm. and 2 cm. From this it can be seen that where I use the expression "air spaces of substantial thickness" I intend to imply that the air spaces shall be substantially greater than those which have been suggested to be formed between crumpled or embossed asbestos paper which is then assembled with an adhesive or other locking means to form a coherent mass, where the air spaces are in the form of innumerable tiny cells.

One of the great benefits of my invention is found in the easy method which it supplies of insulating bodies of uneven or irregular shape. Heretofore such bodies could only be insulated with masses of porous material unless the previously built-up forms were made at great expense. According to my invention, the foil can be shipped to the spot where it is to be used in the form of rolls which take up very little space, and then crumpled or distorted by hand or machine and applied to the surface of the member to be insulated.

Foil such as I use is so thin that it has very little elasticity, with the result that it does not tend to spring back out of the position to which it has been formed; also there is substantially no tendency toward warping or movement of the parts due to swelling and contraction from the effects of moisture, so that there is no necessity of locking the sheets to each other to maintain the irregular shape necessary to provide thick air spaces. Despite the fact that, in order to keep conduction to a minimum, I prefer to use metal so thin that the insulation filling made of a plurality of sheets can readily be compressed with the fingers to a thickness not over one hundredth of its original thickness, nevertheless this metal has sufficient strength relative to its weight so that there is substantially no tendency for the filling to pack down under the force of gravity. Thus if the sheets are held against relative bodily movement and the filling is protected against outside pressure, it will remain substantially indefinitely in the form in which it is applied, even under the influence of heavy vibration and shock.

Holding the sheets against relative bodily movement is very simple and can be accomplished in various ways. Where the sheets are used in horizontal position, the first can be laid on the support and the other sheets laid over the first. Ordinarily in such a case there will either be end members (limiting the ends of the air space) to hold the sheets against shaking sideways, or else the sheets will extend down over the sides of the support to prevent relative movement. In the case where the sheets are used vertically they can be hung in any desired manner. Thus one of the simplest ways is to use a single sheet long enough to form two layers and hang this by its middle portion over some appropriate support positioned adjacent the top of the air space, or separate sheets can be hung on pins spaced

as desired. If the layers of foil do not entirely fill the air space, ties or bars of any desired sort may be used to prevent the sheets from separating. In the case of pipe coatings, the fact that the separate sheets surround the pipe will hold the layers against relative bodily movement and this will be true whether the layers are put on separately or in the form of a spiral.

Ordinarily it will be advisable to supply a protective casing to go over the insulation to protect it from outside pressures. In the case where the insulation is used for filling air spaces created by the usual structural members, as in walls or ceilings, no special casing will be necessary, but in other instances, as in making pipe coatings, an outside shell is advisable, which may be made of metal heavier than the foil. Such an outside shell is not however essential to the insulating efficiency of the structure, and insulation made according to my invention can be used very efficiently for temporary repairs as well as for permanent installations.

By doing away with the spacing means such as asbestos strips or the like, it is possible greatly to reduce the weight of the insulating structure; in fact, the insulation of my invention can be used wherever an air space of substantial size exists, without materially increasing the weight of the article to which it is applied. This is particularly important where large areas are to be covered, for where the sheets are used in flat parallel form, spacers or supports must be provided at relatively frequent intervals, increasing the weight and cost of materials and also greatly increasing the cost of application. Thus this form of insulation is particularly adapted to all forms of vehicles both for land, water and air where the reduction in the weight of the insulation permits additional pay load. If desired, the crumpled form of insulation may be used as a means for separating flat sheets of foil, and it is not necessary that all of the sheets be crumpled.

For the purpose of illustration, examples of my invention are shown in various forms in the accompanying drawing, in which Fig. 1 illustrates more or less diagrammatically a number of crumpled sheets arranged one above another; Fig. 2 is a sectional view of a hollow wooden wall construction with the improved insulation arranged therein; Fig. 3 is a section of a longitudinal pipe insulation; Fig. 4 is a cross section of the structure shown in Fig. 3, and Fig. 5 shows the application of my invention to a bowed structure, for example, the roof of a railway carriage.

Fig. 1 is intended to convey the idea that the sheets are so crumpled as to have a small number of contacts with relatively large air spaces between the sheets. In Fig. 2, this type of insulation is shown in a hollow wooden wall or floor construction where the wooden facings *c* are carried by beams *d*; in the intermediate space the thin crumpled foil *a* is arranged. The individual layers of foil lie loosely one above and adjacent the other and the irregularities in the sheets form the means for keeping the sheets in spaced relation.

In Figs. 3 and 4 pipe *b* is shown insulated by means of sheets of foil arranged between the outer casing *f* and the outer surface of the pipe. The casing *f* is here illustrated as supported by means of the pins *g* which contact with the pipe but other suitable means may be employed for this purpose. In these figures it is to be noted that one of the sheets of foil is not crumpled but is used in the flat form and simply bent around the inner layers of crumpled foil, after which other layers of crumpled foil are applied. Obviously this same arrangement can be used on flat structures as shown in Fig. 2, in which case the intermediate sheet will remain flat.

Fig. 5 shows the manner in which my invention can be readily attached to a surface of irregular shape.

From these illustrative examples it will be seen that my invention is one which can readily be applied to a great variety of uses and can be installed with great ease and simplicity. While my structure is primarily intended for heat insulation it is also true that it has value as a sound insulation.

In the appended claims the word "crumpled" is used to cover the case where the foil is either distorted irregularly by hand or is given a regular, equivalent form by machine.

What I claim is:

1. A heat insulating body consisting essentially of a plurality of layers of heat conductive metal formed into crumpled sheets of a tissue paper-like thickness whereby transmission of heat along the sheet is reduced to a very small factor and having surfaces adapted to reflect heat, such layers contacting loosely with each other at spaced points to form a cellular body having air spaces of great average thickness relative to the thickness of the foil employed.

2. A metallic mass adapted to resist the transmission of heat consisting essentially of a plurality of sheets of thin metal foil so distorted from planular form that the sheets contact mutually to support each other but are held spaced apart for the greater part of their area to form relatively large air spaces between the sheets.

3. A heat insulating structure, comprising a substantially rigid casing and a filling for such casing, consisting essentially of a plurality of layers of very thin crumpled metal foil loosely supporting each other to hold the major proportion of the area of the sheets spaced apart to form cellular air spaces of great average thickness relative to the thickness of the metal employed.

4. In combination, a member to be insulated, a casing member spaced therefrom and a filling for the space between such members, consisting essentially of sheets of very thin crumpled metal foil lying loosely adjacent each other.

5. In combination, structural members forming an air space, an insulating mass in such air space comprising a plurality of layers of crumpled metal foil of tissue paper-like thickness positioned loosely adjacent each other so as mutually to support each other and to be supported by said structural members whereby a cellular structure is formed within the air space of great thickness relative to the thickness of the foil employed.

6. Structural members comprising frame members and facing members forming an air space and heat insulation for such space consisting essentially of very thin metal foil crumpled to contact with such structural members at spaced points whereby such foil will be supported by such members with relatively large air spaces on both sides of such foil.

7. An insulating structure comprising a filling consisting essentially of a plurality of layers of crumpled foil loosely contacting with and mutually supporting each other at spaced points to form air layers of substantial average thickness char-

acterized by the fact that such filling is made of metal so thin that it has substantially no structural strength and such that the filling can readily be compressed with the fingers to a thickness not over one hundredth of its original thickness, whereby transmission of heat by conduction is largely prevented, yet will remain substantially indefinitely in its desired form, and a casing for such filling adapted to hold the sheets against relative bodily movement and protect them from outside pressure.

8. The method of insulating structures which comprises the steps of loosely applying a plurality of layers of crumpled, very thin metallic foil against a member to be insulated so that the layers mutually support each other to maintain air spaces of great thickness relative to the thickness of the foil, and enclosing such layers of foil in a substantially rigid structure adapted to hold such layers of foil against relative bodily movement.

9. The method of heat insulating non-plane members which comprises the step of crumpling a sheet of very thin metal foil, shaping such sheet about the contour of the member to be insulated, loosely applying an additional sheet of said crumpled foil adjacent such first sheet whereby the sheets are mutually supported to form a cellular body, and enclosing such sheets in a substantially rigid structure.

10. Heat insulating means for preventing radiation, as well as conduction and convection of heat from an object, consisting of a plurality of sheets of bright aluminum foil surrounding the object but spaced therefrom and from each other, and a filling of crumpled foil in said spaces.

11. A structure comprising facing members and frame members forming air spaces, and thin sheet material with heat reflective metallic faces interposed in such spaces, such material being so distorted from plane form as to contact with the facing members at spaced points and thereby maintain air spaces of substantial thickness on both sides of such material.

12. In combination, facing members and frame members forming air spaces and a filling for such spaces consisting essentially of sheets of thin sheet material having heat reflective metallic faces distorted from plane form and disposed in such spaces so that the shape of the sheets holds them with substantial air spaces on both sides.

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