April 24, 1934. J. L. GREGG 1,956,323

INSULATING UNIT

Filed Feb. 9, 1931 2 Sheets-Sheet 1

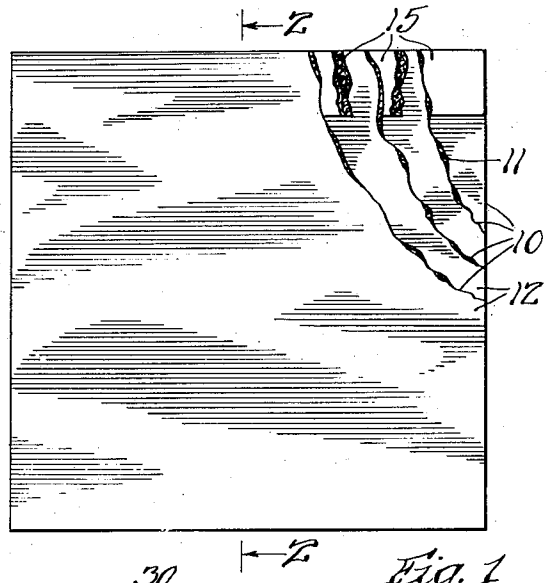


Fig. 1

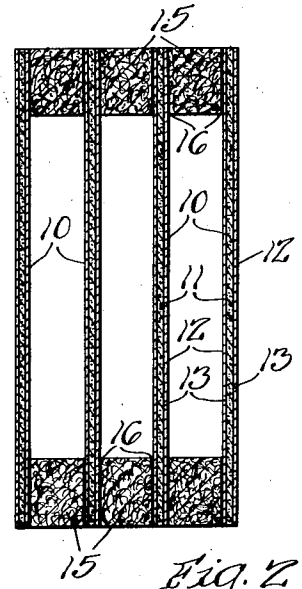


Fig. 2

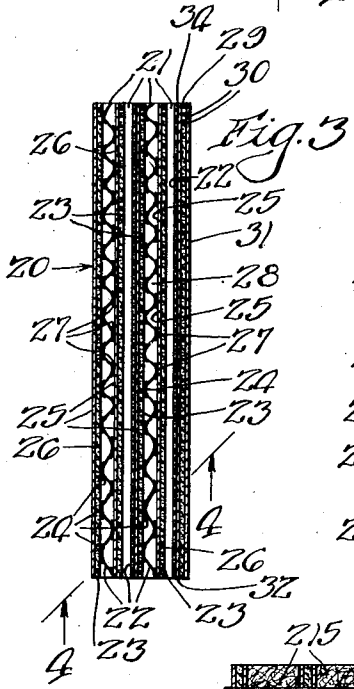


Fig. 3

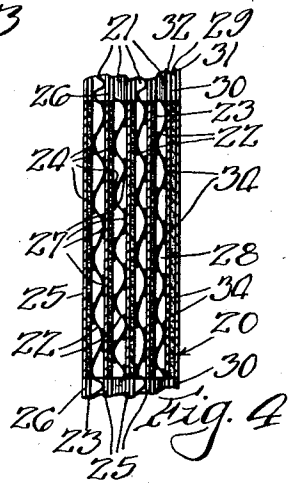


Fig. 4

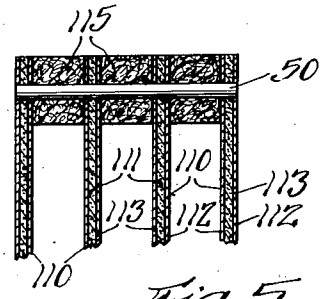


Fig. 5

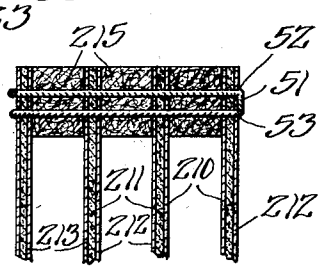


Fig. 6

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INSULATING UNIT

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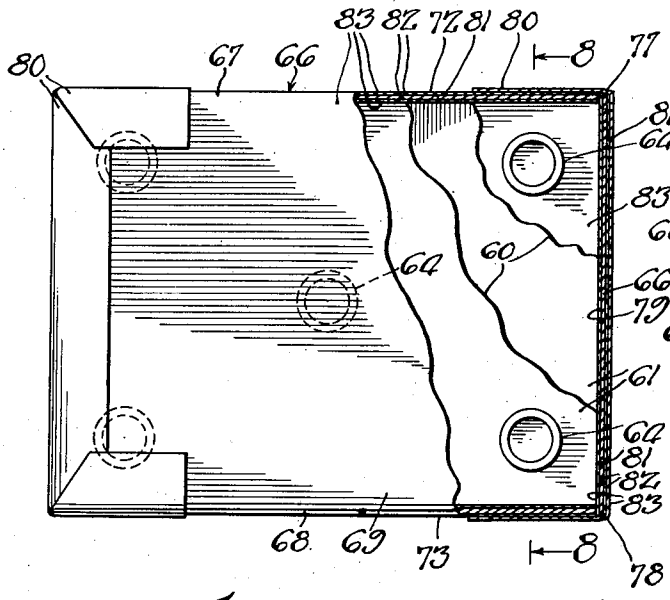


Fig. 7

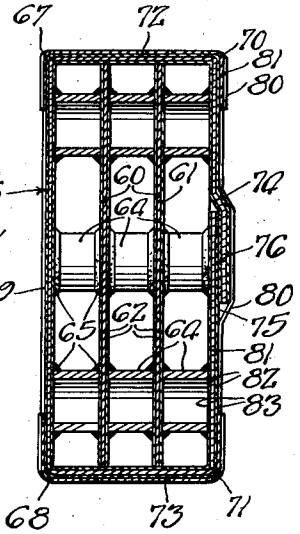


Fig. 8

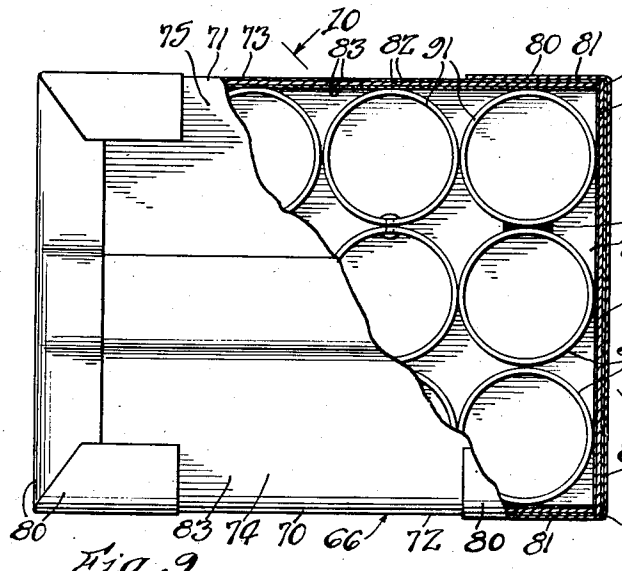


Fig. 9

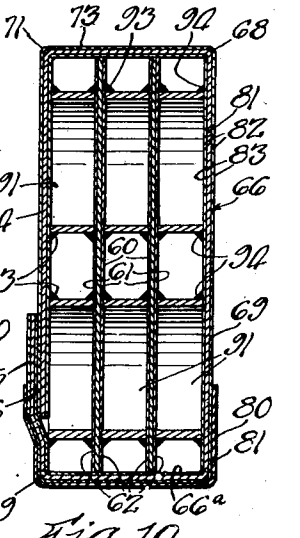


Fig. 10

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Patented Apr. 24, 1934 1,956,323

UNITED STATES PATENT OFFICE

1,956,323

INSULATING UNIT

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Application February 9, 1931, Serial No. 514,516

1 Claim. (Cl. 154—45)

The present invention has to do with an insulation from heat and from cold, and relates particularly to an insulation material which takes full advantage of the radiation of bright metal surfaces.

A series of investigations, experiments, and researches has led to the discovery that highly polished metallic surfaces are particularly suited for heat insulating purposes, provided such surfaces may be properly and correctly associated one with another and with a material which aids in taking advantage of their natural properties.

The present invention is confined generally to the proposition that bright metallic surfaces are splendid insulating means, and relates to a means for employing such surfaces in such a manner that their entire efficiency may be utilized to commercial advantage.

The objects of the present invention, among others, therefore, include the following:

A new and improved form of insulation embodying as a part thereof highly polished metallic surfaces;

Improved means for employing highly polished metals for insulation;

An unique unit for insulation;

An improved combination of bright metallic sheets in insulating units; and

A new and improved structure for an insulating unit.

These objects and such other objects as may hereinafter appear, are obtained by the novel construction, unique arrangement, and improved combination of the several elements described in the specification and illustrated in the accompanying several sheets of drawings, hereby made a part of such specification, and in which a number of forms of the invention are illustrated.

Figure 1 in said drawings is a plan view of an insulating structure embodying the invention, parts of the structure being broken away to illustrate the details thereof;

Figure 2 is a section on the line 2—2 of Figure 1, looking in the direction of the arrows;

Figure 3 is a longitudinal section through a second form of the invention;

Figure 4 is a section on the line 4—4 of Figure 3 looking in the direction of the arrows;

Figure 5 is a transverse section of an insulating structure similar to that shown in Figures 1 and 2, but in which the parts are held together in a different manner;

Figure 6 is a similar view of another type of unit similar to that illustrated in Figures 1 and 2, in which the elements are fastened by the use of cords;

Figure 7 is a plan view of a different type of unit employing tubes of small diameter for spacers, parts being broken away to show details;

Figure 8 is a section of the form of the invention illustrated in and on the line 8—8 of Figure 7;

Figure 9 is a plan view, partly in section illustrating a second type of unit reinforced by tubes, the tubes being larger than those shown in Figures 7 and 8; and

Figure 10 is a section taken on the line 10—10 of Figure 9.

Like reference characters are used to designate similar parts in the drawings and in the description of the invention hereinafter given.

Experiments disclose that the thickness of a metal sheet possesses but slight relation to its capacity to radiate heat. A thin sheet of metal with polished faces is substantially as efficient for radiation as a thicker sheet of the same material. In order to reduce the weight and the cost of metallic material used in an insulation unit, it has been found desirable to employ very thin sheets of highly polished material. Obviously, the cost of production of the unit is materially reduced by employing sheets of so-called foil thickness for the amount of metal required is lessened, and the weight of the unit is conjointly reduced, making the unit more flexible to manufacture and more readily handled.

Very thin sheets of metal are additionally advantageous in the present invention because readily manipulated and because the capacity of a unit made therewith to hold heat is very low.

An ideal structure for insulation purposes depending on high reflectivity for effectiveness would be of very thin metallic sheets having a low capacity for heat and spaced selected predetermined distances apart whereby the atmosphere at one side of such sheets will be separated from the object to be insulated. To suspend such sheets in a permanent spaced relationship to one another in any commercially practicable structure, whether it be an ice box, a wall of a house, or another item, is a physical impossibility without support for at least a part of the individual metal sheets. Structure, therefore, must be added to the spaced apart and very thin foil sheets for the purpose of strengthening them for commercial use. Between such reinforced sheets, also, there must be spacers to admit of an arrangement of sheets in a man-

ner whereby the reflectivity of the polished surfaces thereof may be adequately availed.

The present invention approaches the ideal just described as nearly as it is possible. It provides an improved means for suspending a plurality of polished metal sheets so that their ability to reflect heat rather than conduct it will be accentuated to a maximum degree.

In Figures 1 and 2, one of the forms which the invention may take is illustrated. This particular form of the invention includes a plurality of laminations with spacers therebetween.

Each of the laminations is indicated by the numeral 10. Each lamination comprises a sheet member or core 11 of a material which is heat resisting or non-conducting in nature or which of itself has capacity for storing but little heat. At each side of the core 11 or on one side only, as preferred, is a very thin metallic sheet 12. Each flat surface of the sheet 12 is highly polished. Suitable adhesive 13 is disposed intermediate the insulation core 11 and the contiguous surface of the highly polished metallic sheet 12.

Each lamination 12, therefore, comprises an insulating core of selected strength, covered at one side or both sides with a very thin and generally fragile but highly polished sheet of metal, the metal being adhesively secured to the supporting core by a glue or by other material or means.

From a lamination of the character described arranged in a selected order or with predetermined spacing, insulating units may be constructed. The form of unit shown in Figures 1 and 2 includes a plurality of laminations 10 spaced apart by an insulating bar or member 15. Member 15 is preferably of a material which does not readily conduct heat and which possesses little capacity for heat. Such material is preferably light in weight, inexpensive and quite easily manipulated. It may be relatively porous. Its base may be wood pulp or fibers of a similar nature.

By the employment of an adhesive layer 16 at opposite sides of a member 15, and spacing a plurality of such members 15 predetermined distances apart, contiguous laminations 10 may be secured in a permanent relation. The space intermediate adjacent laminations 10 may be but a fraction of an inch or more, but members 15 are disposed as far apart as the requirements of structural strength will permit.

A unit of insulating material of the form shown in Figures 1 and 2 comprises a plurality of spaced apart laminations 10, such as have been heretofore described, having at intervals spacing elements 15 of a non-conducting material. The spacing elements 15 maintain adjacent foil sheets a selected distance apart, the distance being one which does not interfere with the high efficiency of the foil sheets facing one another for reflecting heat. At the same time, the spacers 15 are efficient for preventing the transmission of heat from one foil sheet 12 to another foil sheet 12 by conduction. The distance between contiguous foil sheets 12 which has been found to be efficient is less than one inch. Much less space or three-fourths inch between sheets has been found useful. The distance between sheets, above one-fourth inch, is by no means critical.

An insulation unit of the type shown in Figures 1 and 2 may be considered as consisting of air layers bounded by bright metallic surfaces, because the laminations 10 are thin as compared to the thickness of the air layers, and the volume occupied by the spacers 15 is small as compared with the volume of the air layers. Heat may be considered as conveyed through such air layers in three different manners, i. e., (1) conduction, (2) convection, and (3) radiation.

The conduction through such layers is analogous to the conduction of heat in a solid body, in which the quantity of heat transferred is a linear function of the temperature gradient and is considerably less than the amount of heat transferred in the best solid insulators with the same temperature gradient.

The transfer of heat by convection represents an actual movement of the warm air from the hot side to the cold side. As the thickness of the air layer is decreased to about one half inch, the quantity of heat transferred by convection becomes very small. In the insulating units of the form described, the metallic sheets are spaced sufficiently close together to prevent any large transfer of heat by convection.

The transfer of heat by radiation is dependent only on the difference of the fourth powers of the absolute temperatures of the walls and on the nature of the walls. If the walls consist of organic materials or unpolished metal, the transfer of heat by radiation is large, while if one or both walls are composed of bright metal, the transfer of heat by radiation is quite small.

In a unit of the type described the heat transfer by radiation is made small both by the use of polished metal bounding one or both sides of the air layers, and by using thin air layers in which the temperature drop across each air layer is small compared with the temperature drop across the entire unit, and the quantity transferred by convection is made small by forming air layers sufficiently thin. The amount of heat transferred is therefore only slightly greater than would be transferred by true conduction in air with the same temperature gradient.

Some heat, of course, will be conducted by the spacer elements 15. Due to the small volume occupied by these spacers, however, the quantity of heat transmitted by them will be comparatively small. These spacers may be oriented so that those in adjacent layers are at ninety degrees to one another or they may be placed one above the other, depending on the rigidity required and the economics of manufacture. No stiffer or heavier backing for the metallic sheets 12 than is necessary for their preservation and to give them definite shape is employed, and no larger or more closely arranged spacing elements are had than is necessary to obtain the structural strength required for the purpose in view.

A second form which the invention may take is illustrated in Figures 3 and 4.

In said form of the invention, a cheaper unit is provided than that illustrated in Figures 1 and 2. Unit 20 comprises a plurality of laminations, one lamination comprising an external wall of the unit differing from the remaining laminations forming the body of such unit. The principal laminations employed include a sheet 21 having corrugations 22 in parallelism thereon. A sheet 23 is adhesively secured to the humps of the corrugations on one side of the laminated sheet 21 to hold the said sheet against distortion normal to the direction of the corrugations, thus expanding the corrugations 22. Such sheet 23 may be secured to sheet 21 by adhesive 24.

Upon said sheet 23, there is mounted a thin sheet of foil 25 secured thereto by adhesive 26.

A series of laminations 21 are arranged normal to one another, in alternation, so that the corrugations 22 in one lamination 21 run in a direction opposite to the corrugations 22 in the next adjacent lamination 21.

A unit structure comprises a predetermined number of laminations 21 secured one to another by adhesive 27 intermediate the polished surface on one side of foil sheet 25 and the corrugations 22 at the open side 28 of the adjacent laminated sheet 21.

One side of the structure, therefore, comprises a thin sheet of foil 25 having a thin backing 23 which backing is secured to a sheet 21. At the other side of the unit 20, it is customary to provide a laminated plane structure of a thin sheet of non-conducting material forming a core 29 upon each side of which is an adhesive 30. To such adhesive, there is applied a thin outer foil sheet 31 and a thin inner foil sheet 32. The foil sheet 32 is adhesively applied, by asphaltum or other suitable adhesive 34, to the open side 28 of lamination 21. Thus, when a plurality of laminations 21 and the external sheet comprising sheets 29, 31 and 32, are adhesively secured one to another, a unit is formed possessing external highly polished surfaces with metallic reflecting surfaces intermediate contiguous spacing elements.

By the arrangement shown, heat in passing from one side of the unit to the other side must pass either through the fibers of the corrugated materials or through the air spaces, some of which air spaces are bounded on one side by a bright metal. The resistance to heat transfer by the unit is large because the material forming the corrugated strips is a poor conductor of heat, and the air layers bounded on one side by a bright metallic surface are even poorer conductors of heat.

The plane sheet (29, 31 and 32) may be at the outside or inside of a unit. The reflecting surfaces thereon behave in exactly the same manner as the other reflecting surfaces heretofore described. The core material 29 intermediate the external and internal foil sheets 31 and 32 upon such plane member is of a character which does not readily conduct heat but which possesses strength.

In order to preserve the various laminations 21 with polished metal sheets thereon against deterioration of the metal from moisture of air, it is entirely practicable to seal up the ends and sides of any unit which is made from such laminations 21. Sealing may be accomplished with a reinforced metal foil sheet or in any other suitable manner as with a flexible sheet of nonconducting material. By so doing, the possibility of moisture penetrating the unit and oxidizing the polished surfaces of the metal therewithin is avoided. Sealing of the ends may be had in any other form of the invention.

In Figure 5, in which the numerals employed as reference characters correspond with the numerals employed for similar purposes in Figures 1 and 2, except that 100 is added thereto, the adhesive used in the first described form of the invention is displaced by a mechanical fastening means securing the sheets or lamellæ and the separators in an assembled relation. The fastening means illustrated in the present instance comprises skewers 50, either of wood or other suitable material, and which are adapted to penetrate selected sheets and separators and terminate flush with an external lamella. Any suitable means may be employed to secure such skewers 50 in position and against displacement. A unit made with skewers lends itself to ready production by machinery.

In Figure 6, another form of the invention in which the several parts are also held together by a mechanical means is illustrated. The various parts are designated in said figure by the same reference characters employed in Figures 1 and 2, save that 200 has been added thereto. In place of adhesive, there may be used a plurality of cords 51 which pass through apertures 52 and 53 arranged or formed in the lamellæ and separators, respectively, the cords 51 being attached in a manner resembling sewing. Said cords 51 are used to draw the separators and lamellæ into an assembled relation, sufficient drawing force being applied to the ends 51 to secure a firm unit. Any suitable means may be selected to reinforcedly secure the cords in assembled position but ordinarily the friction of the cord in the apertures 52 and 53 is sufficient for all purposes.

In either of the forms of the invention shown in Figures 5 and 6 of the drawings, adhesive may be omitted entirely or adhesive may be employed in association with the skewers or cord fastening members.

In Figures 7 and 8, a unit particularly adapted for use in refrigerator insulation is disclosed. Such unit is intended to be employed intermediate the external and the internal walls of a refrigerator and hence, the unit is protected by such walls. It is not subject to ready damage or to great stresses.

Each unit comprises an enclosing member, and a plurality of spaced insulators therein. As shown, each spaced insulator comprises a very thin sheet 60 of relatively stiff material of low heat conductivity. Each of sheets 60 has applied thereto a thin layer of highly polished metallic foil 61, such foil 61 being secured by adhesive 62 to sheets 60 as heretofore described in respect to other forms of the invention. To space the sheets 60 one from another, tubular spacing elements 64 are employed. These spacers comprise a material of low heat conductivity. The spacers 64 are secured to the foil facing sheet by pitch or the like 65. There may be as many layers of insulators as a particular undertaking or specification requires.

About a selected number of sheets 60, and spaced therefrom by identical ring spacing elements 64 which spacers may be of formica or other material of low heat conductivity, is an enclosing sheet or member 66 which is articulated to provide two additional insulating layers, side enclosing members, and end enclosing portions.

Said enclosing member 66 comprises a main body articulated at 67 and 68. The section 69 defined by articulations 67 and 68 provides one side of the insulating unit. Spacers 64 are disposed between the contiguous sheet 60 and section 69.

Said sheet 66 is further scored at 70 and 71 and the material at the side of the scores 70 and 71 is articulated at a ninety degree angle. Between scores 67 and 70, and 68 and 71, side members 72 and 73 for the unit are formed. Sides 72 and 73 are parallel, and are spaced away from the spacer elements 64 heretofore described.

The remaining sections 74 and 75 at the other side of scores 70 and 71 extend toward one another and are of a length permitting overlap. The overlapping portions are attached one to another by a suitable adhesive 76, the portion of the casing formed by sections 74 and 75 being

spaced away from the contiguous sheet insulator 60 by the same type of ring insulators 64 secured in position by pitch 65. The spacing elements 64 may be arranged in alignment, as shown, or in such other position as may be desired. They may be arranged in a staggered position when desired. Arrangement is a matter of choice.

An extension 66*a* of the sheet 69 and at each end thereof is articulated into a position to close the open ends of the unit. The edge 77 of the extension engages the end of section 72; the edge 78 of extension 66*a* engages the side 73 of the sheet 66*a*; and the edge 79 of said extension engages the overlapping sections 74 and 75.

When the extension 76 is articulated to a ninety degree angle, it is secured in position by the application of a thin sheet of foil 80 which is provided with adhesive 81. Such sheet 80 is placed in position by the folding of the foil material thereof in any manner that a relatively smooth end closure may be had, there being thus provided several thicknesses of such material over limited areas of the unit end.

The sheet 66 which is the external wall of the unit should be very tough, quite thin, and non-conducting. On each side of a core 81 therein and secured thereto by adhesive 82 is a sheet of highly polished foil 83, the addition of which metal sheets does not prevent of the sheet 66 from being readily articulated.

By the structure and arrangement therein described, a completely enclosed unit of highly polished foil walls is produced. The whole of the external and internal surfaces are of highly polished metal. A plurality of insulating spacing elements, separated a predetermined distance, comprises the internal structure of the unit. The separators 64 are cylinders of material of low heat conductivity. There is sealed within the cylinder several layers of air. The structure provides what is believed to be a highly efficient skeleton structure possessing great strength. The behavior of the unit illustrated in Figures 7 and 8, in respect to the conductivity and reflectivity of heat, is exactly the same as the behavior of the previously described forms of the invention. A difference between such form and the previously illustrated forms resides in the complete inclosure of the unit into a metal-coated container of predetermined shape suitable to be used between the walls of a refrigerator and otherwise.

Another form which the invention may take is illustrated in Figures 9 and 10 of the drawings. In such form of the invention, the flat sheets 60 comprise the internal structure of insulatory members, the foil being marked 61, and the adhesive 62 as heretofore. Sheets 60 normally are of the flat type rather than the corrugated, although the corrugated type of sheets could be substituted therefor.

The separators in the form shown in Figures 9 and 10, instead of comprising strips, blocks of material, or small tubes, are short sections of relatively large tubes and in which the diameter may be many times the height of the separator. Such tubes 91 may be arranged so that there may be peripheral contact, or they may be spaced to avoid such contact as preferred. When the tubes 91 are in physical contact one with another at their peripheries, adhesive 92 may be applied thereto for the purpose of securing them in a fixed position. There can be a mechanical fastening means therebetween, if preferred.

The tops and bottoms of the tubes are generally adhesively secured, as at 93 and 94, to the adjacent polished foil sheets 61.

The structure illustrated in Figures 9 and 10, and in which the ring separators are of a material having a low coefficient for heat conduction, will be very strong in view of the well-known value of tubular reinforcing members of large diameter but of slight height. Great resistance to compression or flattening, which apparently is the most frequently met difficulty, will be had in insulating units of the character illustrated in said Figures 9 and 10. The use of large rings facilitates rapid fabrication, and for general purposes, it is believed that a structure of the type illustrated in Figures 9 and 10 will have wide usage over a large field of industry.

Certainly, in the assembly of the units last mentioned, particularly where the ring members are to be in peripheral contact, there may be a rapid assembly of parts because accurate positioning of the separators will be possible because of their size, and because they are maintained in physical contact one with another during and after assembly.

Whenever adhesive is employed in any form of the invention, a relatively small quantity should be used. The adhesive, because sparingly used, does not materially increase the heat capacity of the unit.

It has been found practicable to employ aluminum for the thin metallic sheets in each of the structures described. Aluminum does not lose its brilliance from the formation of a slight coating of oxide thereon. Such coating of oxide is relatively slow to form, and once formed protects the sheet against further deterioration. The effectiveness of aluminum to reflect is but slightly reduced as a result of an oxide forming over a polished surface thereof. Additionally, aluminum is light, is inexpensive, takes a high polish, is capable of being rolled into very thin sheets, and possesses a small radiation coefficient and high reflectivity.

Units may take other forms than those illustrated. The principle of the invention is to provide support and protection for highly polished metallic surfaces spaced apart to separate space into sections that will transmit little heat, the spacers holding the sheets apart, being as far apart as the necessity for strength will permit. Such spacers of themselves should be substantially incapable of conducting heat, and of as small a weight as is compatible with the required rigidity. Many other units may be constructed to embody such inventive idea.

Advantage is taken in the present invention of the virtue of bright metallic surfaces to reflect heat rather than to radiate heat. Bright metallic surfaces owe their efficiency in such units to high reflectivity and low radiation. Stated differently, bright metallic surfaces emit relatively little energy in the form of radiation, and absorb relatively little radiant energy.

I claim:

An insulating pad or unit suitable for use with a plurality of similar units in an edge to edge relation to provide an insulating wall and comprising sheets of foil coextensive with the length and width of the unit and having polished faces, reinforcing sheets of a light and relatively thin material of low heat conductivity of the same area as said foil sheets and having a foil sheet adhesively secured to each face thereof, open ended spacing members each having a relatively thin continuous wall of light material of low

heat conductivity, each of said spacing members having its ends in parallel planes, the transverse dimension of said spacing element being greater than its depth and the thickness of the wall thereof being a small fraction of its depth, there being a plurality of said spacing members at predetermined intervals removed from the edges of the unit and adhesively secured to opposed foil sheets, and members of light material of low heat conductivity for sealing each unit about its edge.

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