

April 13, 1948.

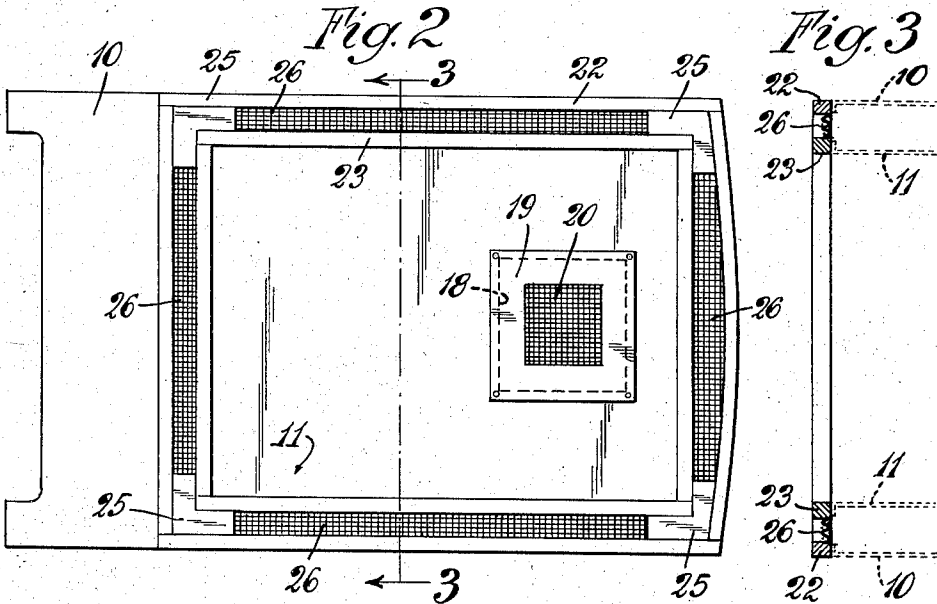
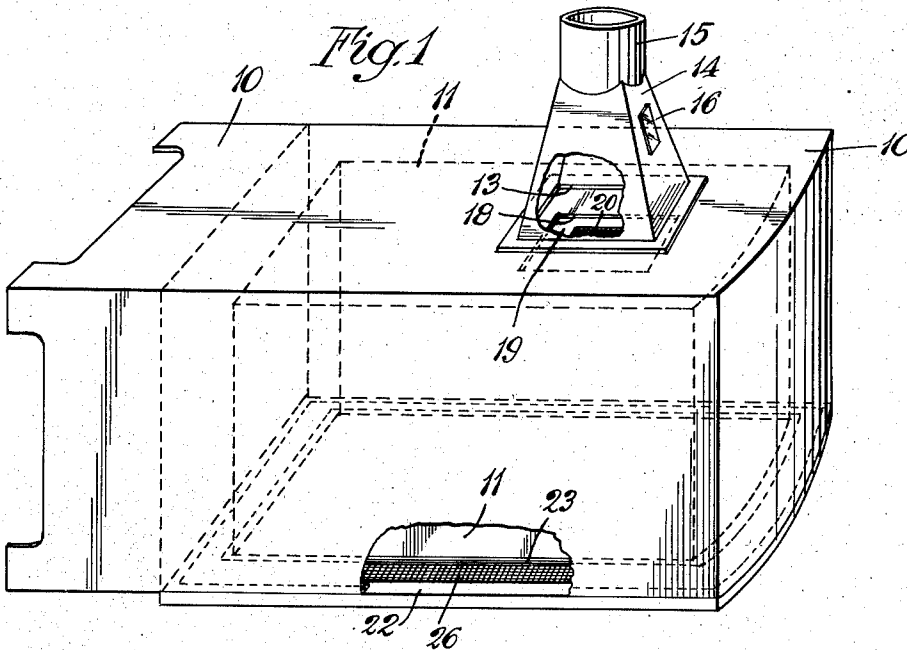
C. C. HERITAGE

2,439,603

INSULATING CONFINED SPACES

Filed March 2, 1943

2 Sheets-Sheet 1



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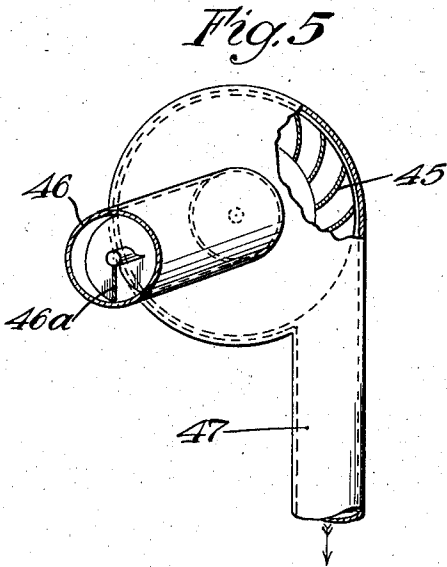
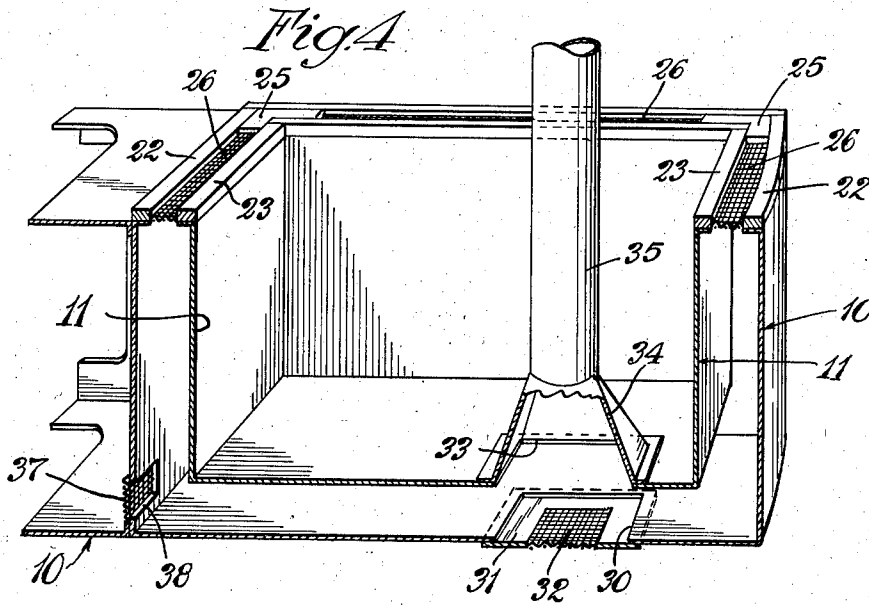
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UNITED STATES PATENT OFFICE

2,439,603

INSULATING CONFINED SPACES

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Application March 2, 1943, Serial No. 477,754

3 Claims. (Cl. 20—101)

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The present invention relates to the placement of particles of thermal insulating material to build up a thermally insulating integrated mass of such material in a confined space. In particular it relates to carrying the material in a gaseous vehicle (hereinafter referred to as air) to a deposited growing mass of such particles formed by deposition of particles from the vehicle.

In its general aspect, the invention contemplates completely confining a space to be so filled with insulation material, whereby to define the form of the mass to be produced. The space may be provided substantially completely by or within existing articles. However, as required or desired for the purposes of the invention, the space to be filled is completely defined by bounding facial walls having essentially some filtering area for exhausting the gas in which particles of the insulating material are introduced, and having essentially in the area of the confining walls one or more inlet areas for introducing the gas containing the particles, each such inlet area being essentially in and a fraction of a confining wall or face in a manner analogous to the relation of the area of a pouring sprue in molds for casting metal articles to a space-defining area of the mold.

It is also a general aspect of the invention that the particles of insulating material are such as may be consolidated into a gas-filtering body, when in finally deposited form, whereby in conducting and completing the introduction, gas entering the space through inlet area may pass through all or a part of the body as required to exhaust through filtering area.

Another general aspect of the invention permits the form of the space to be complex, or angular, and not limited to panel-form spaces. Thus, the vehicular stream of gas is introduced at a differential pressure, relative to the pressures at inlet area and at filtering area, and at such a velocity that the particles suspended in the gas are carried with turbulence inside the space to all portions of the space remote from inlet area, and that the differential pressure packs the deposited mass to a consolidated body filling the space while said pressure of the gas stream is maintained to and, if desired, even after the complete filling of the space.

The invention is applicable in many fields, for example in packing fiber or other insulating material into carboys to protect and insulate the flasks of liquid therein. However, its presently preferred use is in insulating the doors and

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cabinets of refrigerators, such as are used in homes.

In the field of artificial refrigeration, high standards for insulation in domestic and other refrigerators have developed in order to minimize heat loss, because high heat loss adds to the cost of operation. Considerable difficulty has been encountered in the commercial development of refrigerator insulation in parallel with the development of domestic artificial refrigeration. Along with high standards and for low heat loss, low cost of insulating material and of insulating process are important, as are uniformity in each cabinet, and uniformity from cabinet to cabinet in a production line.

In addition, there is the problem of permanence, in which resistance to settling of packed bulk insulation is most important. Such resistance can be attained by increasing the density of packing, with which heat leak or heat conductance increases, as a general rule, in the ranges encountered in refrigerators. It is, therefore, important to minimize density, consistently with acceptable resistance to settling and acceptable insulating value. All these factors lead to a need for a process which is subject to control for meeting them.

In the prior art there has been no low-cost process for packing a specified material uniformly and integrally into a cabinet, and uniformly from cabinet to cabinet in a production line. The present invention provides such a process, and so used it gives reproducible results with any reproducible material. Vegetable fibers such as from wood may readily be produced from time to time with reproducible properties within given specifications, and with such material and with the present invention, a low-cost process for uniformly and efficiently insulating spaces, such as those in refrigerators, becomes available to the manufacturers of refrigerators. Reference is made to my copending application Serial No. 336,495, filed May 22, 1940, now Patent No. 2,325,055, issued July 7, 1943, describing reproducible fibers, which are useful as particles for practice of the present invention.

It is an object of the present invention to insulate a refrigerator cabinet having a door opening, in which cabinet there is mounted a food compartment, where there are openings in each of the cabinet and the food compartment to accommodate the insertion into the food compartment of a refrigerating unit.

It is a particular object of the invention to introduce insulation into the space between said

food compartment, by introducing a stream of gas containing insulating particles, into such an opening for the unit, and preferably through such an opening in the cabinet, while filtering gas from said space through filtering area in part in the other opening and in part at the door opening of the cabinet.

Various other and ancillary objects and advantages of the invention will appear from the following description and explanation of the invention set forth below with reference to the accompanying drawings in which:

Fig. 1 represents in perspective a refrigerator cabinet in horizontal position with its door-opening facing downwardly and with its food compartment mounted therein, there being an opening in the back face of the cabinet connected with means for introducing insulating material, said figure showing also a screened opening in the food compartment opposite the opening in the cabinet;

Fig. 2 is a plan view of the refrigerator of Fig. 1 looking at the normal front face thereof after application of a fixture-plate shown in Fig. 3;

Fig. 3 is a cross-section of a fixture-plate taken on line 3—3 of Fig. 2;

Fig. 4 is a view in perspective of the cabinet similar to that of Fig. 1, but turned to lie on its cabinet back, and showing a reversal in position of the inlet area for insulating material and the opposite filtering area; and

Fig. 5 illustrates a blower and feeding means therefor which is connected to the hood shown in Figs. 1 and 4.

In my earlier application Serial No. 294,212, the process is described generically and specifically with respect to various forms of the space to be filled, and various types of space-confining walls, and removable fixtures, having particular reference to variations in the process for insulating domestic type refrigerators. These variations include filling a refrigerator in which the food compartment is already mounted, and also in which the food compartment is not mounted. In the latter case, a fixture in the form of a dummy for the food compartment is employed, and the fixture is used to provide filtering area, and may be used to provide inlet area. The process is flexible for accommodating it to various types of refrigerators, as well as various types of spaces not necessarily those of refrigerators. In the said earlier application there is claimed specifically a method of filling a refrigerator in which the food compartment is mounted, both the cabinet and the food compartment having openings therein for accommodating the insertion into the food compartment of a refrigerating unit. One of the said openings to the space is used for introducing the gas, while the other is blocked off. The open space at the door opening between the cabinet and the food compartment, where breaker-strip material is located in the completed refrigerator, is closed by a fixture or closure provided with filtering area, and preferably including also some imperforate area. Thus, the gas introduced passes through the gas-filtering body of insulating material built up in the space. Then the fixture is removed, and breaker strip used to close the gap. The space between the openings for the unit thus has insulation, which may be disturbed as necessary in making connections when installing the refrigerating unit.

It is also set forth that the stream is introduced at a differential pressure between inlet and filter areas. This may be effected by having atmospheric pressure at either the inlet area, or at the

filtering area. The latter is preferred for many practical and mechanical reasons.

In the present application it is likewise intended that the pressure be a differential one, but to simplify the description and the illustration, only the preferred one of super-atmospheric pressure at inlet area, is specifically described and illustrated without intention to limit the invention thereto.

After the introduction of the insulating material into the space to be insulated, especially in a refrigerator, there are numerous mechanical operations which may be necessary to complete the article for use or sale. However, these form no essential part of the invention, and detailed description and illustration of them are herein omitted.

The preferred closures or other means having filtering area are preferably permanent fixtures used in a production line, and are in preferred practice removed after each use. However, these may be of other structure, for example, metal or cloth filters of such character that they need not be removed. When retained, they may be a permanent part of the final structure, covered or not. Hence, the removal of such closures is not considered an essential part of the process. But in certain cases it may be included as an essential part of certain aspects or variations of the invention.

The present invention may be used for fibers, flakes and particles of other forms. Examples of fibers are hair, wood fiber, vegetable fiber, kapok, mineral wool, glass wool, asbestos, straw, grasses and many others. Examples of other materials are flaked paper, exfoliated vermiculite, mica, ground cork and like material. Fibers are preferred, because they mat and felt and produce stable forms in more complex variations of the invention where fixtures may be used and removed. The following illustrations are therefore given with respect to wood fiber, such as that according to my said copending application Serial No. 336,495, filed May 22, 1940, now Patent No. 2,325,055, issued July 7, 1943, which was developed primarily for use in the present invention.

The invention involves the building up of a consolidated gas-filtering body of particles of insulating material introduced as suspended matter in a stream of gas, into a confined space to be insulated; and it involves the provision in the confining walls of said space of filtering area to retain the particles and exhaust the gas. The location of inlet area, the number of inlet areas, and the location, size and number of filtering areas are not critical with respect to any given space. This is because the stream of gas is introduced at a velocity to impel the particles with turbulence into the space and to all parts of the space. The greater the shortest distance from inlet area to filtering area, the thicker is the body of insulating material through which gas must pass to exhaust. Therefore, for practical convenience, it is desirable to have filtering area close to, or even adjacent to inlet area. Experience has shown that, because of the turbulence, the particles may deposit in regions some of which are adjacent to filtering area, and others of which are remote from both inlet area and filtering area. The resulting deposit grows toward the inlet area, and to or through the inlet area. In such case the filtering area close to or adjacent inlet area facilitates the deposition of the last-deposited material. The conditions

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establish a complexity of air currents which change as the remaining space to be filled changes. Cyclonic currents have been observed which tend to throw carried particles centrifugally out of the local air stream and deposit them by centrifugal force and in the manner described. Also direct deposition by filtration has been observed as one of the resulting actions to deposit the introduced particles.

In my earlier patent application Serial No. 294,212, the drawings illustrated a refrigerator cabinet having within it its food compartment, being filled by an inlet hood over the opening in the cabinet for the refrigerating unit, while a baffle-plate closure is mounted in the opposite opening for the unit in the food compartment, the filtering area being provided in a four-sided frame which fits as a fixture over the peripheral intervening space at the door opening of the cabinet. However, it is stated therein that the said baffle may be replaced by means providing filtering area, and also that the same hood and the said means may be reversed so that the hood is over the unit-opening in the food compartment. The present application is directed to these modifications.

In Fig. 1, a cabinet 10 with its door-opening downward, has mounted within it a food compartment 11, shown in part by full lines of a fragment only, and otherwise by the dotted lines designated 11. An opening 13 in the back of the cabinet for accommodating a refrigerating unit to be inserted in the food compartment 11 is covered by a hood 14, connected to a conduit 15, and having window 16. The food compartment 11 having an opening 18 opposite opening 13, likewise to accommodate said refrigerating unit, is closed by a plate 19, having in it a screen 20, to provide filtering area.

The door opening has an exposed peripheral area communicating with the space to be insulated, and this area is closed by a substantially rectangular frame shown in Figs. 2 and 3, providing both imperforate area and filtering area. The frame, as a removable fixture, has an outer frame 22 fitting over the edges of the cabinet, and an inner frame 23 fitting over the edges of the food compartment. In Fig. 3 the said edges are illustrated in dotted lines with flanges turned toward the intervening space. The corners between the frames have imperforate area provided by connecting material 25. Between these corners, and between the members of the two frames, are wire screens providing filtering areas 26.

Fig. 4 shows the same cabinet 10 with its food compartment 11 on its back. The same frame is used on the door-face of the cabinet in the same way. The opening in the cabinet is here designated 30, and it is covered by a plate 31 (like plate 19), having a screen 32 therein to provide filtering area. The opening in the food compartment 11 is here designated 33, and it is closed by hood 34, connected to conduit 35.

Fig. 5 shows a blower system to which the conduits 15 and 35 may be connected. A fan-type blower 45 has pipe 46 for the entry of air, into which fiber may be fed by hand, or by a mechanical device, such as a picker, or a worm screw 46a. The fan discharges downwardly through conduit 47.

Consider the apparatus of Fig. 5 when the pipe 47 is 6 inches in diameter and connected to a fixture for filling a space. The fan is operated at 3740 R. P. M. by a 15 H. P. motor of 1800 R. P. M.

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Running idle (connected and operated but no fiber fed), the measured pressures are as follows:

Table I

In pipe 47	Pressure in inches of water
Lateral (static) pressure.....	8.5.
Total pressure.....	10.25.
Velocity pressure.....	1.75.
Velocity.....	5300 ft. per minute.
Output.....	1040 cu. ft. per minute.

The system shown in Fig. 5 has been used to fill a certain space $\frac{1}{4}$ full, then to $\frac{1}{2}$ full, then to $\frac{3}{4}$ full, and then to 100% full, with measurements of the system (idle) at each stage. The measured values are combined in Table II with values taken from Table I and are in the same units as those in Table I.

Table II

Measured in pipe 47	Empty	$\frac{1}{4}$ full	$\frac{1}{2}$ full	$\frac{3}{4}$ full	Full
Static pressure.....	8.5	12	12	13.5	14.75
Total pressure.....	10.25	13	13	13.5	14.75
Velocity pressure.....	1.75	1	1	-----	-----
Velocity.....	5300	4006	4006	-----	-----
Output.....	1040	785	785	-----	-----

It is noted that under conditions where the exit is wholly or to a degree blocked, as when the space is full, there is a "back pressure" encountered at the inlet to the centrifugal fan.

The back-pressure is an important feature of the use of super-atmospheric pressure feed, with apparatus permitting back pressure. Consider in Fig. 5 that the fan may run while the feed line 47 is open. A momentum is established into pipe 47. As this is blocked off, the moving stream is retarded, at first in part, and fiber gradually fills up the inlet conduits. A window (earlier described) indicates this and the process may be stopped. If not stopped the back pressure at the inlet blows fiber back in pipe 46. Thus, fiber fed into the inlet will also be blown out the inlet. The appearance of back-feed or back-pressure is an indication of the final status of being filled.

Many factors influence the result, and practically, it is necessary to arrive at standard conditions for the particular equipment used, and the job at hand. For example, it has been found to be a general rule, that the faster the fiber is fed, the less the density of the mat obtained. However, this rule is limited to a very short period of time. In one tested instance the feeding time for the space was varied from fractions of a minute to several minutes. The curve of density has been plotted vertically against feeding time plotted horizontally. The curve rises rapidly, and at about 25 seconds it begins to flatten out. In about 60 seconds it has reached a maximum density. Such curves were obtained with different fan speeds, and it was found that high speeds (greater kinetic energy to fiber) at the same feeding time gave higher density mats. By constructing such curves from experimental procedure, the conditions for most efficient operation and for uniform operation may be easily determined.

By using the described filtering area opposite the inlet, there may be formed in operation a filtered mass of fibers which acts as a baffle to deflect the air stream laterally in all directions from the inlet area.

The use of a fan is preferred for the reason that it is a means of unfelting the fibers to sub-

stantially individual fibers. It is this form which gives the best results. However, broadly, the fibers need not be completely unfelted, and may be in clusters or small aggregates. Use of other means, such as vacuum on the screen end, or feeding fiber directly into a current of air, is conducive to providing such loose aggregates, rather than individual particles of fiber. The important point is that these are not under mechanical pressure to felt them, and they tend to unfelt in process.

The terms "screening means" and "filtering area" as used herein or in the claims refer to an area with any effective lattice or perforated member which acts as a screen to filter particles from the carrying gas, and it is to be distinguished from a member porous to air and from a crack or an elongated slot.

It is not essential that filtering area be limited to the areas disclosed, and it may be located anywhere in the total area confining said space. This is exemplified in Fig. 4 by a screen 31 covering a small hole 32 at the bottom-rear of the space to be insulated, such hole being useful for piping connections to a refrigerating unit. The size and location of filtering area relative to inlet area, and the velocity of the stream of gas, are all such that particles are introduced with turbulence in all portions of the space to be filled, and pack therein.

Numerous modifications and variations of the invention, not necessarily confined to refrigerators, are contemplated as falling within the scope of the appended claims.

I-claim:

1. In depositing particles to form insulation in situ in a refrigerator formed of inner and outer shells each with an open face together providing an opening for closure by a door, which shells provide a continuous space between them opening through screening means in said door opening, each of said shells having an opening in its wall opposite said door opening to permit installation of a cooling unit, of which two wall openings one provides an introductory inlet to said space of size relatively large compared with the foramina of said screening means, and the other is covered by a closure including like screening means, the method which comprises, suspending in a moving gas, particles of insulating material which pack to a consolidated body that is a gas-filtering body at an insulating density of the so-packed particles; introducing the resulting moving gaseous suspension into said space by conducting the suspension to and through said introductory inlet; simultaneously venting said gas from said space through said screening means, and there filtering said vented gas from particles; thereby depositing and packing particles to form a growing gas-filtering mass thereof in corresponding portions of said space over and extending away from said screening means; simultaneously maintaining in the remaining portion of said space a condition of turbulence of said gaseous particle-suspension by maintaining a high and sufficient velocity therefor in introducing said suspension whereby the turbulence causes deposition and packing of particles in margins of the turbulent space; and continuing said introduction, said maintenance of turbulence, and said venting of said gas through said screening means and also through said growing mass at least until a body of said particles begins to form in said inlet and said space is completely packed with said particles consolidated to a gas-filtering body.

at an insulating density and resultingly molded into said space and compressed therein by the differential introduction pressure between said inlet and said screening means.

2. In depositing particles to form insulation in situ in a refrigerator formed of inner and outer shells each with an open face together providing an opening for closure by a door, which shells provide a continuous space between them opening through screening means in said door opening, each of said shells having an opening in its wall opposite said door opening to permit installation of a cooling unit, of which two wall openings that in the outer shell provides an introductory inlet to said space of size relatively large compared with the foramina of said screening means; and the other is covered by a closure including like screening means, the method which comprises, suspending in a moving gas, particles of insulating material which pack to a consolidated body that is a gas-filtering body at an insulating density of the so-packed particles; introducing the resulting moving gaseous suspension into said space by conducting the suspension to and through said introductory inlet; simultaneously venting said gas from said space through said screening means, and there filtering said vented gas from particles; thereby depositing and packing particles to form a growing gas-filtering mass thereof in corresponding portions of said space over and extending away from said screening means; simultaneously maintaining in the remaining portion of said space a condition of turbulence of said gaseous particle-suspension by maintaining a high and sufficient velocity therefor in introducing said suspension whereby the turbulence causes deposition and packing of particles in margins of the turbulent space; and continuing said introduction, said maintenance of turbulence, and said venting of said gas through said screening means and also through said growing mass at least until a body of said particles begins to form in said inlet and said space is completely packed with said particles consolidated to a gas-filtering body at an insulating density and resultingly molded into said space and compressed therein by the differential introduction pressure between said inlet and said screening means.

3. In depositing particles to form insulation in situ in a refrigerator formed of inner and outer shells each with an open face together providing an opening for closure by a door, which shells provide a continuous space between them opening outwardly through screening means including screening means in said door opening, each of said shells having an opening in its wall opposite said door opening to permit installation of a cooling unit, of which two wall openings one provides an introductory inlet to said space of size relatively large compared with the foramina of said screening means, and the other is covered by a closure including like screening means, the method which comprises, suspending in a moving gas, particles of insulating material which pack to a consolidated body that is a gas-filtering body at an insulating density of the so-packed particles; introducing the resulting moving gaseous suspension into said space by conducting the suspension to and through said introductory inlet; simultaneously venting said gas from said space through said screening means, and there filtering said vented gas from particles; thereby depositing and packing particles to form a growing gas-filtering mass thereof in corresponding portions

of said space over and extending away from said screening means; simultaneously maintaining in the remaining portion of said space a condition of turbulence of said gaseous particle-suspension by maintaining a high and sufficient velocity therefor in introducing said suspension whereby the turbulence causes deposition and packing of particles in margins of the turbulent space; and continuing said introduction, said maintenance of turbulence, and said venting of said gas through said screening means and also through said growing mass at least until a body of said particles begins to form in said inlet and said space is completely packed with said particles consolidated to a gas-filtering body at an insulating density and resultingly molded into said space and compressed therein by the differential introduction pressure between said inlet and said screening means.

CLARK C. HERITAGE.

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The following references are of record in the file of this patent:

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Certificate of Correction

Patent No. 2,439,603.

April 13, 1948.

CLARK C. HERITAGE

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Column 2, line 46, after the word and period "invention." insert the following paragraph:

The present invention is a continuation-in-part of my prior application Serial No. 294,212, filed September 9, 1939, wherein the principles of the process are disclosed, which application is generic to the present application.

and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 11th day of May, A. D. 1948.

[SEAL]

THOMAS F. MURPHY,
Assistant Commissioner of Patents.