The present invention relates to heat insulating panels; and while it is particularly concerned with the provision of heat insulating panels for use in the construction of household refrigerators, freezers, and other cooling devices, the present heat insulating panels are of general application, and may be used for heating appliances, construction of dwellings, or any form of housing in which it is desired to prevent the passage of heat through a structural member forming a part of the housing.

One of the objects of the invention is the provision of improved heat insulating panels which may be manufactured economically, which have a minimum number of parts, which maintain their heat insulating value for a long period of time, which are structurally strong, and which may be relatively thin as compared with the thick insulation required in the prior art for achieving the same insulating value.

Another object of the invention is the achievement of the foregoing results by the use of a metal walled panel, the walls of which are insulated from each other about the edges of the walls and hermetically sealed, forming an enclosure which may be evacuated to increase the insulating value and remove the air that might transmit heat from one metal wall to the other by convection air currents or by conduction, thus greatly increasing the insulating value of the panel.

Another object of the invention is the provision of improved evacuated and filled metal panels in which the heat insulating value is such that the panels may be made much thinner than the insulating value of the prior art and so that refrigerators and other housings requiring insulation may provide a maximum amount of internal space, while utilizing a minimum amount of external space for the housing or cabinet.

Other objects and advantages of the invention will be apparent from the following description and the accompanying drawings, in which similar characters of reference indicate similar parts throughout the several views.

Referring to the drawings, of which there are three sheets,

FIG. 1 is a view in perspective of a complete insulating panel embodying the invention.

FIG. 2 is a fragmentary sectional view of a household refrigerator cabinet taken at the corner of the door opening, utilizing the insulating panels of the invention.

FIG. 3 is a fragmentary sectional view taken through the filling and air conduits utilized in making the invention.

Referring to FIG. 1, 20 indicates in its entirety a heat insulating panel embodying the invention. This panel may be of any shape, but is shown as being rectangular in form, and includes a pair of sheets of metal 21, 22 joined at all of the four edges by the insulating edge sealing structure indicated by those numerals, and having an hermetic seal with the inside of each plate extending continuously around the entire panel to form a hollow metal panel, which may be evacuated.

The metal utilized for the sheet metal walls 21 and 22 is preferably a metal which has a coefficient of expansion which is approximately equal to the coefficient of heat expansion of the glass strips which are preferably used for sealing the edges 23–26 of the panel 20. For example, 20 gauge cold rolled steel or enameling iron may be employed; and certain alloys may be employed, as No. 430 titanium steel.

The edge strips 23–26, with which the edges of the panel are enclosed, are preferably made of glass having substantially the same coefficient of expansion as that of the metal; and a soft, soda-lime glass, such as Corning G–5, G–6, or G–8, is preferably employed.

A typical glass has a coefficient of expansion over a range of 25 degrees to 300 degrees C. of approximately $11.8\times10^{-6}$ per degree centigrade. This glass has a softening point of 1248 degrees F. and an annealing range of 940 degrees F. to 840 degrees F.

Such insulating panels may range in thickness from about 3/16" to about 2". A panel constructed as described is vacuum tight, and capable of standing a hydrostatic pressure of plus or minus 15 p.s.i., the seal is reliable under a very wide temperature range, for example, from minus 30°C. to plus 70°C. in the presence of up to 100°C. temperature differential between metal sheets.

Another glass suitable for use with stainless steel panels has a coefficient of expansion of $9.9\times10^{-6}$ per degree centigrade over a temperature range of 25 degrees to 300 degrees C., a softening point of 1297 degrees F., and an annealing range of 995 degrees F. to 880 degrees F.

The foregoing characteristics are merely exemplary of suitable types of glass; and the most important characteristic is that the glass must be capable of being integrally and permanently welded to the metal of which the sheets are made, such as cold rolled steel or iron, or to the stainless steel strips which may be used with the glass.

The space between the steel sheets is preferably filled with highly divided perlite powder, which is a naturally occurring volcanic glass of which the primary constituent is silicon-dioxide ($SiO_2$) with smaller amounts of aluminum trioxide ($Al_2O_3$) and smaller quantities of the oxides of such metals as iron, titanium, calcium, magnesium, sodium, etc.

Perlite has the advantage that it may be shipped to point of use in an uncompressed state, weighing about 100 pounds per cubic foot; and then it may be expanded, by vaporizing the water content in it, to about 8 pounds per cubic foot.

Perlite is very abundant and very cheap and may be heated without danger up to about 1300–1400 degrees F. and has a softening point in the range of 1800 degrees F. Perlite is preferably used in a finely divided form which will pass fine mesh screen of from 20 to 100 mesh per inch; and under vacuum such powder shows high insulating properties.

The panel is preferably filled to such an extent that the sides may bulge about 10% and the evacuation may compress and compact the perlite approximately 10% bringing the steel sheets back to parallelism.

Perlite in the finely divided state is a very efficient insulating material at pressures up to about 5 mm. of Hg; and it has the further advantage that its thermal conductivity under a good vacuum is markedly less than its thermal conductivity at ambient pressure.

The method of filling the panel with powder is illustrated in FIG. 3, in which 27 indicates a filling opening surrounded by a tube 28, which is connected to an enlarged tube 29 for carrying excess air. The enlarged tube 29 contains a concentric filling tube 30, which may be welded to a restricted portion 31 of the enlarged tube, and which has a laterally turning discharging end 32.

The enlarged tube 29 has a laterally extending suction conduit 33, which may extend to a suction pump through a porous filler 34, which prevents the powder from passing.

The concentric tube 30 extends into and is welded to a restricted portion 35 of a funnel tube 36, which is provided with a supply 37 of the insulating powder, to be fed
by gravity. An air pressure tube 38 is provided with a nozzle for projecting air under pressure into the end 39 of the concentric tube 30 and for entraining with it the powder that is fed by gravity from the supply 37 in funnel 36.

The opening 27 in the panel is preferably located in one of its corners, which may be disposed uppermost; and thus it is so located that, with the other corners extending downward, the entire panel may be filled from a single opening.

A high frequency vibrator, which may comprise an electric motor 40, having an eccentric weight 41 on its shaft 42, is fixedly secured to the panel, and places the panel under high frequency vibration to compact the powder while it is being filled and the excess air evacuated.

Referring to FIG. 2, this is an illustration of the method of effecting an air-tight seal between a door panel and a side wall panel of a household refrigerator and for reducing condensation.

Referring to FIG. 2, 71 indicates a side wall panel of a refrigerator housing, which has panels of the type described for its two side walls, rear wall, top, and bottom, and is provided with the hinged door 72. In this figure the edge seal comprises a U-shaped strip of stainless steel 73 with diverging flanges 74, 75 integrally welded at 76 and 77 to the sheets 21 and 22 and provided with an evacuated peritile filling 78.

In order to provide an air-tight seal at the door a thick U-shaped plastic edge seal 79 is cemented to the panel 71, and this seal 79 is substantially rectangular, comprising a yoke 80 and two side flanges 81 and 82. The side flanges 81 and 82 are grooved at 83 and 84 to receive the sharp edges of the steel sheets 21 and 22 with the welded edges 76, 77 of the U-shaped seal 73.

A similar U-shaped seal 85 is similarly secured to the edges of door panel 72; and the side of the plastic seal 85 has a plane, but resilient surface 87 of the plastic seal 79.

The plastic seal 85 extends all the way around the door, engaging similar plastic seal members 79 on the forward edge of all of the walls around the door opening. The door 72 preferably supports an inner plastic panel 88, having a backwardly extending plastic shield 89, which is located all around the door, and which has only sufficient clearance at 90 with respect to the inner walls to permit the door to have pivotal movement.

The deep crack represented by the clearance 90 has a temperature gradient from the door seal at 86, 87 backward to the interior of the cabinet and aids in reducing or preventing condensation about the door sealing members at 79 and 85.

It will thus be observed that we have invented improved refrigerator housing structures and component insulating panels which may be employed for this purpose or for the construction of any housing which is to be heat insulated.

The present heat insulating panels may be made quite thin as compared with the insulation of the prior art in refrigerators; and thus more space may be provided on the inside of the refrigerator, while occupying the same amount of space by the outside of the cabinet.

While we have illustrated a preferred embodiment of our invention, many modifications may be made without departing from the spirit of the invention, and we do not wish to be limited to the precise details of construction set forth, but desire to avail ourselves of all changes within the scope of the appended claim.

Having thus described our invention what we claim as new and desire to secure by Letters Patent of the United States is:

A heat insulating panel comprising a pair of sheets of similar shape, said sheets being arranged parallel to each other and integrally joined and sealed around their edges by a heat insulating edge closure forming an inner space which is hermetically sealed and filled with insulating material, the air being evacuated from the space between said sheets to increase the insulating value of the insulating material and sheet assembly and to increase the structural strength by the air pressure holding the sheets tightly against the compacted insulating material, the said edge closure comprising a U-shaped metal strip having its end edges integrally joined to the sheets at their edges all around the panel, the strips being of thin gauge to reduce heat conduction therethrough; and an edge seal formed of a yieldable material and having slotted portions grippingly receiving the joined edges of the sheet and strip to form an edgewise extension of each panel adapted for sealing engagement with similar edgewise extensions of contiguous such panels.

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