Dec. 11, 1934. A. A. LADON 1,983,617

THERMAL INSULATION MEDIA

Filed April 27, 1933

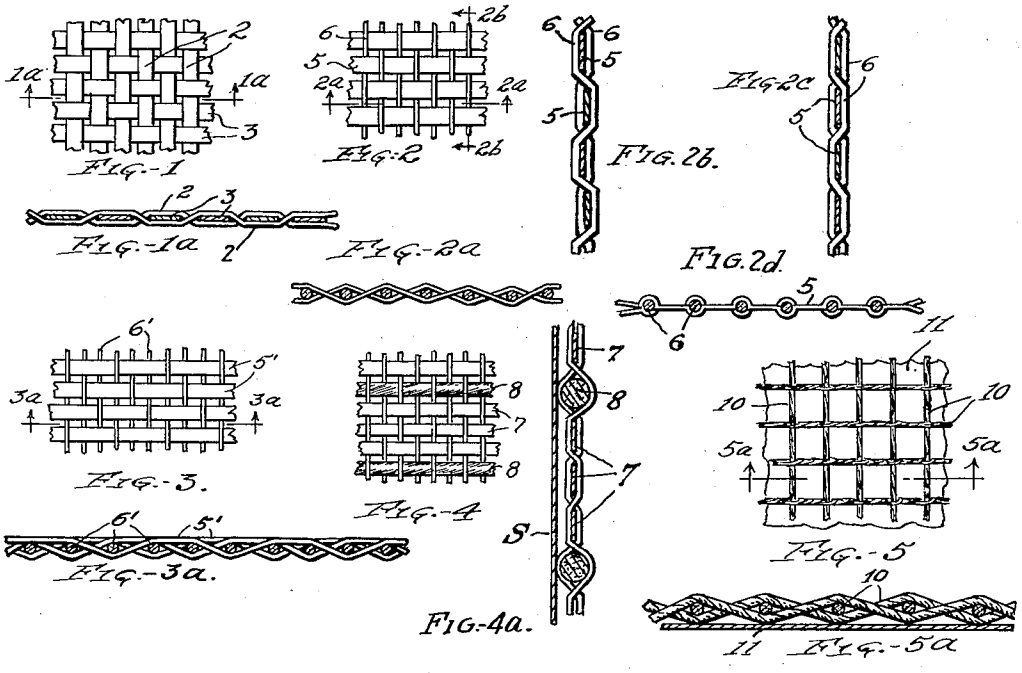

FIG.-1 FIG.-2 FIG.-2b. FIG.-2c FIG.-2d

FIG.-1a 2' FIG.-2a

FIG.-3. FIG.-4 FIG.-4a. FIG.-5

FIG.-3a. 11 FIG.-5a

FIG.-6 FIG.-7 FIG.-8

FIG.-9 FIG.-10

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Patented Dec. 11, 1934

1,983,617

UNITED STATES PATENT OFFICE

1,983,617

THERMAL INSULATION MEDIA

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Application April 27, 1933, Serial No. 668,191

14 Claims. (Cl. 154—45)

The principal object of this invention is to provide a new and highly efficient thermal insulation medium for general insulation purposes.

Another object is to provide a thermal insulation medium which will withstand considerable flexure without danger of becoming fractured or distorted, whereby such medium may be successfully used for many purposes such that most heat insulation materials due to relative rigidity or instability could not be successfully used.

A specific object is to provide a method and apparatus for reducing heat loss or transmission through glass windows in buildings, (dwellings, greenhouses, factories, offices etc.) and in general wherever glass is used to admit light and exclude weather or other elements.

A further object is to provide an efficient heat insulation medium which will permit the passage of a portion of the light rays therethrough and which will also be valuable as a light diffusing medium when used at glass openings in buildings, vehicle bodies and the like.

Still another object is to provide a heat insulation medium for insulating pipes, tubes, compartments, etc. which will be superior in adaptability and function to insulating media heretofore used for such purposes.

Other objects and the advantageous features of the invention will become apparent from the following description relating to the accompanying drawing showing the preferred forms for various uses.

While the invention relates to thermal insulation generally and the described embodiments may be employed wherever thermal insulation is a problem, one problem, the solution of which is of unusual current importance, is that of reducing heat loss at the usual glass window, skylights and the like; both for retaining heat in winter and preventing the entrance of heat in summer.

It is generally accepted that approximately 25% of the heat loss in connection with buildings is through glass windows and this is entirely apart from loss by leakage through the window frames. Reception of undesirable heat from outside when the problem is cooling is likewise seemingly out of proportion at the windows. A great deal of development has been concerned with the provision of insulation media to reduce such heat transmission and loss. Storm windows and adjustable blinds and shades are commonly known examples of this development.

The high heat reflective value and low emissivity of comparatively thin metal foil with a shiny surface has been known and used in solving many insulation problems but apparently no attempts have been made to use these properties of metallic foil or its equivalents in reducing heat loss at glass windows, etc. Metal foil is necessarily opaque and if used over the entire window surface it precludes the passage of both light and air. I propose to use flat or flattened metal wire, generally similar to metal foil but in fabric form with strands or ribbons of such bright metal running either in one direction only in a suitable fabric or in both directions, but so arranged that light and air may easily pass through the fabric. The provision of interstices through which light and air may pass is an optional feature and the arrangement thereof and proportional area of openings and closed spaces will be determined according to specific uses.

I have found that such flat metal-wire fabric or metal-fibrous fabric may be carried on rollers in the usual fashion of supporting window shades, porch curtains, etc. and such fabric used for relatively long periods without deterioration. It may also be supported in suitable frames, as window blind sections or made up into window curtains of more or less conventional type.

For shade or curtain material and for similar uses in the practice of this invention, I also propose to facilitate the transmission of light through the fabric by using suitable transparent strands (clear woof e. g.) say cellulose acetate or by rendering ordinary fibrous strands translucent where fibrous strands are used, say by treating such fibrous strands with oil or suitable stable liquid which will maintain the fibrous structure relatively translucent for a long period of time. The latter treatment may be effected before or after weaving.

A further feature is the provision of closed or substantially closed air pockets, which, in association with flat bright metal wire or its equivalents, compares favorably with the best heat insulation materials known. Examples of modifications of my invention to include air pockets will be hereinafter described.

In addition to flat bright metal wire strands or ribbons incorporated in fabric form in the usual fashion, I may also employ bright metal strips or ribbons wound spirally on strands or cords of other material; cotton or asbestos e. g. Such combined fibrous and metallic strands being woven into suitable fabric form.

The invention makes possible a great variety of decorative effects by weaving or coloring treatment generally followed in the textile arts.

One of the most extensive uses for metallic foil as an insulation medium has been for pipes and containers but heretofore considerable loss by conduction has been experienced, particularly where sheets or strips of foil are wrapped several times around the pipes, etc. to be insulated. Some reduction of this heat loss by conduction has been accomplished by using spacer sheets or strips of material of low heat conductivity between the successive layers of foil and by using short lengths of foil; but these expedients greatly increase the cost of application. I propose to insulate pipes, e. g. with combined flat metal wire e. g. and fibrous fabric, the flat wire e. g. strands being effectively separated from each other in the weaving process and heat loss being further prevented by the relationship of the flat wire e. g. to the object being insulated, viz: the metal strips lying lengthwise of the object being insulated, and the fibrous strips or strands spirally surrounding the object.

In addition to the above mentioned uses for buildings my invention may also be used in making insect screens, the flat wire e. g. strands being sufficiently open in weave to provide for the transmission of adequate light and also air for ventilation. I also propose to employ a plurality of spaced layers of such flat metal wire and fibrous strand fabric in a single screen to increase the heat insulation properties of the screen without materially decreasing air flow therethrough for ventilation.

The principles herein set forth may be applied effectively in the textile industry in the manufacture of many articles of use, examples being bed covers and various articles of clothing, for example as an inner lining in overcoats, hats, mittens, gloves etc.

In the building industry sheets and strips of the metal fabric or metal-fibrous fabric may be used successfully in the same manner that other heat insulation materials are used.

In the discussion of metal fabric and various forms thereof shown, it is to be borne in mind that the bright metal strands may be of any shape and size but preferably having rounded edges, as in the case of making the strands by rolling ordinary round wire to flatten it. Strips of metal foil may also be used, say from .005 mm. in thickness up to such proportions that insulation value is largely lost by increase in heat conductivity. Strips cut from a sheet of foil have a disadvantage in that the edges are sharp and have a tendency to cut fibrous strands when such are used in the fabric. Increase in thickness or size of strand is, from a practical standpoint, limited by the desired flexibility.

The combined metal-fibrous fabric hereof may be made by coating fibrous fabric or the strands composing it with metal as by known metal spray methods or electro or other deposition methods. In general aluminum is preferred and suitable treatment, such as buffing, used when necessary to effect a bright surface, or any metal or alloy which retains its high heat reflectivity and low emissivity qualities.

In the drawing:

Fig. 1 is a plan view of a small section of fabric material in which the strands running both ways are metal. Fig. 1*a* is a sectional view thereof.

Fig. 2 is a view similar to Fig. 1, wherein the fabric strand running in one direction is of fibrous material, preferably of low heat conductivity. Figs. 2*a* and 2*b* are sections one at right angles to the other as indicated on Fig. 2. Figs. 2*c* and 2*d* are sectional views showing a modification,—these sections corresponding in general to Figs. 2*a* and 2*b* respectively.

Fig. 3 shows a different arrangement of metal and fibrous strand whereby the metal surface is more exposed on one side of the fabric than on the other.

Fig. 4 shows a modification wherein one of the strands is much heavier than the adjacent strands whereby generally isolated air pockets are formed between whatever surface the fabric is applied to or against which it may rest, and the metal strand portions of the fabric. Fig. 4*a* is a cross section as indicated on Fig. 4.

Fig. 5 is a plan view of a section of composite insulation material using plain sheet foil and open fibrous fabric. Fig. 5*a* is a modification of the arrangement of Fig. 5.

Fig. 6 is a modification of the arrangement of Fig. 5.

Fig. 7 is a view similar to Fig. 5 showing an insulation medium particularly for transmitting considerable light but no air.

Fig. 8 is a diagrammatic illustration showing another manner in which flat metal wire and fibrous material may be combined in making metal threads for weaving fabrics suitable for my purpose.

(The above figures show the parts greatly enlarged).

Fig. 9 is a diagrammatic view showing the manner in which articles, particularly pipes or in general tubular articles, may be insulated by wrapping.

Fig. 10 is a perspective view of a window shade or curtain embodying the invention as a suitable example of one practical use to which the medium hereof may be put.

The element of the fabric that presents the surface of high reflectivity and low emissivity can be any metal, or alloy of metals, or composition of matter, that presents a surface of the properties mentioned. Generally speaking, the surface of such a material is smooth and bright. A material that, over long periods of time, remains with such a surface is preferable.

Aluminum is easily drawn and rolled, and maintains a bright surface of high reflectivity and low emissivity for considerable time. Alloys of aluminum with magnesium, or with other metals are satisfactory. The increase in strength of alloys of aluminum over commercial aluminum make them desirable. Any of the white metals can be used. Also, copper or alloys of copper can be used. The latter, if necessary, can be plated, or sheradized and polished, or otherwise finished to increase the properties desired in reflectivity and emissivity.—In the case of using metals which readily tarnish (silver and copper e. g.) the surfaces may be suitably treated to maintain a bright surface preferably by suitable application thereto of cellulose acetate lacquers, cellulose xanthate lacquers, though clear varnishes or lacquers may be used also. The acetate lacquers are preferred because of having less tendency to break down. The above discussion of metals and treatments thereof applies to all modifications herein shown or described.

Referring in detail to the drawing and first to Fig. 1, the fabric section illustrated, comprises interwoven strands 2 and 3 of flat bright metallic wire of foil.

In the form shown in Fig. 1 the fabric may be made to present the greatest metal surface

area. The fabric used alone or associated with other heat insulating materials functions as a heat insulator principally by reason of high heat reflective qualities of the shiny metal as above pointed out. Light or air for ventilation may be permitted to traverse the fabric by leaving interstices 4, in the weave. A modification of this (not illustrated) comprises making say the warp strands of round wire (aluminum e. g.) and the woof of bright metal (aluminum e. g.) flat wire.

In Fig. 2 the strands 5 are formed of flat wire strips preferably largely of aluminum, and the strands 6 are of fibrous nature and preferably of a material having low conductive properties such for example, as cotton, wool, flax, silk, etc. Asbestos may be used though its heat conductivity is relatively high. Attention is called to the section Fig. 2*a* in which the undulating character of the metal strands 5 is shown for enhancing the insulating effect by reflection of heat at many angles. Instead of the arrangements of Figs. 2, 2*a* and 2*b* the warp and woof strands may be as shown in Figs. 2*c* and 2*d* wherein the more undulating strands are of fibrous material and the less undulating strands are metal. This has a special advantage in that the fibrous strands project at both sides of the fabric beyond the bright exposed surfaces of the foil strands. When two such layers of fabric are placed against each other or when one layer rests on any surface or is in contact with any surface the metal strands of one section of fabric are effectively prevented from coming into contact with the metal strands of the adjacent section, or with surfaces such as just mentioned, and heat loss by conduction from one layer of fabric to the other or from the metal strands to any adjacent surface is effectively prevented.

The fibrous strands, may, of course, be colored as desired for design effects. Further treatment of the fibrous strands contemplated is rendering these strands translucent by the application of say linseed oil thereto either before or after the weaving operation.

When fireproofing qualities are desired for the finished product the fibrous strands may be chemically treated as by sodium tungstate e. g. as known in the textile arts. The metal is, of course, fireproof without special treatment. Further, if desired, the fibrous strands may be treated with aluminum stearate e. g. in a suitable carrier such as benzine or carbon tetrachloride to prevent or decrease absorption of water by the fabric.

It should be noted that in the arrangement of Figs. 2*c* and 2*d* a greater amount of shiny metallic surface is exposed by reason of the undulations of metallic strand, see Fig. 2*a*, and from the standpoint of thermal insulation by individual layers the Fig. 2 arrangement is more efficient because of reflecting heat in countless directions.

Referring to Figs. 3 and 3*a* it will be noted that the strands 5′ of metal continuously overlie a plurality of strands 6′ whereby on one surface of the fabric so formed greater metallic surface is exposed than on the other. In a curtain or window shade for example, this has a distinct advantage in preserving a cool interior of a building where the exposed side as viewed in Fig. 3 is positioned toward the glass because the metal surface exposed to direct light rays is surprisingly more effective than when hidden or partially concealed from such direct rays.

Referring to Figs. 4 and 4*a* it will be noted that there are several metallic strands 7 separated by heavier strands 8, preferably of suitable fibrous material and preferably parallel to the metal strands though they may be perpendicular thereto. For example, the strands 8 may comprise every tenth warp strand, the remaining warp strands being flat metallic wire e. g. The woof strands in this arrangement are preferably of fibrous material and relatively light, or the woof strands may also be flat metal wire e. g. When such section of fabric is supported against a surface such as S, Fig. 4, a definite air pocket is formed between adjacent strands 8, the surface S and the fabric structure intermediate the strands 8.

Referring to Figs. 5 and 5*a* these figures show a composite insulation material wherein foil is used but not woven with the fibrous material. Preferably this consists in providing a fairly open fabric of cotton, asbestos, etc. 10 to which is attached a suitable section or plurality of sections of foil 11. The foil may be secured to such fabric by any suitable glue or cement, preferably a mineral glue.

Again, the fabric may be treated to render the same fireproof or moisture-proof and when used in a curtain or shade the medium is most effective with the foil exposed toward the glass, particularly for summer use. This form is well adapted for use in layers, building up an insulation body of required thickness.

The open mesh fabric used with foil as described above not only strengthens the foil and prevents it from wrinkling or tearing or being otherwise damaged in application or use but is an extremely effective spacing means, particularly where several layers of foil are used. The open mesh fabric effectively separates the different layers of foil from each other, preventing heat loss by conductivity from one layer of foil to another, and sufficiently separates the intervening air into discommunicated pockets to minimize convection losses.

Several layers of foil and open mesh fabric may be assembled prior to installation or the desired thickness of insulation may be built up on the job by applying successive layers of foil and fabric to a wall e. g. to be insulated, attaching the layers to each other by suitable cement and finally applying any suitable coating, say paper, for decoration or as a support for other decorative coating.

Referring to Fig. 6, this shows the foil layer 11′ perforated as by a multiplicity of openings 11″ for the transmission of light or air therethrough. The foil may be backed by suitable open cloth fabric as indicated at 10 in broken lines.

Fig. 7 illustrates an arrangement suitable where considerable light transmission is desired but no air transmission through the web. This may comprise an open mesh flat bright metal weave which has been dipped e. g. into a solution such as cellulose acetate and the latter allowed to solidify in the interstices of the weave, as at 14. Sheet material such as "Cellophane" may instead be secured to the flat metal wire fabric. The Fig. 7 arrangement constitutes a very practical manner of reducing heat loss both by convection and by conduction (from one layer of foil body to another e. g.) because the transparent materials particularly in the case of treatment of the fabric by suitable solution such as mentioned above, coats and physically insulates the metal.

Fig. 8 illustrates that fibrous strands such as 12

may be covered by flat metal wire strips, preferably largely aluminum, as at 13 in the usual manner of making so-called "metal cord" and this combined metallic and fibrous strand woven into a fabric in any suitable fashion or in accordance with any portion of the preceding description.

In insulating objects such as pipes by wrapping the improved fabric around such objects it is preferable to have the metallic strands lie parallel to the object surrounded, whereby there will be less heat loss by conduction from one layer to another. Fabric may be applied in this fashion by wrapping the material in suitable lengths to build up the desired body directly around the pipe, that is to say, maintaining the strip in the same plane transversely of the pipe, or such object may be helically wrapped as indicated in Fig. 9. In the latter event the insulating fabric may be bias cut so that the metallic strands run diagonally of the strip of fabric but parallel to the pipe. For such insulation as indicated in Fig. 9 the arrangement of warp and woof strands is preferably either as indicated in Figs. 2*c* and 2*d* or as indicated in Figs. 4 and 4*a* for the formation of adequate air pockets and for maintaining the metal of adjacent layers definitely out of contact. Figs. 5 and 5*a* are also well adapted for such built up insulation body.

Referring to Fig. 10, this shows the fabric hereof incorporated in a roller type of window shade 15, the roller having the usual mounting at 16, and the shade being provided with a suitable re-inforcement at its lower edge as at 17. Such shade or any other article made as herein described may be laundered (including ironing) the same as ordinary fabric.

I have found that the fabric is not only very durable and will withstand fracture and buckling in a manner superior to ordinary shade or curtain materials and at the same time has the advantage of being heat insulating while transmitting and diffusing light coming from the window and transmitting air if desired. It should be mentioned that the closer the weave the more efficient the material is for retarding the flow of heat therethrough but then it also lets less light and air through. The specific uses should determine the density of weave as previously stated.

Used as insect screens (not shown) the material is preferably supported on suitable frames and more than one layer of fabric may be used suitably spaced apart to provide greater insulating effect particularly in insulating the building against sun ray heat in summer.

I have mentioned above that the uses for the fabric herein described includes bed covering. For this use the metal wire e. g. strands should run lengthwise of the cover because by this means heat loss by conduction is materially reduced in effect as compared to having the metal strands run crosswise. With the metal running lengthwise the heat of one portion of ones body is conducted to or past other portions of his body rather than entirely away therefrom.

I claim:

1. As a heat insulation medium, a woven fabric incorporating a sufficient percentage of relatively thin and flat permanently bright metallic strands to materially impede the passage of heat through the fabric.

2. As a heat insulation medium, woven fabric including strands of flat metal wire having a bright surface, either the warp or woof of the fabric being spaced to provide for the transmission of light and/or air therethrough.

3. As a heat insulation medium, woven fabric, comprising flat bright aluminum strands forming either the warp or the woof.

4. As a heat insulation medium, fabric comprising flat bright metallic strands forming both the warp and woof.

5. As a heat insulation medium, a woven fabric, comprising bright metallic strands forming either the warp or the woof, and comparatively heavy fibrous strands separating the metallic strands into groups and serving to increase the thickness of the fabric in the region of such heavier strands whereby, when the fabric is in contact with a surface to be insulated, air pockets will be formed between such surface and the metallic portion of the fabric and the metal will be maintained out of contact with such surface.

6. As a heat insulation medium, woven flat bright metallic strands, and a translucent imperforate web bridging the interstices of the weave and secured to the metal.

7. A thermal insulation medium comprising a woven fabric including substantially flat strands of non-tarnishing metal having a bright reflective surface, said metal being selected from the group containing aluminum, magnesium and respective alloys of said metals.

8. As a heat insulating medium, a woven fabric including bright metal strands maintained in undulating form by other strands of the fabric whereby said fabric when placed adjacent substantially any surface touches said surface at a plurality of spaced zones intermediate which the metal is spaced material distances from said surface.

9. As a heat insulating medium, a woven fabric comprising flat strands of a base metal, the surfaces of which strands are permanently bright and shiny metal.

10. The method of insulating a body against the passage of heat thereto or therefrom, comprising arranging a woven fabric including undulating strands of flat bright metal adjacent said body, whereby the bright metal surfaces are for the most part spaced from said body.

11. As an insulation medium, a woven fabric and means associated therewith to render one surface of the medium permanently bright and metallic, and openings through the medium for the transmission of light and/or air.

12. A heat insulating medium adapted to be placed against a surface to be insulated, said medium comprising woven fabric having incorporated therein a plurality of bright metallic strands in sufficient quantity to provide a heat reflecting surface on one face of the medium, and a plurality of non-metallic and substantially non-heat conductive elements operatively associated with said fabric on said heat reflecting surface thereof, said elements being in spaced relation to each other and adapted for engagement with the surface to be insulated whereby the heat reflecting surface of the fabric will be exposed toward the said surface to be insulated but in spaced relation thereto.

13. A heat insulating medium comprising a woven fabric including bright metallic strands, non-metallic strands woven into the fabric in spaced relationship to each other and exposed on the surface of the fabric, exposed portions of the non-metallic strands projecting outwardly beyond the plane of the metal strand portion of the fabric for the purposes described.

14. A heat insulating medium comprising a woven fabric including strands having a permanently bright metallic surface and other non-heat conductive strands also woven into the fabric and projecting above the plane of the bright metallic surface portion of the fabric, whereby when the fabric is placed against a surface to be insulated the non-heat conductive strands will maintain the bright metallic surface portions of the fabric in spaced relation to such surface to be insulated.

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