May 5, 1936. P. A. WICKMANN 2,039,372

INSULATOR

Filed Jan. 19, 1935

Fig. 1.

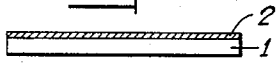


Fig. 2.

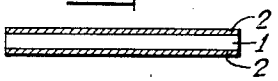


Fig. 3.

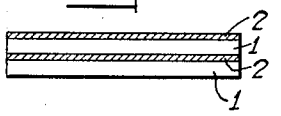


Fig. 4.

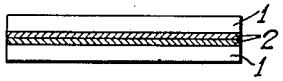


Fig. 5.

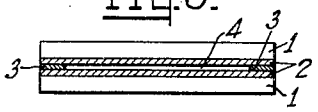


Fig. 6.

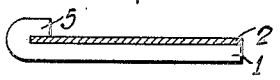


Fig. 7.

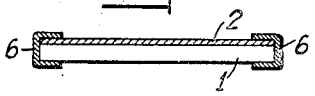


Fig. 8.

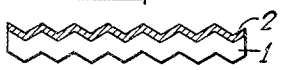


Fig. 9.

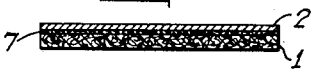


Fig. 10.

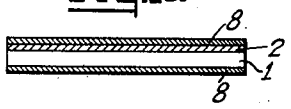
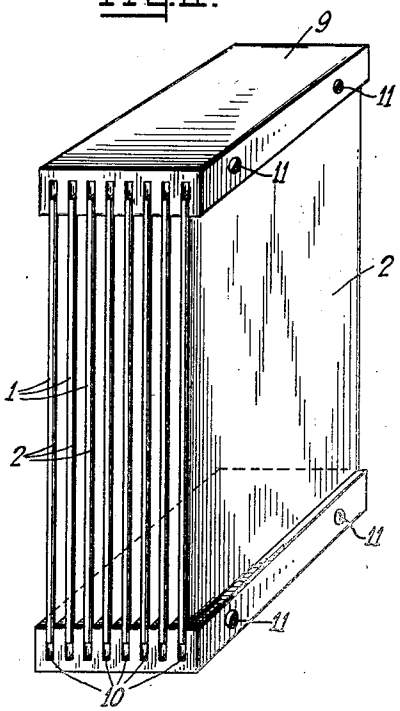


Fig. 11.



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UNITED STATES PATENT OFFICE

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INSULATOR

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Application January 19, 1935, Serial No. 2,543

10 Claims. (Cl. 154—44)

This invention relates in general to thermal insulators and, in particular, to an insulator against visible and infra-red radiation. The present application is a continuation-in-part of my application Serial No. 696,832 filed November 6, 1933.

The invention has for its general object the protection of various products, articles, containers and chambers against the effects of light and thermal radiation and against heat derived therefrom.

It is another object of the invention to provide, as an article of manufacture, an insulator against light and/or thermal radiation comprising an element having a low thermal conductivity and another element having a high reflectivity for light and thermal radiation.

It is a further specific object to provide an insulator against light and thermal radiation characterized by being thin, flexible, light in weight and economical to produce and having a metal reflecting surface which is capable of following the changes in dimensions of the base and which can be bent and flexed without cracking.

It is a specific object of the invention to provide fibrous insulating materials having a porous and rough surface with a non-porous and smooth surface and thereafter to deposit on the prepared surface an extremely thin coating of metal having a high reflectivity for light and thermal radiation.

A further specific object of the invention is to provide an insulating sheet which is moistureproof, greaseproof, air and light proof, and capable of being fashioned into containers or used as a wrapper for the protection of articles from the effects of changes in the atmospheric conditions surrounding them.

Other objects of the invention will in part be obvious and will in part appear hereinafter.

The invention accordingly comprises an article of manufacture possessing the features, properties and the relation of elements which will be exemplified in the article hereinafter described and the scope of the invention will be indicated in the claims.

According to the invention, an article having high reflectivity for light and thermal radiation and high insulation values is formed by depositing on one or both sides of a sheet of material having a low thermal conductivity, a multiplicity of fine particles of metal in the form of a layer having the appearance of a smooth, continuous coating and having a thickness of not substantially greater than .0002 of an inch. The deposit of metal employed in this invention is more properly described as a coating than as a metal film and distinguishes over the latter in being heterogeneous in structure and hence capable of following the expansion, contraction and wrinkling of the base without cracking or flaking off, and in being strongly adherent to the base without the use of an adhesive. In particular, the metal coating of the invention is especially adapted for water-swelling colloids such as regenerated cellulose, gelatine, casein, alkali-soluble cellulose ethers which bases are subject to changes in dimensions due to changes in the atmospheric conditions.

In its preferred embodiment, the backing consists of a flexible sheet of film of a non-fibrous organic plastic material such as regenerated cellulose, cellulose derivatives, gelatine, casein, or other synthetic or natural plastics, or a composite sheet formed, in whole or in part, of one or more of such materials.

The reflecting surface deposit may be formed of any suitable metal which is characterized by affording a substantial degree of reflectivity for thermal radiation, which has preferably a relatively low thermal conductivity and which is, in addition, capable of being deposited in the form of particles of atomic dimensions to give the appearance of a continuous coating having a smooth surface of high lustre. Suitable metals for the preparation of this coating include silver, gold, platinum, chromium, tin, and other heavy metals as well as alloys thereof.

By way of illustration, but not limiting the scope of the invention, the thin coating of metal may be deposited upon the backing material by cathode sputtering from suitable electrodes. For example, exceedingly thin coatings of silver and other metals may be deposited on the base material by cathode disintegration of heated metal electrodes having a thickness of from ⅓ to 3 times the length of the main free path, at working pressure, of the atoms formed by the disintegration of the cathode.

It is to be understood, however, that the present invention contemplates the use of thin layers of metal particles produced in any suitable manner such, for example, as by the deposition of metal from a solution, as by electrodeposition or chemical deposition, or by a cathode disintegration process other than that above disclosed. The coating of metal may be formed by evaporating a suitable metal and condensing the metal vapor on the surface of the base material. In all of these processes, the disintegrated metal, in the

form of particles of atomic dimensions, is deposited as a thin layer having a granular discontinuous structure, but giving the visible appearance of a continuous coating. The coating of metal has a preferred thickness of .0001 of an inch but may have a thickness up to .0002 of an inch.

For a more complete understanding of the nature and objects of the invention, reference should be had to the following detailed description taken in connection with the accompanying drawing, in which:

Fig. 1 is a sectional view of a simple modification of the novel insulator of the present invention comprising a single backing element and a single reflecting coating.

Fig. 2 is a sectional view of a further modification of the improved insulator comprising a single backing element carrying a reflecting coating on both sides.

Fig. 3 illustrates a sectional view of a modification of the novel insulator in which there is provided a plurality of backing elements and a plurality of reflecting coatings in alternate layers.

Fig. 4 illustrates a sectional view of a modification of the novel insulator which comprises a plurality of backing elements carrying reflecting coatings on opposing sides.

Fig. 5 illustrates a sectional view of a modification of the insulator of Fig. 4 in which an air film is provided between the opposing reflecting coatings.

Fig. 6 illustrates a sectional view of an embodiment of the present insulator in which the reflecting coating is provided with a hem.

Fig. 7 is a sectional view of an insulator of this invention provided with an edge-reinforcing element.

Fig. 8 is a sectional view of the insulator of Fig. 1 after it has been modified by embossing or the like.

Fig. 9 is a sectional view of an insulator in which the base sheet has been given a preliminary surface coating before the deposition of the metal coating.

Fig. 10 is a sectional view of an insulator which has been provided with a transparent coating over the base and the reflecting coating.

Fig. 11 is a view in perspective of an insulating unit comprising a plurality of sheets of the novel insulator of the invention.

Referring now to Fig. 1, the novel insulator of the present invention consists in a simple embodiment of a single flexible sheet 1 of backing material of the class described carrying on one surface a thin coating 2 of metal particles having a high reflectivity for light and/or thermal radiation and having a smooth surface of high lustre. Alternatively, as shown in Fig. 2, both surfaces of the backing 1 may carry a thin coating 2 of metal having a high reflectivity for thermal radiation. For some purposes a plurality of such insulator sheets may be used with advantage. In such cases, the metal coatings of the two adjacent insulator sheets may face in the same direction, as shown in Fig. 3, or the metal coatings may contact each other on opposing faces, as illustrated in Fig. 4.

Further, it has been found that the degree of insulation is materially increased by separating the adjacent sheets by an air film. The air film may be provided either when the metal coatings are facing in the same direction or when the metal coatings face each other. In Fig. 5 there is illustrated a simple embodiment of this modification of the invention in which two sheets of the same dimensions, each comprising a flexible sheet of non-metallic material 1 having a thin coating of metal 2 are united throughout areas adjacent the edges thereof by a layer of a suitable adhesive, the remaining areas of the opposing faces being free of adhesive so that an air film 4 is provided between them. It will be apparent that if one desires to increase the cross-sectional area of the air film a spacer strip 3 of some suitable material such, for example, as wood, metal or plastic, coated on both sides with a suitable adhesive, may be disposed between the sheets.

In certain applications of the novel insulator of this invention, as will be hereinafter further described, it is advisable to provide the insulator sheet with means to resist tearing at the edges. For instance, a suitable means of reinforcing the edges may comprise a hem 5 formed by folding over the edge of the material as shown in Fig. 6. In this modification of the invention, the metal coating need not be deposited over that portion of the material which is to comprise the hem. Or, as an alternative, an extraneous material, preferably of low thermal conductivity, in the form of a narrow strip or band 6 of paper, fabric and the like may be folded about and secured to the edges of the insulator sheet, as illustrated in Fig. 7.

In accordance with the practice which has been found desirable for certain purposes in insulation engineering, the insulator sheet may be given a plastic alteration of its surface such, for example, as by passing the sheet through a pair of embossing rollers to produce a sheet having surface irregularities, as illustrated in section in Fig. 8.

When the base of the insulator is a porous fibrous material, such, for example, as paper, fiber board, asbestos, felt, fabric, leather, the base is preferably first treated or coated with a suitable film-forming material or composition to impart to the base a non-porous, smooth intermediate surface coating 7 upon which the metal coating 2 is deposited, as shown in Fig. 9. Suitable intermediate coatings may be formed from synthetic or natural gums or resins, drying oils, varnishes, cellulose derivative lacquers, gelatine, casein and other film-forming substances. These substances may be applied to the base by coating it in a known manner with a solution of one or more of the coating materials in a suitable solvent. If desired, plasticizers, pigments, waxes, etc., may be added to the film-forming substance to impart flexibility, color, moisture resistance, etc., respectively.

The functions of the intermediate coating are, among others, to render the base non-porous and smooth so as to impart a corresponding smooth surface to the metal coating; to enable a continuous coating of metal to be produced with the minimum amount of metal thus effecting a saving in the coat of the insulator; to strengthen the backing; to prevent the formation of cracks in the metal coating when the base is bent or flexed; and to increase the adherence of the metal particles to the fibrous materials. It is to be understood, however, that non-fibrous base material may be given a preliminary coating if desired although a preliminary coating or an adhesive layer is not necessary to secure adherence of the metal particles to such material.

To protect the thin, fragile coating of metal

from damage by abrasion or from tarnishing by oxygen, sulphur or other agents, the metal coating may be covered with a thin over-coating 8, as shown in Fig. 10. The over-coating should be one which is free of ingredients having a tendency to discolor upon exposure to visible and infra-red radiation and it should be inert with respect to the underlying metal. A suitable material for this purpose comprises a transparent, preferably moistureproof, film-forming substance or composition such, for example, as a lacquer containing a cellulose derivative, a plasticizer and a wax; a varnish containing a synthetic or natural resin, a plasticizer and a wax; as well as compatible mixtures of chlorinated diphenyl, chlorinated rubber, polymerized vinyl compounds, with or without plasticizers, gums or resins, and waxes. A moistureproof overcoating on both sides of the insulator is especially advantageous where the base sheet 1 consists of a water-swelling colloid such as regenerated cellulose, gelatin, casein and alkali-soluble cellulose ethers, since the coating not only prevents the tarnishing of the metal deposit 2, but also prevents the distortion of the base with change in the atmospheric humidity.

In Fig. 11 there is illustrated one modification of a multi-ply insulator of the invention, in which the sheets of insulator are arranged in parallel and affixed at opposing ends by a clamping device 9 provided with slots 10 in which the edges of the sheet are embedded and a bolt or screw 11 by which the block may be compressed so as to hold the sheets within the slots. It is immaterial what exact form this unit may take but it is preferable to separate the insulator sheets by spaces of suitable dimensions so as to provide alternate layers of insulator and layers of air or gas. If such insulating units be incorporated within the walls of vehicles, a substantial insulation against thermal radiation is provided.

Further, for some purposes, it has been found advantageous to color the backing sheet with a substance capable of absorbing light transmitted by the metal coating. The insulator is thus rendered more or less opaque in the particular region of the spectrum absorbed by the article or in which region the metal film is more or less transparent. For example, a red dye may be used to render the backing substantially opaque to the blue region of the spectrum. Such an insulator material with a red backing would be advantageous for protecting foods, the skin, etc., from the effects of the more active blue light, for which light some metals, such for example as silver, are more or less transparent.

The novel insulator provided by this invention is especially applicable for use in protecting various objects, articles, containers and chambers against the effects of visible and infra-red radiation and against the heat derived therefrom. The applications of the novel insulator of the invention may be illustrated by the following examples.

The flexible insulating sheet herein provided may be employed as a wrapping material for fruits, dyed textiles, tobacco products, soft drinks, wines, champagnes and other materials, and objects which it is desired to protect against the effects of visible and infra-red radiation. The insulator sheet herein described may be employed as one member of a blank for boxes, cartons, bags, trunks (especially for the tropics), and other formed containers for preserving foods such, for example, as candy, butter, cheese, vegetables, and industrial products such, for example, as soap and the like. Further, it may be employed as an inner lining for hats, such, for example, as tropical helmets, and umbrellas for use on the beach, porch, garden, street, and for linings or partial linings for clothes, dresses; for window protection, in the form of shades, awnings, curtains; book covers, lamp shades, fire screens and other objects or articles which it is desired to insulate against thermal radiation.

The novel article of this invention may be employed as an insulator for thermos or Dewar flasks of the double-wall types. In such installations, it is preferably incorporated intermediate the double walls of the container.

It has long been desired to insulate chambers in refrigerators and in vehicles, such, for example, as automobiles, railroad cars, airplanes, ship's cabins, etc., against the heat derived from exposure to the sun and from motors, burners, etc. The insulator of this invention is particularly adapted for use as an insulating medium for such vehicles.

When the article of this invention is used for insulating moving vehicles, it will be found that regenerated cellulose is admirably suitable for use as the flexible sheet of non-metallic material forming the backing, as such material has a high tensile strength and tends to shrink when heated, so that the sheets will remain taut within the frame or support. In view thereof, there is little danger of adjacent sheets crumpling and contacting each other as is the case with the unbacked metal foils heretofore used as insulators for vehicles.

It is observed that the present invention provides a novel and useful insulator having many advantages over prior insulating materials. The backing element of the present insulator is characterized by having a relatively low thermal conductivity. This property decreases the quantity of heat transmitted under given conditions as compared to a self-sustaining metal foil. The other member of the novel combination consists of a metal coating characterized by extreme thinness and a smooth surface having a high lustre. This latter characteristic results in the coating being an excellent reflector of visible and infra-red radiation.

While the present invention has been described with some degree of exactness and detail, it is to be understood that the invention is not limited to such detail, but inasmuch as certain changes may be made in the above article and different embodiments of the invention could be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

Having described my invention, what I claim as new and desire to secure by Letters Patent is:

1. As an article of manufacture, an insulator against light and thermal radiation comprising a sheet formed of a non-fibrous, organic, plastic material and having on its surface a multiplicity of particles of metal of atomic dimensions deposited in a layer having a granular structure, but giving the visible appearance of a continuous, lustrous coating, said layer of metal particles having the property of following the expansion, contraction and wrinkling of the sheet material without cracking or flaking off.

2. As an article of manufacture, an insulator against light and thermal radiation comprising a

sheet formed of a non-fibrous, organic, plastic material swelling in water and having on its surface a multiplicity of particles of metal of atomic dimensions deposited in a layer having a granular structure, but giving the visible appearance of a continuous, lustrous coating, said layer of metal particles having the property of following the expansion, contraction and wrinkling of the sheet material without cracking or flaking off.

3. As an article of manufacture, an insulator against light and thermal radiation comprising a sheet formed of a non-fibrous, cellulosic material and having on its surface a multiplicity of particles of metal of atomic dimensions deposited in a layer having a granular structure, but giving the visible appearance of a continuous, lustrous coating, said layer of metal particles having the property of following the expansion, contraction and wrinkling of the sheet material without cracking or flaking off.

4. As an article of manufacture, an insulator against light and thermal radiation comprising a sheet formed of regenerated cellulose and having on its surface a multiplicity of particles of metal of atomic dimensions deposited in a layer having a granular structure, but giving the visible appearance of a continuous, lustrous coating, said layer of metal particles having the property of following the expansion, contraction and wrinkling of the sheet material without cracking or flaking off.

5. As an article of manufacture, an insulator against light and thermal radiation comprising a sheet formed of a non-fibrous, organic, plastic material swelling in water and having on its surface a multiplicity of particles of metal of atomic dimensions deposited in a layer having a granular structure, but giving the visible appearance of a continuous, lustrous coating, said layer of metal particles having the property of following the expansion, contraction and wrinkling of the sheet material without cracking or flaking off, said metallized sheet having a coating of a moistureproof, transparent composition.

6. As an article of manufacture, an insulator against light and thermal radiation comprising a sheet formed of regenerated cellulose and having on its surface a multiplicity of particles of metal of atomic dimensions deposited in a layer having a granular structure but giving the visible appearance of a continuous lustrous coating, said layer of metal particles having the property of following the expansion, contraction and wrinkling of the sheet material without cracking or flaking off, said metallized sheet having a coating on both sides of a moistureproof transparent composition.

7. As an article of manufacture, an insulator against light and thermal radiation comprising a sheet formed of a non-fibrous, organic plastic material and having on its surface a multiplicity of particles of metal of atomic dimensions deposited in a layer having a thickness of not substantially greater than .0002 of an inch and having a granular structure but giving the visible appearance of a continuous lustrous coating, said layer of metal particles having the property of following the expansion, contraction and wrinkling of the sheet material without cracking or flaking off.

8. As an article of manufacture, an insulator against light and thermal radiation comprising a sheet formed of a non-fibrous, organic plastic material and having on its suruface a multiplicity of particles of metal of atomic dimensions deposited in a layer having a granular structure but giving the visible appearance of a continuous lustrous coating, said layer of metal particles having the property of following the expansion, contraction and wrinkling of the sheet material without cracking or flaking off, said sheet material being colored with a substance capable of absorbing light transmitted by the layer of metal particles.

9. As an article of manufacture, an insulator against light and thermal radiation comprising a sheet formed of regenerated cellulose and having on its surface a multiplicity of particles of silver of atomic dimensions deposited in a layer having a granular structure but giving the visible appearance of a continuous lustrous coating, said layer of metal particles having the property of following the expansion, contraction and wrinkling of the sheet material without cracking or flaking off.

10. As an article of manufacture, an insulator against light and thermal radiation comprising a plurality of superimposed transparent sheets formed of an non-fibrous, organic plastic material, at least one of said sheets having on an enclosed surface a multiplicity of particles of metal of atomic dimensions deposited in a layer having a granular structure but giving the visible appearance of a continuous lustrous coating, said layer of metal particles having the property of following the expansion, contraction and wrinkling of the sheet material without cracking or flaking off.

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