United States Patent

[11] 3,573,430

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London, England
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[45] Patented Apr. 6, 1971

[54] **SURFACE HEATING DEVICE**
4 Claims, 55 Drawing Figs.

[52] U.S. Cl. **219/385,** 99/171, 219/386, 219/538
[51] **Int. Cl.** **F27d 11/00**
[50] **Field of Search** 219/385, 386, 438, 444, 538, 552; 99/171, 175

[56] **References Cited**

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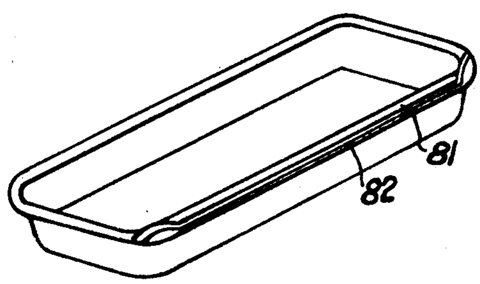
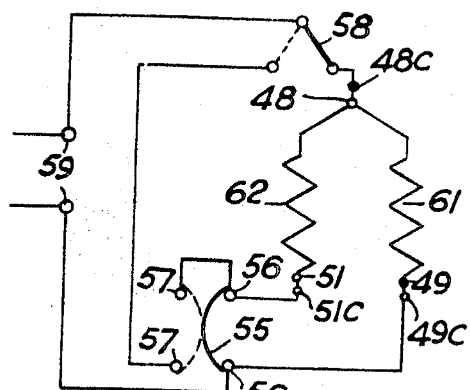
Primary Examiner—J. V. Truhe
Assistant Examiner—C. L. Albritton
Attorney—Watson, Cole, Grindle and Watson

ABSTRACT: A dispensable container for a substance to be heated therein incorporates a low voltage surface pattern heating film with externally accessible terminals, the relative disposition of the film container and substance being such that the heat generated by the film does not exceed that dissipated into the substance by more than 4 watts per square inch, means also being provided to ensure that more heat reaches the substance than the external surface of the complete package.

There may be heat insulation between the container and its surface. The film may be of patterned metallic foil. There may be provision to supply heat from outside by radiation or conduction. There may also be provision for a small body of liquid between the film and substance, the liquid having access to a substantial area of the substance so that the temperature is limited to the boiling point of the liquid.





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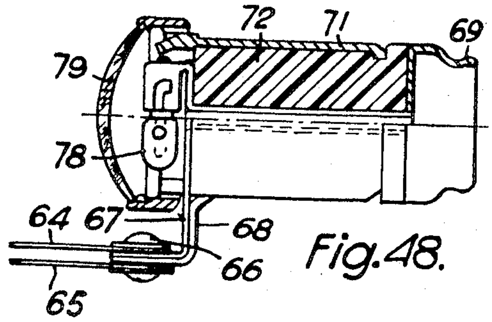

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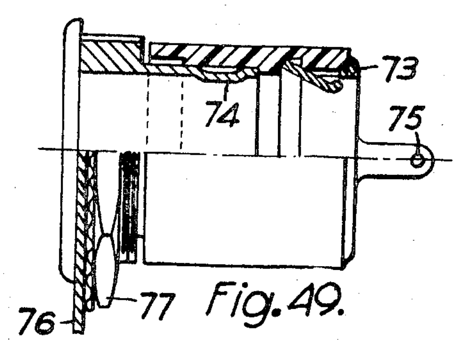

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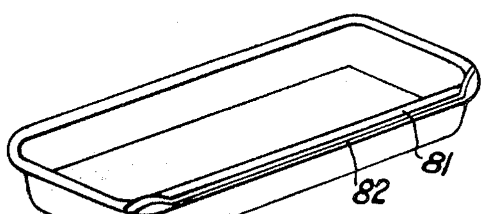

Fig.1.

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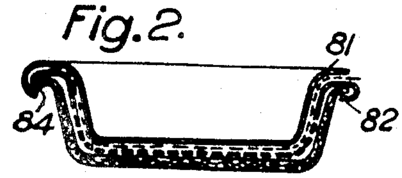

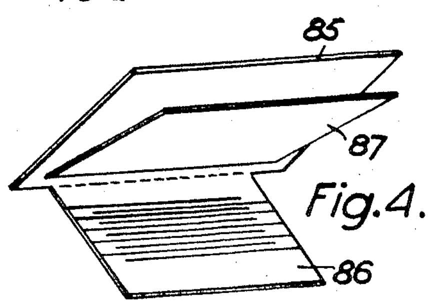

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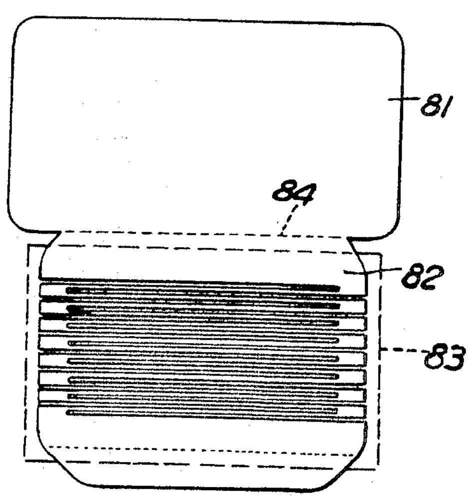

Fig.3.

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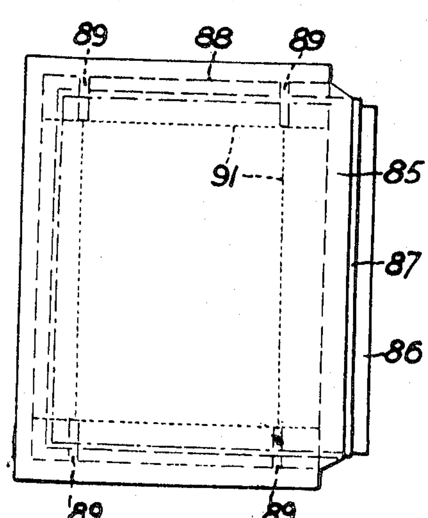

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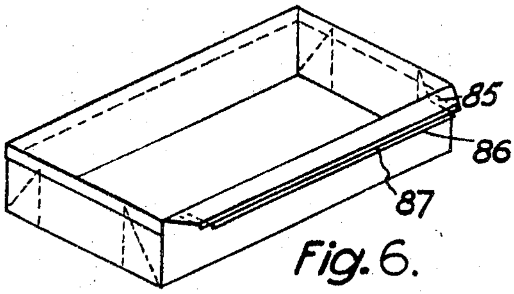

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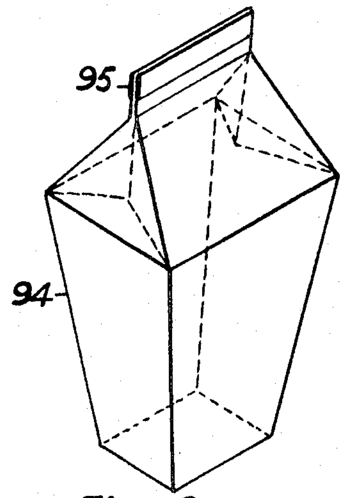

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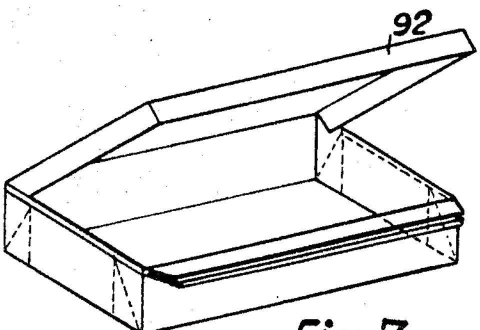

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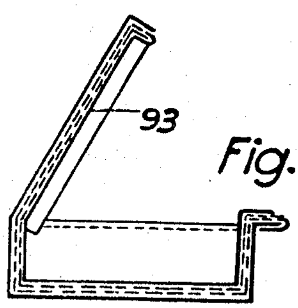

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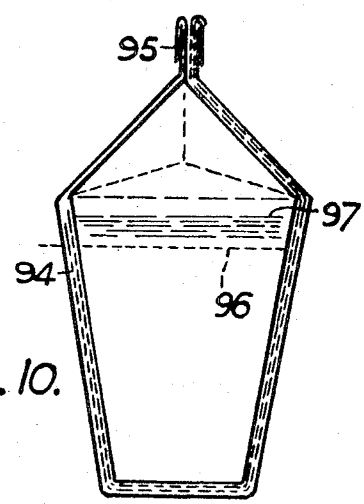

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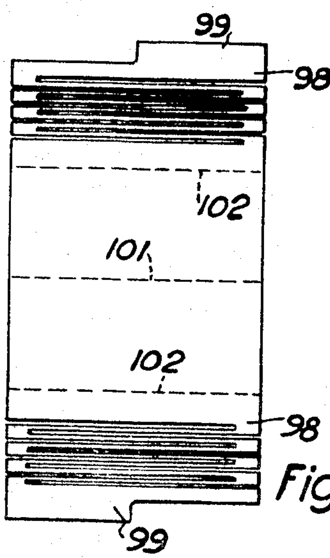

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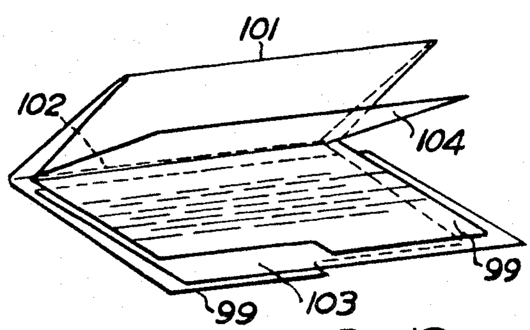

Fig. 12.

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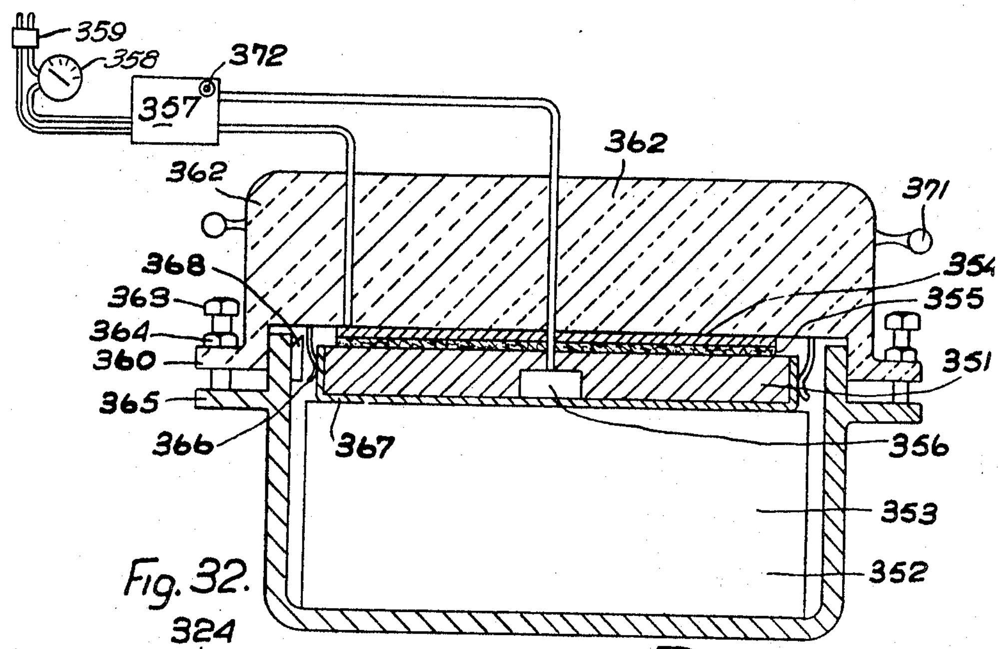

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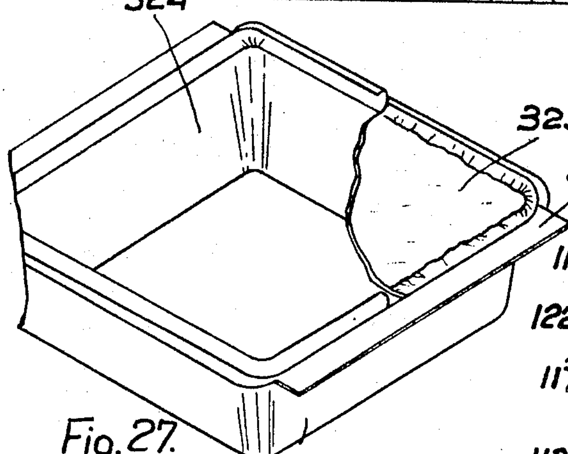

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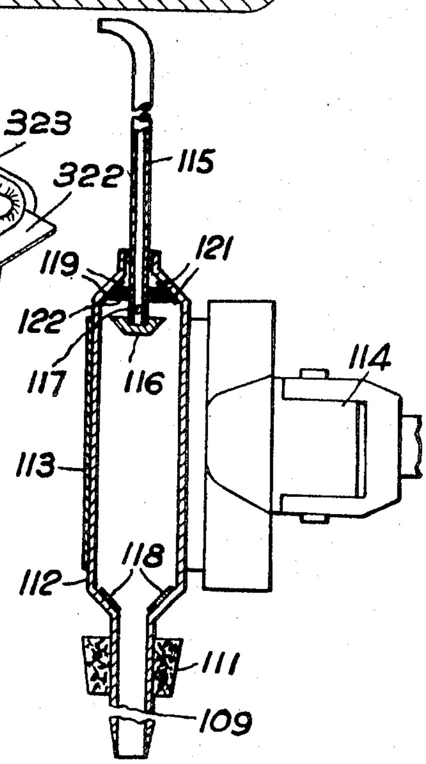

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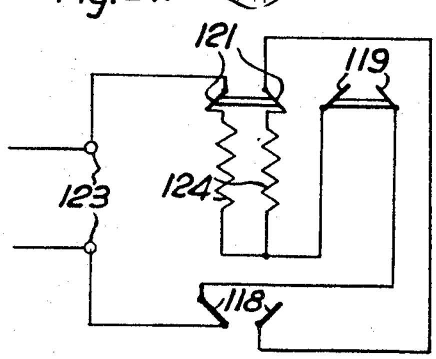

Fig. 14.

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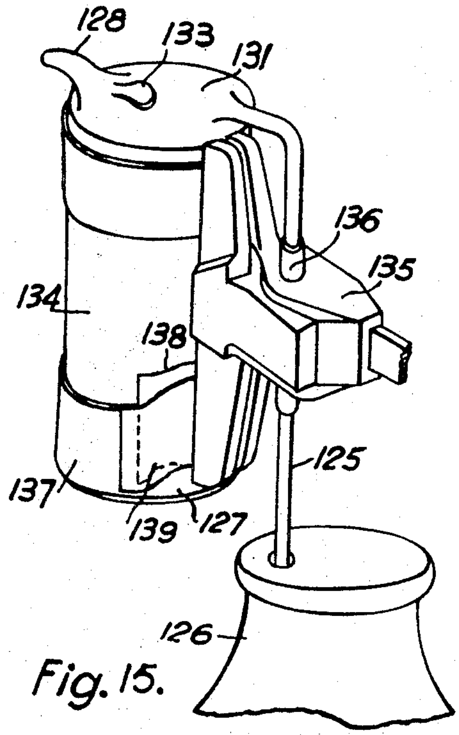

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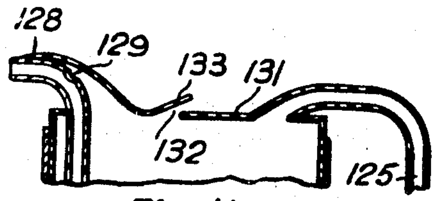

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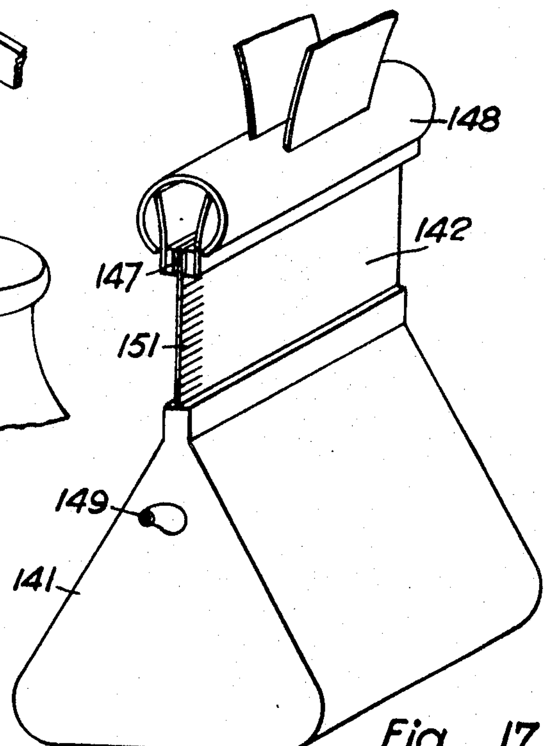

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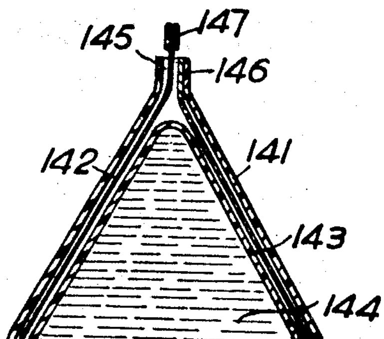

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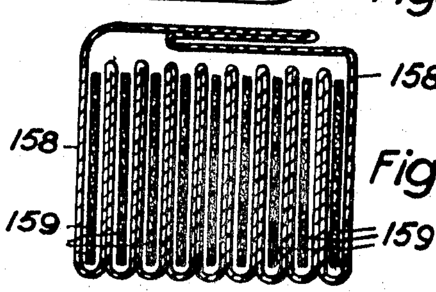

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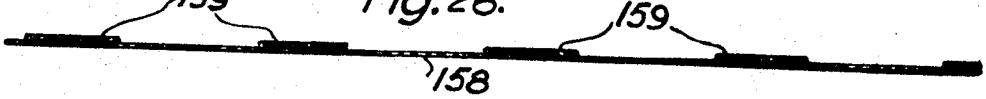

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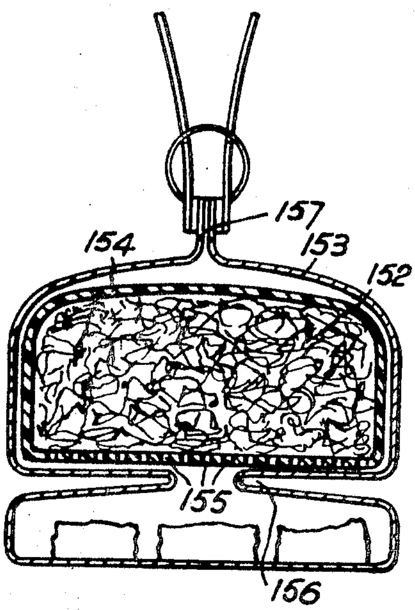

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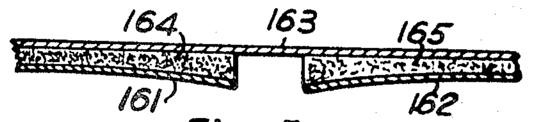

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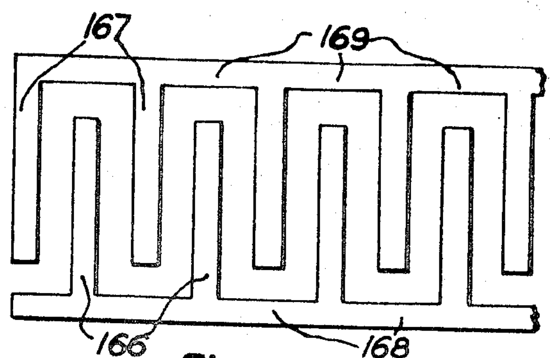

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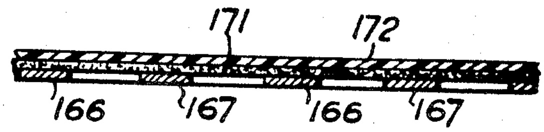

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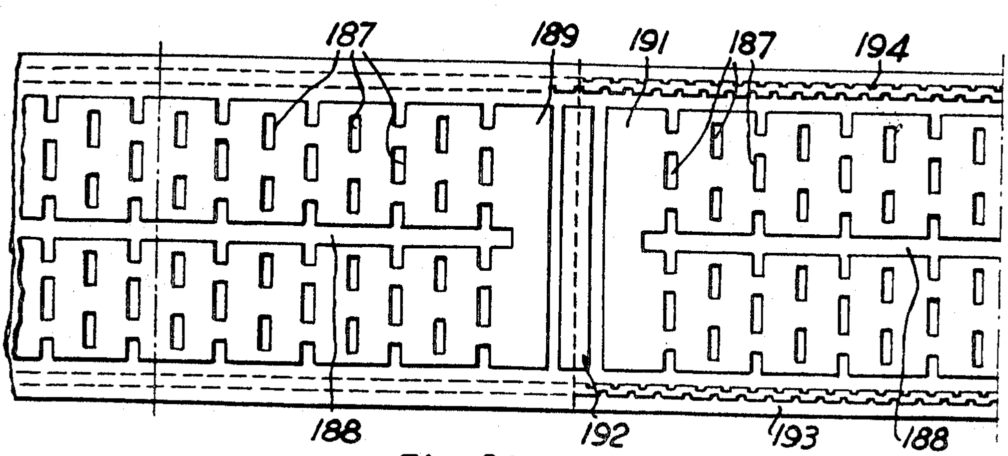

Fig. 50.

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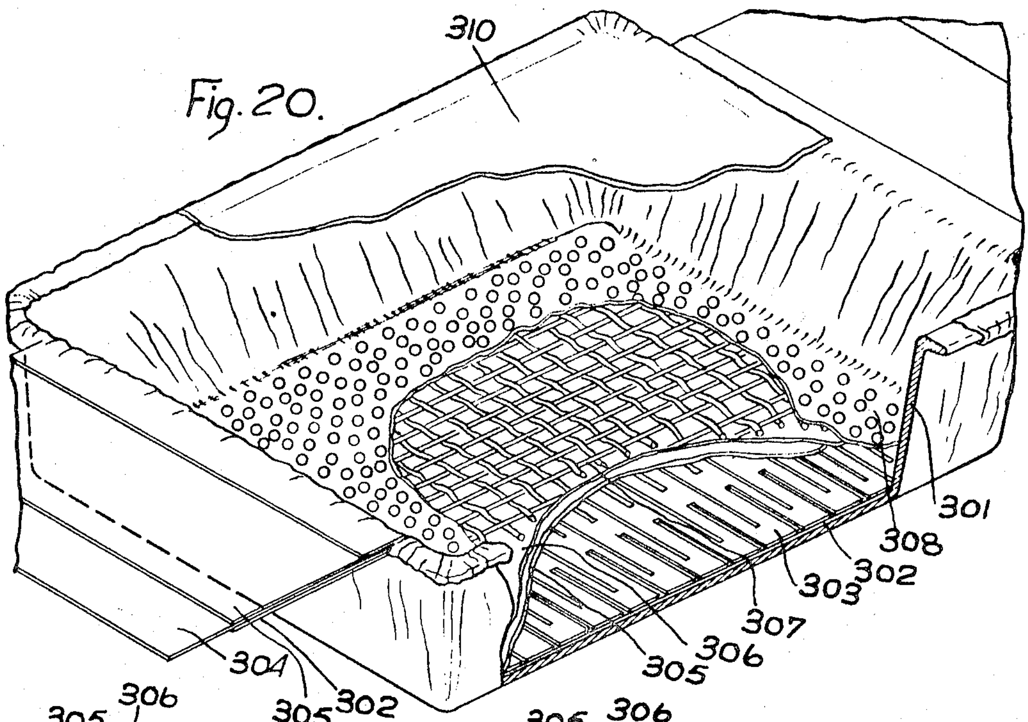

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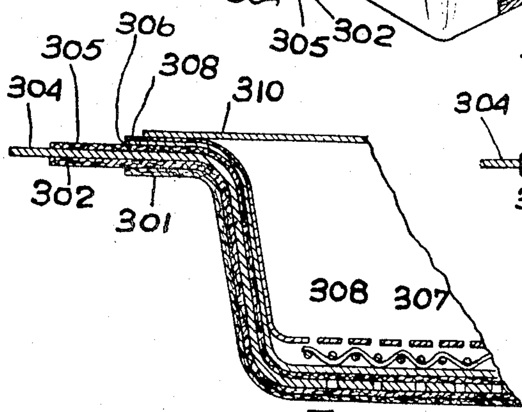

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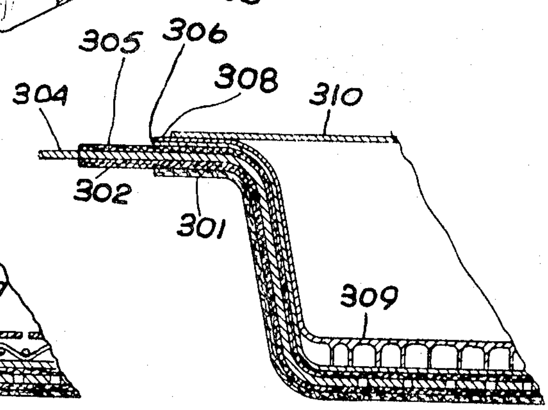

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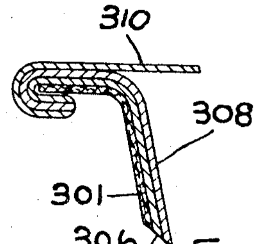

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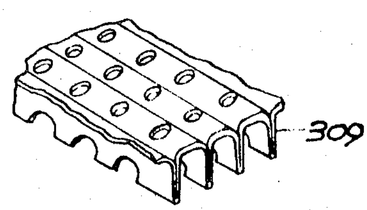

Fig. 24.

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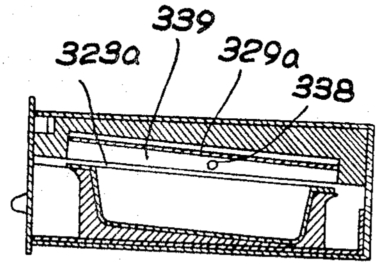

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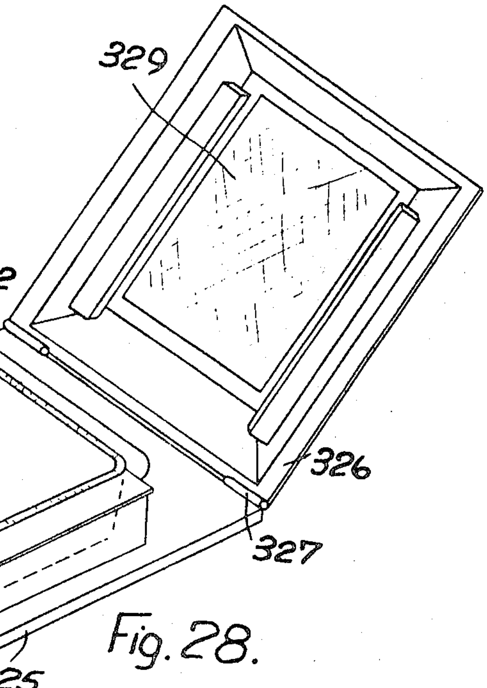

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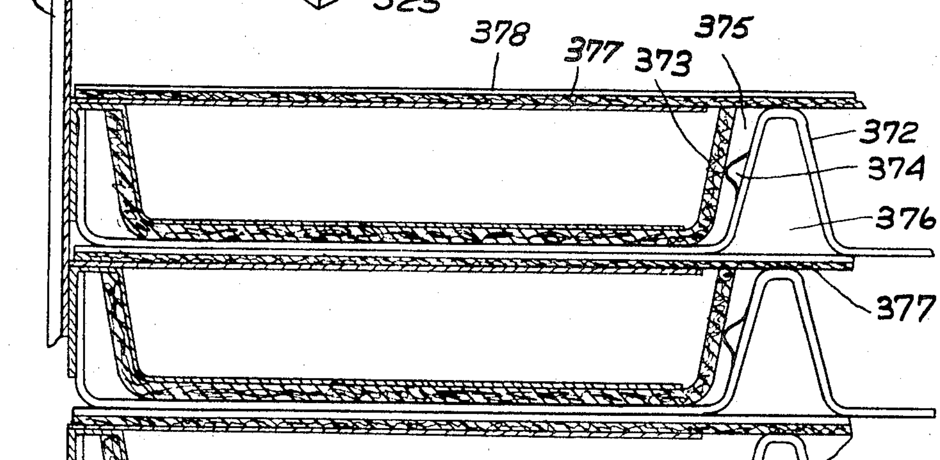

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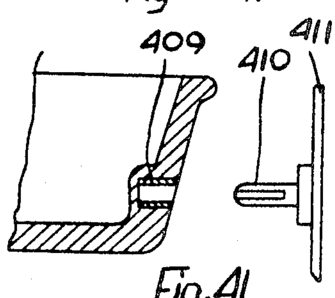

Fig. 41.

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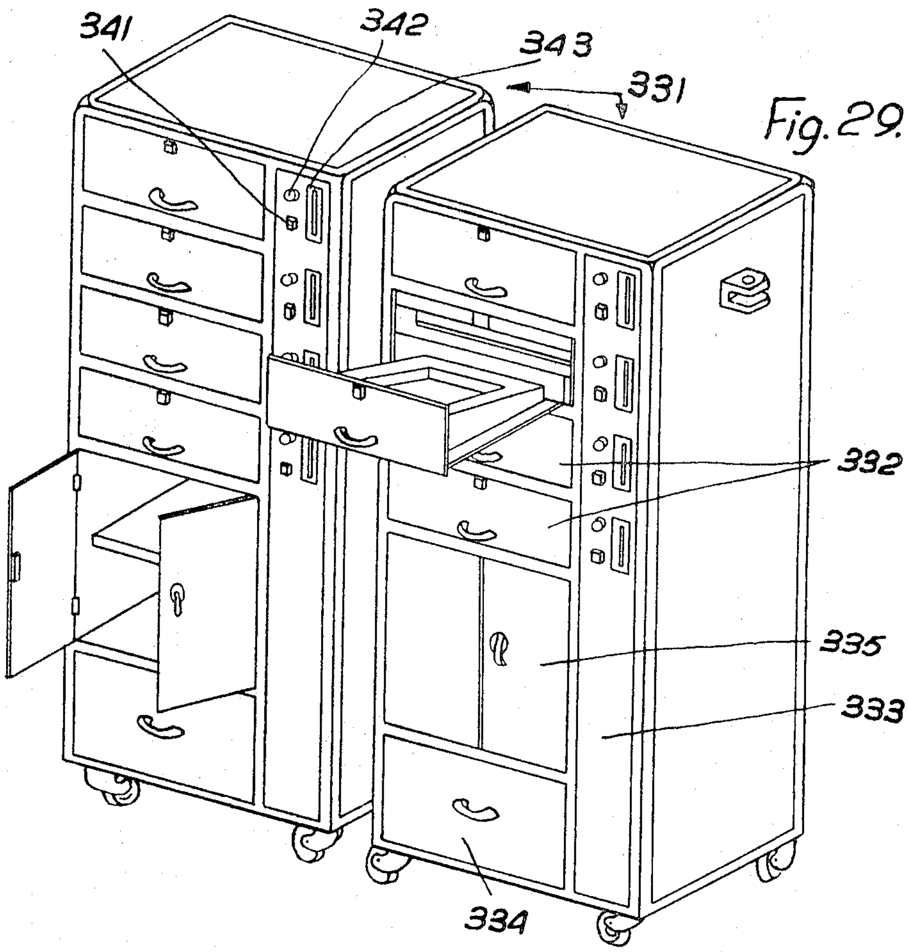

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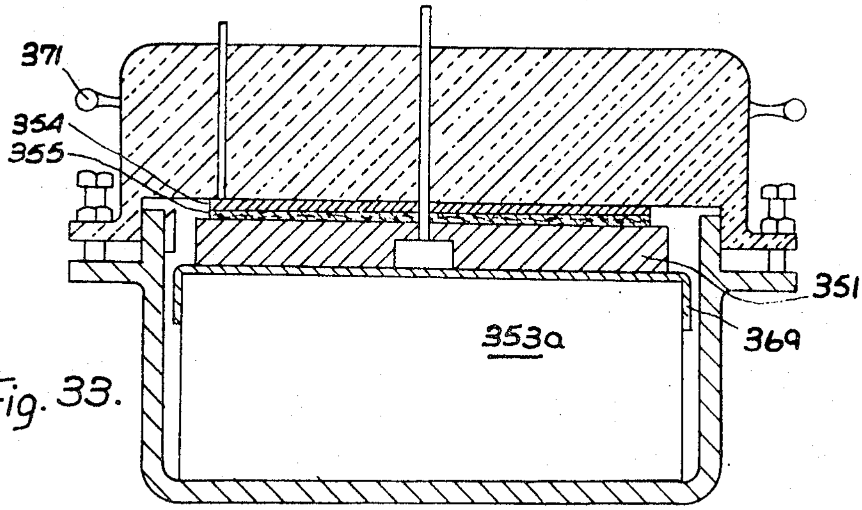

Fig. 33.

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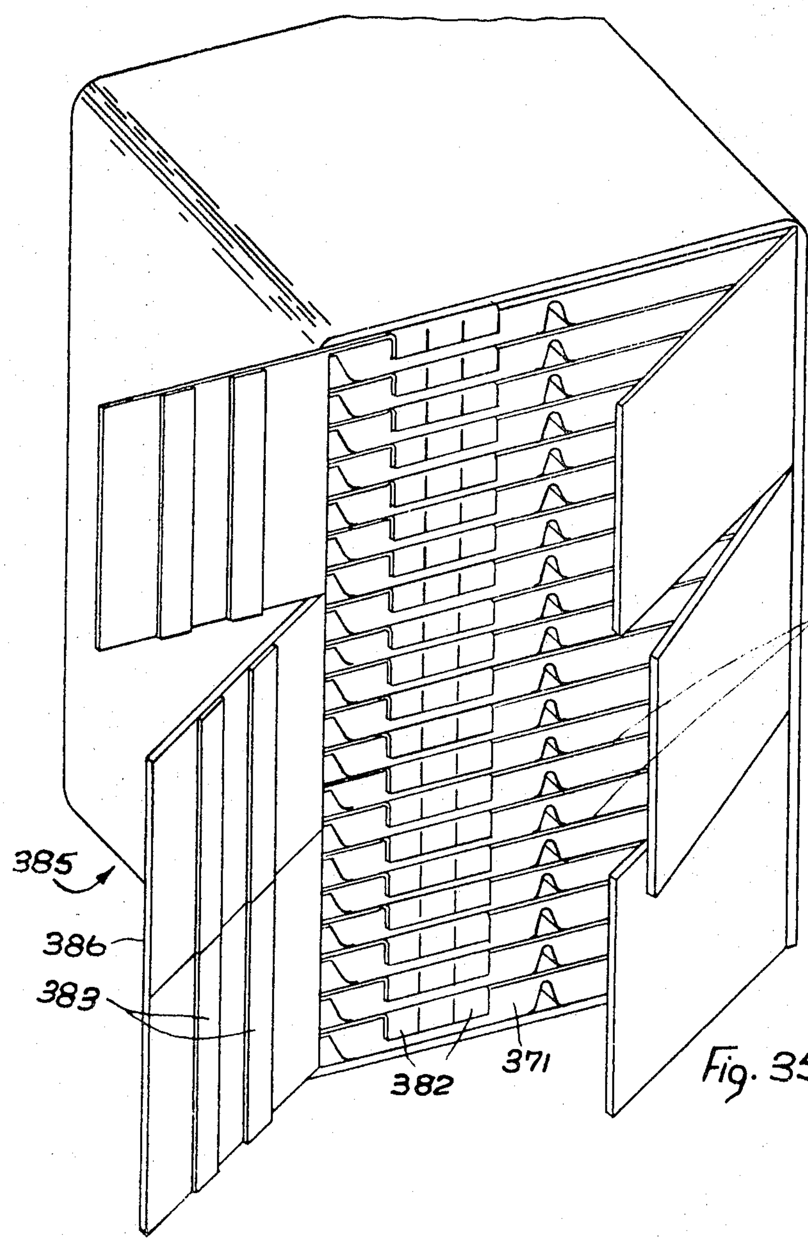

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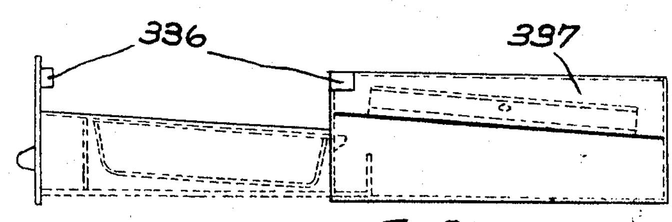

Fig. 31.

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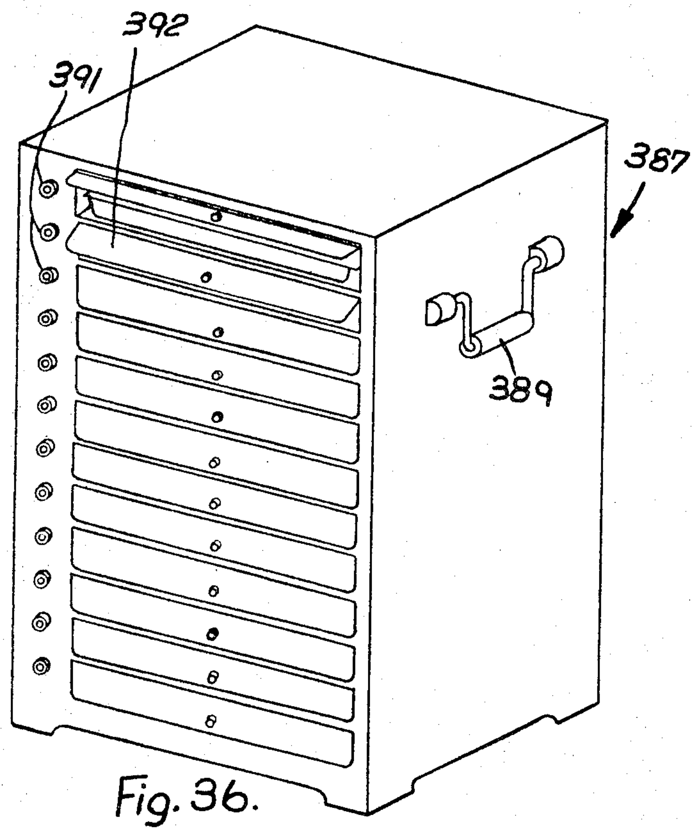

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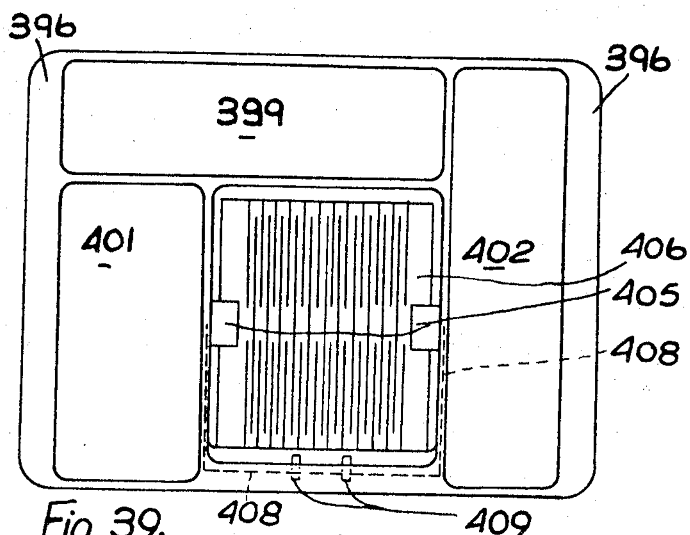

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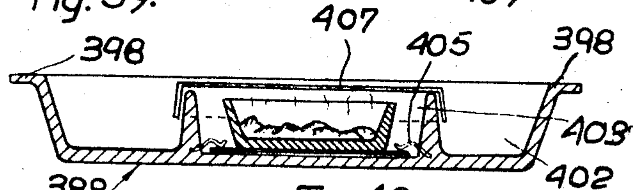

Fig. 40.

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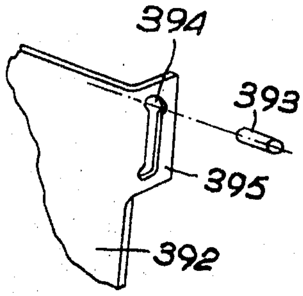

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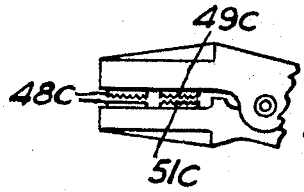

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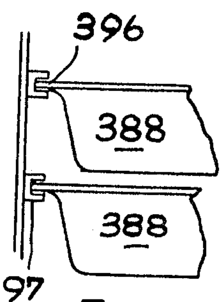

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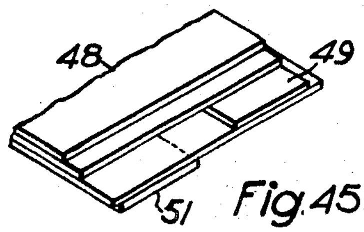

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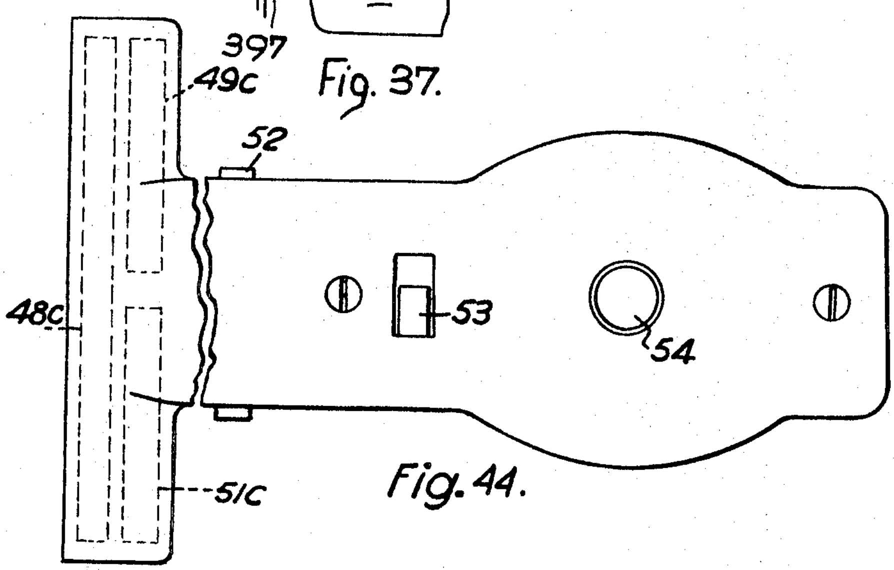

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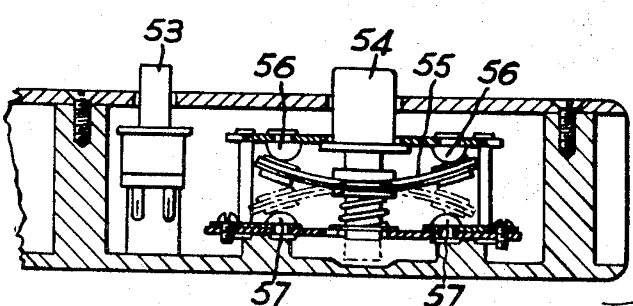

Fig. 46.

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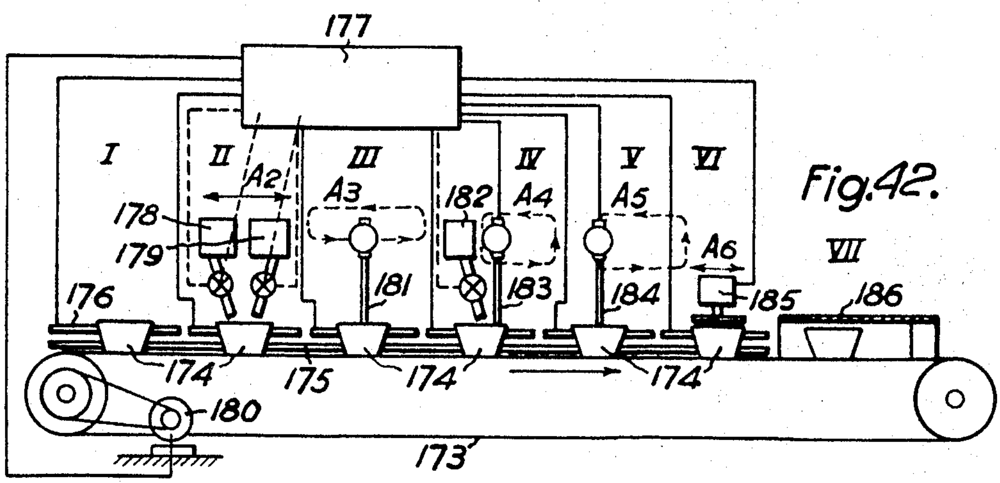

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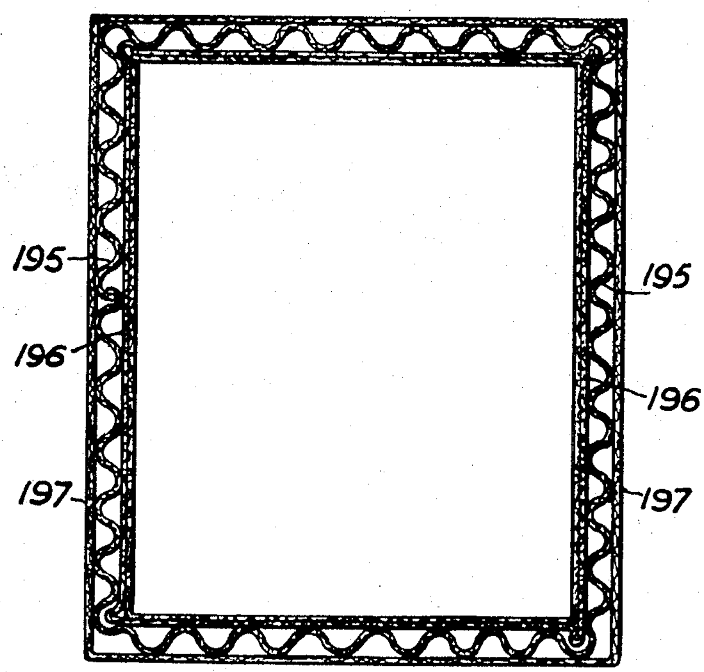

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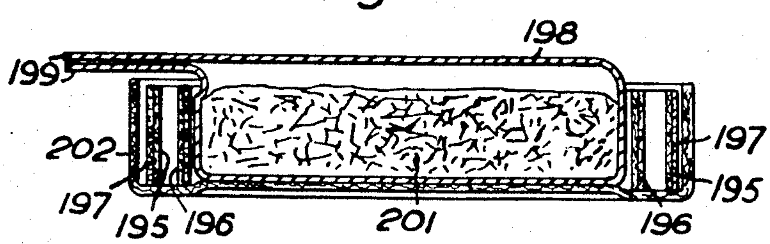

Fig. 52.

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SURFACE HEATING DEVICE

This application is a continuation-in-part of my Ser. No. 301,488 filed Aug. 12, 1963 for Surface Heating Device (now matured into U.S. Pat. No. 3,296,415) which was itself a continuation-in-part of my Ser. No. 749,554 filed Jul. 18, 1958 for Surface Heating Device (now matured into U.S. Pat. No. 3,100,711).

The invention relates to the heating of substances contained in packages of relatively small size. Foodstuffs in single or multiportions for immediate consumption are a convenient example illustrative both of the order of size and the kind of substance but the invention is not restricted to this example and can be applied to many other substances which it may be desirable or necessary to heat in the package, as for example, adhesives, coating materials, synthetic resins and similar thermosetting or thermoplastic materials, greases and chemicals. Hereinafter foodstuffs will usually be referred to for convenience.

The present invention provides for a substance to be heated while contained in a dispensable container included in a package to which end a thin low-voltage heating film is incorporated in the package at least during the heating operation, this film having a surface pattern presenting a resistive electrical path between at least two terminals to which access can be obtained for connection to a supply without removing the substance from the container. Thus by making connection of the terminals to a supply having a voltage appropriate to the resistance of the path heat can be generated in the film by which the substance can be heated. One object of the present invention is to enable such an arrangement to be used to heat the substance rapidly without any risk of hot spots in the conductive pattern which might damage the material, damage the pattern or have other undesirable results.

If it could be ensured that the whole conductive pattern were in intimate contact with the substance so that direct conduction of heat into the substance took place, the temperature gradient would be small, there would be no local hot spots and the permissible rate of heating would be limited essentially only by the heat conductivity of the substance and the time necessary for the substance to reach the required temperature. In practice however the conductive pattern usually cannot be allowed to come into direct contact with the substance because such contact may be undesirable for electrical reasons or on account of the nature of the substance and material of the pattern, for reasons of packaging, use or processing or storing of the substance, etc. There will usually therefore be at least one thin layer of material between the pattern and the substance to insulate the former and protect the latter; there may be more than one such layer as will appear later. Also it may be necessary for the pattern of the film to extend to parts of the container which are not or may not remain in direct contact on their external surfaces with the substances or even extend outside the container altogether, so that from these parts of the film heat can be dissipated only by radiation or possibly by radiation with some convection. Shortly stated therefore the dissipation of heat from the film in general will not be a simple function only of its area, and there will be a serious risk of local hot spots if a uniformly distributed resistive pattern is uniformly supplied with current without consideration of any differentiation required by the particular conductive heat transfer into the substance.

For reasons of efficiency, and it may be to enable the package to be handled in comfort, it is desirable that as much of the heat as possible should be dissipated with the substance and as little as possible in other directions.

According to the present invention the problems thus presented are solved by dimensioning the pattern so that in operation in addition to the dissipation into the substance no part of the pattern has to dissipate more than 4 watts per square inch, or in other words when the pattern is connected to a supply to the appropriate predetermined voltage the difference between the heat dissipated into the substance in the container from any area of the surface of the heating film and

the wattage supplied to said area is less than 4 watts per square inch of said area, while means are also included in the package ensuring that when the film is energized more heat is dissipated into the substance than reaches the external surface of the complete package. While such a difference may not be critical in any absolute sense, extensive investigations have shown that under such conditions rapid heating by a dispensable heating film without hot spots or damage becomes possible.

Depending on the manner in which the substance and the film are disposed in relation to one another during operation and the disposition in relation to one another during operation of layers which come between the actual conductive pattern and the substance itself it may be possible to use a film the loading of which is uniformly distributed over the whole patterned area, or it may be necessary to vary the loading in different parts of the film.

To assist in controlling the relative rate of dissipation of heat into the substance and to the external surface of the package, in some cases the film may be spaced a substantial distance inwardly from the external surface of the package, and the space thus left may be at least partly filled with thermal insulation. The package may include a wall having a flexible, thin, impervious and heat resistant inner layer, e.g. of metallic foil, and means ensuring intimate contact of the heating film with the outside of said layer at least when the film is connected to the supply.

A development of the invention provides for some other substance to be carried on a common supporting means such as a tray, thermal insulating means being provided whereby heat reaching the external surface of the package is hindered from reaching the further substance, thus for example enabling meals to be prepared consisting of both hot and cold foods.

A further object of the invention is to provide a heater additional to the heating film and so to construct a wall of the package that the heating of the substance can be supplemented by heat radiated by the additional heater.

Another object is to include means in the heat path between the film and the substance whereby the surface temperature at any point on the substance is prevented from rising above a predetermined maximum value, e.g. a value at which it is damaged or develops some undesirable characteristic such as stickiness. Thus at least during part of the heating period the film may be spaced from the surface of the substance to be heated thereby, and a small body of liquid may be present in the space which has access to the substantial area of the substance so that the temperature of the substance is kept down to boiling point of the liquid. This provision for the presence of liquid between the heating film and the substance is well adapted for use with deep frozen substances. The deep frozen substances may be enclosed within the container at least by a wrapper of metallic foil having perforations distributed thereover, a further substance which boils when heat is supplied also being included in the package and having access to the perforated foil. Such a package may be supplied separately from a heating film so that the two can be put together for use, or the package be heated by some conventional heater such as a gas or electric cooker.

Still another object of the invention is to enable the heat supplied by the film to be supplemented by conducted heat from another source, to which end a heat conductive flexible wall with one surface in contact with the substance, may have in contact with its other surface over a substantial area a plate equipped with means for supplying heat to it under the control of a temperature sensing element within the plate whereby the temperature of the plate is maintained within known limits, so enabling heat to be supplied to the substance at a rapid rate without the risk of local hot spots or temperature rises.

It may here be mentioned that for the purposes of this specification and in the claims "dispensable containers" means not that the container has to be dispensed with for technical reasons such as destruction being necessary for access to the contents but that it is economically dispensable. Generally speaking food and many other substances are packaged in containers the cost of which in comparison with the cost of their contents makes it economically feasible to dispense with them once opened, a highly desirable possibility from the hygienic point of view at least in the case of food. The films used in the present invention can also be produced sufficiently cheaply to enable them to be dispensed with, and their nature will generally be such that their cost will be lower than the cost of collecting, cleaning and reconditioning (e.g. sterilizing) and reassembling with other parts of the package so that there will be no incentive to attempt their recovery which would generally be undesirable at least in the case of food.

As will be shown they may be made of materials such as metallic foils which are commonly used in packaging, sometimes with the addition of such material as carbon e.g. graphite which in the quality and quantity required is also very cheap.

As mentioned above the films are designed to operate on a low voltage which is not dangerous to human contact generally below 50 volts and preferably a good deal below 50 volts. This not only avoids danger, but considerably cheapens the film by avoiding the need for high-class insulation. The low voltage may advantageously be the same as that of the usual motor car battery, namely 12 volts. Voltages of this order enable meander patterns of very convenient dimensions to be used in practicing the invention.

Further objects and features of the invention will become apparent from the following description with reference to the accompanying drawings. The drawings are diagrammatic and in particular where the heating film or other material is shown in section in most cases thicknesses are much exaggerated.

FIG. 1 is a perspective view, and

FIG. 2 a cross section of a moulded troughlike dispensable container according to the invention.

FIG. 3 illustrates the heating film used in FIGS. 1 and 2.

FIG. 4 illustrates the production of a heating film for a folded container.

FIG. 5 is a plan of the blank from which such a container can be made.

FIG. 6 is a perspective view of the folded container.

FIG. 7 is a perspective view, and

FIG. 8 a cross section of another folder container.

FIG. 9 is a perspective view, and

FIG. 10 a section of yet another folded container.

FIGS. 11 and 12 illustrate the production of a heating film with two branches.

FIG. 13 is a vertical section of a dispensable container for heating and dispensing a batch of liquid.

FIG. 14 is a circuit diagram of the container of FIG. 13.

FIG. 15 is a perspective view, and

FIG. 16 is a detail section of another dispensable container for heating and dispensing a batch of liquid.

FIG. 17 is a perspective view, and

FIG. 18 a section of a dispensable container in which the heating film also indicates the quantity of substance removed.

FIG. 19 is a section of an embodiment which provides for movement of the heating film in relation to the contents of the container.

FIG. 20 is a perspective view, partly in section of a further development for steaming or similar heating a substance.

FIGS. 21 and 22 are detail sections of FIG. 20.

FIG. 23 is a detail similar to FIG. 21 of an alternative to FIGS. 20 to 22.

FIG. 24 is another detail of this alternative.

FIGS. 25 and 26 show two stages in the use of a dispensable container in which the configuration of the heating film is changed between stages.

FIG. 27 is a perspective view of a container the contents of which are to be heated by radiant heat.

FIG. 28 is a perspective view showing the container of FIG. 27 in position prior to heating.

FIG. 29 is a perspective view and FIGS. 30 and 31 are details of a further development for radiant heating.

FIG. 32 is a section of another container the contents of which are to be heated by a contact heater.

FIG. 33 is a detail of a modification of FIG. 32.

FIG. 34 is a detail section and FIG. 35 a perspective view of an arrangement for heating a substance while maintaining another substance on the same support cold.

FIG. 36 is a perspective view of a more elaborate arrangement for the same purposes as that of FIGS. 34 and 35.

FIGS. 37 and 38 are details of FIG. 36.

FIGS. 39 and 40 are a plan and cross section of one of the trays used in this arrangement, the former with no food container in place.

FIG. 41 is another detail.

FIG. 42 illustrates a plant which may be used for processing food during packaging in containers according to the invention.

FIG. 43 is a detail side view, and

FIG. 44 is a plan view of clip device making connection to a heating film.

FIG. 45 illustrates the terminals of the film for which the device of FIGS. 43 and 44 is designed.

FIG. 46 is a detail longitudinal section of FIG. 44.

FIG. 47 shows a circuit using the device of FIGS. 43 to 46.

FIG. 48 is a longitudinal section of a plug, and

FIG. 49 is a longitudinal section of a socket for making connection to a clip device for connection to the heating film.

FIG. 50 shows a form of heating film which can be used in the invention.

FIG. 51 is a sectional plan and FIG. 52 a sectional elevation of a form of package within the scope of the invention.

FIG. 53 is a cross section of a heating film which can be used in the invention, embodying a carbon film.

FIG. 54 is a plan of the electrodes, and

FIG. 55 a section of another form of heating film embodying a carbon film.

A convenient form of container used in a package according to the present invention is a troughlike box made of moulded paper mache or similar material or folded from cardboard, paper or the like, the heating film being made integral with a folded-over unpatterned portion which forms an impervious cover layer which serves to enclose the substance in the container notwithstanding that the other material of the package may be porous, a thin electrically insulating layer coming between the folded-over portion and the pattern. The paper mache or folded cardboard, paper or the like is a relatively stiff fibrous material and it forms a thermally insulating layer, while the thin insulation and plain folded-over portion do not impose any great thermal resistance between the pattern and the packaged substance.

FIG. 1 is a perspective view and FIG. 2 a cross section of an open troughlike box which may be moulded of such material as paper mache. The heating film itself is made from metallic foil of the general form shown in FIG. 3. It consists of a plain part 81 integral with a patterned part 82. In the FIG. a single meander path is formed by the pattern between the central zone and one margin of the complete piece of foil, but this is only one variety; generally the pattern comprises a number of repeats. The part 81 is of somewhat greater length than the part 82. A thin layer of insulating material for example paper of somewhat less width than the portion 82 but greater length is laid over it as indicated by the dotted line 83 and the portion 81 is then folded-over the insulation on the line 84. This portion is of less width than the insulation 83, and thus after folding its edge is overlapped by the insulation. The margin of the portion 82 extends beyond the edge of the insulation 83. The foil and insulation may be held together by adhesive. The film so made is depressed into the troughlike box and the edges are lapped over the edges of the box as indicated by the cross section FIG. 2, the dimensions of the film being designed so that the fold at 84 reaches just under the edge of the box, the edge of the portion 81 remains wholly on top while the projecting margin of the portion **82** is also lapped over the edge of the box. These two margins thus constitute the terminals of the pattern and connection can be made by means of a clip such as described in my U.S. Pat. No. 3,100,711.

The length of the patterned portion **82** may be such that it lies wholly within the box while the length of the portion **81** is such that it extends over the end walls of the box and over the upper edge. There will be some puckering of the portion **81** at the corners but this need not damage it and the foil will form an impervious lining which covers the slots in the pattern and is of good heat conductivity. The folding of this portion to fit the container may be facilitated by crimping the material and such crimping may also extend to the patterned portion **81** or the latter may be plain while only the portion **82** is crimped. After the box has been filled the open top may be closed by a cover held by adhesive and this may be arranged actually to press the packed substance against the heating film. Instead of a simple cover a second similar box can be used and the two be secured together by adhesive at the margins but the terminals of the films will need to be brought further out to permit connection to be made.

FIGS. **4** to **6** illustrate a somewhat similar container to FIGS. **1** to **3**, but produced by shaping, scoring and folding of flat stiff fibrous thermally insulating material such as cardboard, incorporating the heating film. As before the film itself is made of a doubled-piece of foil comprising a plain part **85**, a patterned part **86**, and a layer of insulation **87** between the two portions. After the film has been made, it is laid on (and may be laminated to) a sheet **88** of cardboard or similar material which has been slotted as at **89** and creased at the dotted lines **91**. Thereafter the assembled material is folded at the crease lines and in the corners in the well-known fashion to produce an open box as in FIG. **6**.

The laminated packaging material can be produced in a web and is cut up in pieces for shipping as flat stock to be erected into a box when the box is filled. It can instead be supplied in the web, and the plain parts **85** which are to form the impervious inner layer of the box can be left uncrimped, if desired, although the patterned parts **86** may be crimped.

It will be seen in FIG. **5** that the margin of the patterned part **86** extends furthermost to the right, that the insulating sheet **87** does not extend quite as far while the edge of the plain part **85** of the foil does not reach quite to the edge of the paper sheet **87**, but all these margins extend so far that when the folding is completed a projecting margin is formed with foil exposed on both sides. This foil constitutes the terminals and the projecting margin of the part **86** may be folded under so that both terminals are slightly overlapped by the paper **87**. As before the patterned part **86** does not extend beyond the ends of the bottom of the box but the plain part **85** covers the bottom and all four walls of the box. The box may be closed by a plain cover or two boxes may be used together if provision is made for access to the terminals.

If it is necessary or desirable to provide for the substance in the box to be heated from the top as well as the bottom as shown in FIGS. **7** and **8** a folded box may be produced having an integral hinged lid **92**, a heating film **93** extending into the lid. The film itself is made on the same lines as in FIGS. **4** to **6** the dimensions being modified and the terminals are brought out exactly as in FIG. **6**. The shape, slotting and creasing of the cardboard or similar material and the manner of folding are in themselves well known and need not be described further. With this arrangement connection to the film can be effected without opening the box but if preferred the margin with the terminals can be folded inward so that the box must be partially opened to gain access to the terminals though they may then be folded outward. The package may be sealed with the terminals folded in and the lid sealed so that the purchaser has to destroy the seal to obtain access to the terminals.

Other schemes for supplementing the heat supplied by the heating film, including supplementary heating from the top are described later.

For packaging and heating a liquid, a box as shown in FIGS. **9** and **10** may be used. Such a box again is of well-known form and can be produced by folding from a blank of suitable shape on very similar lines to FIGS. **4** to **8**. A heating film **94** with accessible terminals **95** is incorporated and the patterned area extends up to the level **96** while the liquid level is at **97**, so that it wholly covers the area of the film in which heat is developed.

By suitably changing the dimension and proportions of the blank various other folded box-type containers can be produced and similarly moulded containers on the lines of FIGS. **1** to **3** can be produced with different proportions. A moulded container can be provided with a heated lid by extending the film into a moulded lid.

A particular difference between a moulded container and a folded container is that the latter necessarily has sharp corners at the folds while a moulded container can be produced with rounded corners which may be more desirable in some cases. Where the heating film extends into the lid the pattern may be dimensioned so that the heat developed per unit of area is different in the lid from what it is in the bottom of the container.

FIGS. **1** to **10** show the heating pattern consisting only of one meander path. This is done for sake of simplicity of drawing; each pattern can consist of a group of equal or different repeats, i.e. meander paths in parallel. These examples also assume a pattern of a single resistance or resistance grouping between two terminals and thus a single rate of heating and of heat distribution to the contents of the container under a specific supply voltage. A pattern with two branches having its terminals disposed to have connection made to it by a suitable clip (as described with reference to FIGS. **16**, **17** and **18** of my U.S. Pat. No. 3,296,415) may be made as illustrated in FIGS. **11** and **12**. A piece of foil (which again may be cut from a continuous length bearing a repeating pattern) has two patterned margins **98** each with a half-length tab **99** at the extreme edge these tabs being relatively longitudinally staggered. The foil is scored and folded at its longitudinal centerline **101** and again at two longitudinal lines **102**. Two pieces of sheet insulation e.g. paper are introduced. One piece **103** goes between the two patterns. On one edge it reaches almost to the score lines **102** while on the other edge it reaches just beyond the edges of the tabs **99** so that the latter are effectively insulated from one another. The second sheet of insulation **104** is introduced between the upper surface of one pattern and the undersurface of the doubled center zone of the film. One edge of this insulation reaches the folds **102** while the other leaves the upper tab **99** exposed. The dimensions of the film and position of the score lines **101**, **102** are such that the fold at **101** does not reach to the outer edge of the insulation **104** so that the latter effectively insulates the plain part of the foil over the upper pattern. The two tabs **99** constitute terminals while the zone of the plain part of the foil adjacent the fold **101** constitutes a common terminal. It will be clear that a heating film so made can be used for example in boxes such as those described with reference to FIGS. **1** to **10** and that the plain parts of the foil can be made longer to cover the end walls of the box. They can also be used in the heating of liquids at the time of dispensing from a storage vessel as described below.

An arrangement which enables specific quantities of liquid to be drawn out of a storage vessel and then heated before being dispensed comprise a tube having one end portion adapted to be inserted into the vessel, another end portion for discharge and between the end portions an enlargement of such volume as to contain at least one batch of the liquid. Suction is generated at the discharge end of the tube by sucking, by squeezing the flexible tube walls or otherwise and flow control means enable this to be used at choice to draw liquid from the vessel into the enlargement and to draw liquid from the enlargement through the discharge end. The dispensable heating film is in good contact with tube wall at least over the major part of the enlargement and the whole device constitutes a dispensable container. Flow control means may be combined with switching means for the heating film whereby the current can be varied according to whether liquid is being drawn into the enlargement or out of the enlargement, the film then having a pattern with at least two branches as described above.

FIG. 13 shows a device on the above lines. The tube 109 carried for example by a cork or similar stopper 111 and long enough to extend to the bottom of a storage vessel such as a bottle has a portion 112 of enlarged diameter above the stopper and of a volume to contain one batch to be dispensed. In good heat conductive contact with the wall of the enlargement 112 is a heating film 113 having two branches the terminals being brought out and connection being made by a clip 114. However there need only be two terminals and two contacts on the clip as the control of the flow through the two branches is not effected through the clip but by means of a drawoff tube 115. The drawoff tube is a sliding fit in the contracted upper end of the enlargement. To draw liquid into the enlargement the tube 115 is brought into its uppermost position shown in FIG. 15, when a fitting 122 ensures a sufficiently airtight closure of the enlargement. Suction on the outer end of the tube 115 will now draw liquid into the enlargement 112 and if the outer end is now closed by the finger the liquid will remain in the enlargement while the tube 115 is depressed until a conical fitting 116 at its lower end seats in the bottom of the enlargement and thus prevents liquid from running back into the bottle. There is a hole 117 in the tube 115 which is just above the fitting 116 so that if now suction is applied to the outer end the liquid will be drawn through the hole 117 into the tube 115 and out of its upper end, air entering between the tube 115 and the contracted end of the enlargement, a groove being provided if necessary for the passage of air.

There are two contacts 118 at the lower end of the enlargement which are bridged electrically by the fitting 116 in the lowered position of the tube 115. There are two separate pairs of contacts 119, 121 at the upper end of the enlargement which are separately bridged by the fitting 122 on the tube 115 when this in the position shown in FIG. 13. The circuit is shown in FIG. 14. With the tube 115 in the position of FIG. 13 for drawing liquid into the enlargement there is no bridge across the contacts 118, consequently the supply passes from the lower of the terminals 123 first to the contacts 119 which are bridged by fitting 122 and thence to a terminal common to the two branches 124 of the heating film and then through the contacts 121 also bridged to the other terminal of the supply. Thus the two branches are in parallel and the maximum rate of heating is achieved. After the liquid has been heated as desired the tube 115 is depressed and in its lowermost position contacts 119 are disconnected, contacts 121 are disconnected, but contacts 118 are bridged. Accordingly the lower terminal of the supply is connected to the upper end of one of the branches 125 and the upper end of the other branch 124 is connected to the other terminal of the supply. The two branches are thus connected in series and the rate of heat development is therefore reduced to a quarter of what it was before, serving to maintain the temperature of the liquid which will slowly rise or fall depending on the conditions of the particular case. Suction can be applied by any means but it is contemplated that this device is generally to be used for a beverage to be consumed by suction applied by the mouth after the fashion of a drinking straw.

The device illustrated in FIGS. 15 and 16 enables suction to be generated by the device itself more conveniently than in the device of FIG. 13.

In this case there is again a tube, marked 125 which reaches to the lower end of the storage vessel 126. It is shown passing through a closure in the top of a bottle but might carry a cork or the like as in FIG. 13. The tube 125 communicates with the upper end of an enlargement 127 which is made of cheap flexible material, e.g. polythene. The enlargement is equipped with a discharge tube 128 which reaches practically to the bottom, but also has an aperture 129 near its upper end, just under the flexible top 131 of the enlargement. Close by is an aperture 132 in the top 131 with a flap 133 which can close it but which tends to spring open.

Around the enlargement 127, in good heat-conductive contact with it, is the dispensable heating film 134 provided with a two branch pattern. Connection is made to one branch by a clip 135, the pivot 136 of which is tubular and 16 and this serves to hold the clip and enlargement together by passing the tube 125 through the pivot.

The second branch of the film pattern has a terminal area 137 covered at its end, near the clip attachment, by thin insulation 138 such as paper and over this is a piece 139 of spring foil with which the clip makes contact and which overlaps the paper 138 but normally springs away from the terminal area 137.

In use, by closing apertures 129 and 132 by finger pressure on the top 131 and flap 133, and applying suction to the end of the discharge tube 128 liquid can be drawn out of the vessel 126 and the enlargement 127. If the flap 133 is now released while the aperture 129 is held closed, continued suction will draw liquid out of the enlargement 127 and the tube 128. Alternatively the enlargement can be squeezed to drive out air, the apertures 129, 132 and the discharge end of the tube 128 be closed and the enlargement then released when its expansion will generate suction which will draw some liquid up into the enlargement and this pumping action can be repeated until the enlargement is full. Then further squeezing with both apertures closed will discharge liquid from the enlargement through the tube 128.

One terminal of the film will be in circuit as long as the supply is connected, while the other can be brought into action by pressing the foil 139 into contact with the terminal area 137. The fact that these foils are bare does not matter with a low supply voltage of say 12 volts. Both branches are brought into operation for rapid heating of the liquid when the enlargement is full, and one branch to maintain the temperature during the discharge of the enlargement. Alternatively the clip and terminal pattern of the film may be as described above with reference to FIGS. 11 and 12 to enable the heat dissipation to be varied.

The devices shown in FIGS. 13 and 16 can readily be produced by moulding such a material as polythene and will be cheap enough to be dispensable. Their shapes may vary considerably from those shown without any change in their operation. They may also be made of other materials and by other methods without any change in their operation, for example of folded paper or the like of a quality which remains impervious for the necessary period of use.

A dispensable container and dispensable heating film according to the invention can also be used in cases in which only part of the contents of a package are to be used at a time, in which case the film can be provided with means visible from the outside indicating the proportion of heat substance removed from the container. For example the film may be wrapped around the substance and have one end held under tension so that when some of the substance has been withdrawn, the film is drawn close to the reduced volume of the substance, a corresponding length of the film being drawn out of the container and serving as a measure of the removed substance.

As shown in FIGS. 17 and 18 a dispensable container 141 of somewhat similar form to that shown in FIGS. 9 and 10 and which could similarly be made of folded paper or cardboard is equipped with a heating folded-over 142 which surrounds a flexible bag 143 containing the substance 144 to be heated but is not stuck to the inside of the container. The container has a narrow aperture 145 of its full width and one edge 146 of the film is secured to the edge of the aperture, while the margin 147 at the other edge incorporates the terminals and passes through the aperture. When the container is full (FIG. 18) this only need emerge enough to permit access to the terminals by a clip 148 through which connection is made. Before use, this margin may be folded-over and covered with a seal of paper or the like. The container also has provision for withdrawing heated substance through the end. For a granular substance it may for example simply be cut open for the purpose or have a scored area which can easily be removed, or if the substance is a liquid or becomes liquid when hot there may be a tube 149.

To heat the substance the whole is simply suspended from the clip as indicated in FIG. 17, when the weight holds the film in tension. When some of the heated substance is removed, a corresponding length of the film is drawn out and it is calibrated with markings indicated at 151 showing what proportion has been removed.

The above example has the film movable in relation to the container and its contents. So far as any part is no longer dissipating heat into the substance it is outside the container and accordingly as long as the film has no area dissipating more than 4 W/sq. inch no difficulty should arise even though this part dissipates heat at the same rate so that in contact with the substance. However other cases arise in which relative movement between the film and container is required, effected by means operable without removing the substance from the container for the purpose of changing the heat dissipating relationship of the film to at least part of the substance in the container. It may be necessary for example to change from conductive heating to radiative heating or to apply the heat to two different substances one of which changes its state and requires greater space for its accommodation.

An example of the latter is illustrated in FIG. 19. This illustrates the defreezing and then steaming of frozen raw food such as vegetables. The food 152 is enclosed in a bag 153 which incorporates the heating film and is held in a separate wrapper 154 at least the bottom of which is porous as at 155. The heating film is designed so that it develops most heat at the bottom of the bag. The lower part of the bag has at least one concertina fold as at 156 and contains the necessary water or other liquid. This liquid can be in the form of an ice cube inserted during packing or liquid can be added by the user when he opens the upper end of the bag to gain access to the terminals 157. In use the bag is suspended by the terminals 157 in a clip connector such as that described in my U.S. Pat. No. 3,100,711 with reference to FIGS. 4 and 5. The bag at first remains folded until defreezing is completed and the liquid is heated up, but when the pressure rises the fold 156 unfolds and room is left at the top for steam. If need be, there can be several folds depending on the proportions, the rate of boiling and such like conditions. Only a small steam escape is provided and there will be a constant reflux of condensed steam back into the body of liquid being boiled. Instead of a bag, a box may be used but this must be large enough to provide the necessary steam space.

A further development of the above scheme which permits a high input of heat to the food or other substances without the temperature rising above a value likely to cause difficulties through the development of stickiness and other undesirable phenomena due to surface decomposition is shown in FIGS. 20 to 24. This is particularly applicable to food or other substances which contain a low proportion of liquid but are permeable to vapor. If the food or other substance should be impenetrable to vapor, e.g. if it is deep frozen, it is made penetrable by holes or channels being provided for in the slab prior to, during, or after freezing and/or vapor paths being arranged along the sides of the slab by pulling the sidewalls of the package a little away from the frozen slab.

The characteristic of this development is that the substance is packed in such a way that there is a small body of liquid in the space between the heating film and the solid part of the substance at least as soon as melting has progressed sufficiently to affect the solid part.

Preferably the body of liquid is contained in a pervious spacer between the heating film and the substance. Accordingly, as long as any liquid is left, the temperature of the liquid cannot rise above its boiling point and the vapor thereby produced which is at this same temperature, permeates the substance and heats it, mainly by delivering its latent heat to the substance. This causes condensation and the liquid runs back into the bulk container in the spacer. In the typical case of water the temperature will not rise more than a little above 100° C. because pressure developed will not rise substantially above atmospheric. The rate of heat transferred can be relatively high because with water for example the latent heat amounts to nearly five times the sensible heat at boiling point.

The separator can be of any convenient construction and any convenient material which will withstand the temperature and not give rise to undesirable chemical reactions. Typically it can be of metal, e.g. aluminum or of so-called plastics material, e.g. nylon. In the case of food the liquid and the spacer are desirably edible. Thus the spacer may be a thin slab of ice or edible jelly, or it may be a porous biscuit or wafer or a reticulated structure of jelly, with the spacer filled with water, preferably frozen when assembled.

FIGS. 20 to 24 illustrate two examples. The package itself is similar to that illustrated in the earlier example (FIGS. 1 and 2) and comprises a shallow tray or box 301 of paper mache, or other suitable material, and a heating film 303 lining the bottom of the container. It could equally well be made in accordance with other earlier examples such as those of FIGS. 5 to 10.

The foil pattern 303 is backed by an insulator 302 of paper or the like. If the frozen food pack is heated in a tray or pan the paper mache container is not necessary and the insulator forms the bottom of the frozen food pack. It serves also to insulate the foil pattern 303 from the tray if the latter is a metal tray.

There is also an insulator 305 of paper or the like on the upper surface of the film, but at the two ends the film extends beyond the paper at 304 constituting bus bars or terminals. The upper insulator 305 is covered with an aluminum foil 306 to protect it from the liquid. There is an inner lining 308, the bottom of which is perforated and spaced from the foil 306. This liner 308 receives the substance to be heated. Its edges are folded-over the insulator 305 (FIGS. 21 and 23) at the ends and closely over the margin of the tray 301 elsewhere (FIG. 22). There is a cover 310 of aluminum foil which is similarly positioned or secured around the edges.

The space between the perforated bottom of the liner 308 and the foil 306 serves to receive a pervious or porous spacer which holds them apart and which holds the liquid. In the first example (FIGS. 20 and 21) this spacer 307 consists of a loosely woven, knitted or simply tangled stranded material which may for instance be of cord, wire or nylon.

In the second example (FIGS. 23 and 24) the spacer is integral with the bottom of the liner 308 which is folded into ribs 309 located between the apertures. It is emphasized that these are only examples of possible materials and constructions of absorbent spacer, and in particular in the case of food the spacer may be of edible material.

Instead of the combined perforated foil 308 and ribs 309 the insulator 305 could be crimped or otherwise folded into ribs (these ribs could be perforated) and form a spacer for either the perforated foil 308 or for the solid food directly, if the solid food parts are large enough to rest on the ribs. In this case a perforated foil 308 is not necessary for preventing direct contact with the heating film.

A similar effect can be obtained by other forms of combined insulating spacer and barrier, such as very porous plastic sheets, nets or sieves used as the insulator without provision of a perforated foil.

While the provision of a foil or film-type spacer barrier is preferred for the purpose of ensuring that there is a body of liquid in the space between the solid food and the heating film, other means to ensure this result are also possible and are within the scope of this invention. The frozen food slab may, for instance, have a slanted bottom like an inverted pyramid or roof the crest resting on the flat tray. The heating film being heavily crimped collects the liquid in the crimps, melts channels for the vapor path and is so lightly fixed to the food that after the ice to which it adhered has melted, it drops away from the bottom of the food to allow more space for the liquid or vapor. In this variety neither a special spacer nor a barrier is required, spacing being effected by the shaping of the frozen food slab.

In another variety of the present invention the perforated foil is used as a wrapping for the frozen food which is supplied packed in this wrapping while the heating film with all or only some of its parts 302, 303, 304, 305 is supplied separately so as to permit a choice for heating the food either by the heating film or in a metal pan on a standard gas or electric cooker.

The rapid heating of the frozen food can be still further accelerated by the tray **301** being vibrated and/or by the heating film being supplied with pulsed current. This "shock-heating" by a cyclic succession of heavy current and no or low current periods gives the food a better opportunity to take up the heat of condensation.

For some purposes it may be desirable for the heating film or part of it to occupy a compact configuration before the ultimate removal of the heated substance from the dispensable container, means being provided which are operable without removing the substance from the container for stretching the film or the aforesaid part of it into an extended form and location for transferring heat from it to the substance. To permit heating while the film is in its compact configuration its terminals are made accessible without removing the substance from the container.

An example of food in slices. In FIG. **25** the film is a long web **158** folded concertinawise, the folds holding thin slices **159** of the foodstuff. The whole may be enclosed in a usual wrapping or container not shown. This arrangement permits very quick heating up in view of the large surface area in contact with the food and the thinness of the food sandwiched between the folds of the heating film. As shown only the odd folds of the web are filled with food slices, the even folds being compressed together; thus the web assumes a comblike configuration. The comb ends may as shown be bent to enclose the slices completely. The heating film may be porous or perforated to permit circulation of liquid or vapor between adjacent slices or the slices may have inner wrappings for easier and cleaner removal. More than one web may be arranged in a food package or container. This application of the heating film is one preferred way for quick defreezing of deep-frozen food, for rendering wafers and biscuits crisp again and for many solid foods which are enclosed in a package of insufficient surface areas to permit a speedy enough penetration of heat from that area to the inside.

When the film is supplied with current in its folded compact configuration each slice is heated from both sides and this combined with the small external surface ensures rapid heating. When the slices are to be removed, the whole is unfolded into the form shown in FIG. **26**. Assuming all the slices **159** remain associated with the corresponding folds of the film **158**, when unfolded there will be a single width of film alternating with each slice. Thus if the current supply is maintained a smaller proportion of the total heat will be conducted into the slices so that they will be heated to a lesser extent. The pattern of the film can be designed to proportion the heat which reaches the slices and that which is simply radiated away as desired, in particular it may be more than 4 watts per square inch in those parts on which the slices rest and less in the other parts.

The heating film can have terminals not shown at the folds or some of them to permit the heating of a single slice or of a group of slices whether in the folded or unfolded configuration.

As above mentioned it may be desirable in some cases to provide for the heat supplied by the heating film to be supplemented by heat from another source. FIGS. **27** to **33** illustrate some possibilities.

One purpose served by these developments is not only to effect heating quickly and efficiently without the risk of local overheating, but to permit the package itself to determine or directly to control the magnitude and time function of the heating parameters, i.e. temperature, type, direction, and source of heat energy fed into packaged material; humidity or steam developed and kept in enclosure or released, or material processed dry; pressure in enclosure.

The example illustrated in FIGS. **27** and **28** is the heating of a deep frozen foodpack but it is to be understood that the scope of the invention is not limited to this example but extends to all materials and services for which this type of processing can be advantageously employed.

In FIG. **27** a deep frozen foodpack is illustrated which is on similar lines to those of FIGS. **1** to **8**. A heating film suitably of aluminum foil is provided on the inside of a cardboard or paperpulp box forming container **321**. The film itself is not shown, but its terminals or bus bars **322** are folded over the edges of the container **321** to enable connection to be made to it as in previous examples. A black-coated aluminum foil **323** covers the top, and the terminals **322** extend sideways. Instead of the dispensable cardboard or paper mache box a tray of heat resistant material (fiberglass moulding, enameled steel tray) can be used into which the frozen food wrapped in heating film is always placed for heating purposes.

The inner layer **324** of the packaging wrap is aluminum foil or a heat stable plastic film. The foil patterned into a heating element is either laminated to this inner layer or is placed inside the foodpack as on immersion type of heater. In the latter case the slots in the foil should, at least to some extent, not be blocked by any supporting film or paper so that there is a free passage for steam or fluid through the foil-heating film. A plastic or woven net, an open mesh textile, fibers stuck on to the foil, perforated paper or plastic film are examples of suitable supporting layers.

A black cover foil **323** is a suitably thin aluminum foil with a matt black epoxide coating on the outside and the natural matt surface inside. Other heat stable coatings of the aluminum foil are also suitable. Foil anodized and dyed black on both sides is preferred where the cost of anodizing is not objectionable. A cheap though less effective alternative is the use of finely embossed foil. The purpose of this surface treatment is to have a cover which is heat stable, and has a high radiant heat absorption factor so that it transmits radiant heat efficiently to the material inside the package. In some cases it may suffice for only the internal surface or external surface of the cover foil to have a high radiant heat absorption factor.

When the heating film is used as immersion film the food is preferably not only covered but fully wrapped in a foil or film which is black on the outside surface. While the wrapping is in contact with the food to which it transmits absorbed heat, mainly by conduction, the cover foil is usually spaced a little from the food. It transmits the absorbed heat to the food therefore mainly by radiation if its inside surface permits efficient emission of radiation. The blackening or matting of its inside as well as outside surface serves this purpose.

FIG. **28** illustrates an enclosure for heating a single foodpack containing for example ten portions. It consists of a base **325** to which a hood **326** is hinged at **327**. The base has two contact bars **328** on which the bus bars **322** of the heating film of the foodpack rest. The hood is provided with a preferably black metal sheet **329** of approximately the same size as the cover foil **323** of the foodpack. A flat electric heating element not visible in the drawing, e.g. a heating film, is laminated to the outer surface of the sheet **329**, and thermally insulated on its outer side so that the metal sheet **329** can heat up quickly and can radiate almost all the heat generated on to the cover foil **323** of the foodpack when the hood **326** is closed. The closure desirably automatically effects the switching on of the current to both the heating film via the contact bars **328** and to the radiating sheet **329** in the hood. The closed hood also forms a well insulated closed chamber round the foodpack preventing escape of vapor if a hole in its rear wall (not shown) is kept closed.

The food in the pack is heated by both the heating film inside or on the aluminum foil enveloping the food, and by the radiant heat emitted from the hot sheet **329** in the hood. The cover foil **323** absorbs the radiant heat and transmits it to the food by radiation and contact with the vapor to the space between itself and the top surface of the food. If it is desired that this vapor should escape so that the food becomes more concentrated after heating the cover foil **323** is provided with openings and the hole in the rear of the hood is opened. These openings in the cover foil may have been sealed prior to the heating by a film or other sealant of low melting point so that the package is closed all around until it is placed in the enclosure and the heating has progressed to a temperature at which the sealant melts and thereby opens the apertures in the foil.

A slight pressure-cooking effect can be achieved by suitable choice of the sealent but if a substantial pressure cooking effect is desired the hole in the hood is sealed to the base by provision of an elastic gasket around its lower edge.

The heating parameters are controlled first of all by the current to the heating film and the current to the radiating sheet which are independently regulated in amperage and according to a time function. The parameters are further controlled by the amount of liquid put into the foodpack, by the provision of a cover foil with or without openings, and by the timed operation of a pressure valve in the hole in the hood.

If the heating film is in the center of, or within the food and used as immersion heater, other permanent heat-radiating sheets similar to the sheet **329** can be arranged on the base **325** or on the sides of the hood in addition to the sheet **329** radiating on to the cover foil **323**. These additional heat radiating panels may be controlled in the same way as the top sheet. The food or other packed materials is in this case preferably packed in black, heat absorbent film or foil and/or a black enameled tray is used instead of a cardboard or paper mache box to hold the package during heating and handling afterwards.

FIGS. **29**, **30** and **31** show trolleys **331** which can be linked into a train to run from a control point to outlying wards of a hospital, or stand behind a serving counter in a canteen, each comprising a chest of drawers **332** each serving as a compartment for one pack such as that of FIG. **27**, and a panel **333** with separate controls for each drawer. The lower part of the trolley includes a cubicle **334** for a transformer and electrical accessories common to all drawers. There is also a cupboard **335** for plates, cutlery or other utensils.

FIG. **30** shows a section through one drawer compartment while closed for heating a package and FIG. **31** shows the drawer sprung open for the hot foodpack to be taken out or a cold one just put in. Each drawer is an enclosure very similar to that shown in FIG. **28** above described. There are certain differences: the drawer is wedge shaped so that locking and switching-on devices indicated at **336** also ensure contact pressure on the bus bars and a good seal to the fixed upper part **337** of the compartment in which the radiant panel **329***a* and an opening **338** leading to a pressure valve is located in the small space **339** above the cover foil **323***a* of the foodpack when the latter is in the locked drawer.

The space **339** may be illuminated by a light source not shown and provision can be made for it to be inspected from the outside when the drawer is in the locked position, as by making parts of the front and rear walls of the fixed upper part **337** of clear glass and/or providing the drawer with a glass front or glass covered opening.

The pressure in the space **339** may be controlled by a solenoid operated pressure valve not shown housed in the panel **333** on the right side of the drawer compartment and to which the opening **338** leads. It permits the vapor or steam developing during the heating to escape fully or to a desired degree only, and it can give to the compartment fully efficient time controlled pressure cooker functions whereby the pressure can be programmed both in magnitude and time.

If air, or steam pressure, or a special gas or vacuum line is available and is carried to the panel, the pressure valve can connect the compartment to such gas, vacuum, air or steam pressure line and achieve the processing of the material under the time controlled influence of the chosen atmosphere. For heating of prepared food this special atmosphere is usually not necessary except when the compartment is required to exercise the function of an autoclave and the food is heated in the pack for sterilization and storage purposes rather than direct consumption. For some other materials, however, this processing control of heating in a special atmosphere of a selected gas or vapor under a desired pressure according to a desired timing is of more general use.

The pressure cooking of food for which a drawer compartment as shown in FIGS. **29** to **31** is suitable is generally cooking under the pressure of the steam developed from the liquid in the food package. Only light pressures would be permissible unless the compartment were very strongly built and sealed. For higher strength the preferred shape of the compartment would be cylindrical or even spherical with bulkhead types of doors instead of rectangular drawers.

FIG. **29** shows a pushbutton switch **341**, a pilot light **342**, and a slot **343** for a panel of plastics material next to each compartment on the panel **333** at the right-hand side of the drawer compartments which are all at a height off the floor convenient for servicing without bending down. A panel is issued with each foodpack and carries the programme of the processing of this pack in a relief configuration and/or specific perforation. The panels as well as the foodpacks may be color coded and may carry also other symbols to ensure that the panel belonging to a particular foodpack is readily identified.

The heating process starts when the foodpack is placed into the drawer, the drawer is locked, the panel belonging to the particular pack is inserted and the switch **341** pressed. The programme carried by the panel is thereby set in operation which generally means that the radiating panel **329***a*, the heating film and the pressure valve are energized according to the specific magnitude/time function desired for the particular foodpack. Temperature, humidity and pressure-sensing elements fixed in the compartments may be used to control the execution of the programme.

The electric circuit and the circuit components associated with a particular compartment including fuses, contactors, timers, relays, solenoid operated pressure valve, the circuitry of the sensing elements and the panel sensing circuit and mechanism, are mounted on a separate rack or chassis next to the particular compartment behind the right-hand panel **333** while the transformer in the cubicle **334** of the trolley supplies all the packs, four in this example, with the power required at the preferred low voltages earlier specified herein.

In the foregoing description of FIGS. **27** to **31** it has been shown by way of example how this development of the invention is applied for use in canteens, hospitals or other communal food serving establishments when a good many parameters of processing are to be controlled. If the foodpack is smaller, say a single portion pack, and fewer or only one of the parameters needs controlling, the arrangement can, of course, be simplified. In a vending machine, for instance, the insertion of a coin may be used just to set the heaters in operation for a preset cycle and instead of the trolley with its various controls a design on the lines of well known vending machines may be used with much simpler electric circuitry and settings not accessible to the public.

A further development of or alternative to that described with reference to FIGS. **27** to **31** will now be described with reference to FIGS. **32** and **33**.

The main feature of this development is a thick plate **351** of material of good thermal conductivity, usually but not necessarily of metal such as aluminum or copper, which fits easily with plenty of play into a vessel **352** holding the food **353** or other substance to be heated. The food or other substance may be deep frozen. The vessel **352** may itself be a box or the like as described above with reference to FIGS. **1** to **6** and equipped with a heating film, or it could be as described with reference to FIGS. **20** to **24**; any cover would be removed before the plate **351** is put into it. When in place the plate **351** rests on the food **353** either directly or with an interposed layer or layers to be described. An electric heater **354** is electrically insulated by insulation indicated at **355** from, but in good thermally conductive contact with, the plate **351**. A foil heating film, referred to above, or described in any of U.S. Pat. Nos. 3,283,284, or 3,033,970, or 3,020,378 or 3,149,406 is a preferred heating element for this application particularly if it is run at a low voltage, not dangerous to touch, i.e. below approximately 50 volts.

A temperature sensing element **356**, such as a thermostat of the capillary tube type, is embedded in a hole drilled in the plate **351** and leads to a switch, contactor or other control device **357** which regulates the energy supplied to the heater **354** so that the plate **351** is held at a desired temperature within the narrow limits of this control arrangement. The heater is rated to have sufficient power quickly to replace into the thermal capacity of the plate **351** any heat which it has lost when in contact with the substance to be heated even when this heat loss is the maximum loss foreseen during practical use of the device. The temperature at which the plate **351** is held is adjustable by adjusting the control device **357** at which the thermostat **356** operates. The adjustment dial **358** is preferably on or near a fused plug **359** from which the supply to the heater **354** is drawn or at some other convenient location.

A thermally insulating cover **362** constitutes an efficient lagging over the heater **354** on top of plate **351** so that almost all heat energy from the heater **354** flows downwards into the plate **351** and neither the heater nor the plate can dissipate heat upwardly to any great extent.

The parts **351**, **354**, **355**, **356** and **361** form a lid which can be closed on to the vessel **352**. In addition to the above essential components the lid may also contain the following optional features:

There may be provision to limit the depth to which plate can sink into the food when the lid is placed on it. This provision may be adjustable bolts, handles, knobs, protrusions or the like and limit the lowest position of the plate relative to the edge of the food vessel or to its bottom or to another convenient point. By way of example the lid is shown provided with lugs **360** through which pass bolts **363** provided with lock nuts **364**. Descent of the lid is checked by engagement of the bolts **363** with lugs **365** on the vessel **353**. There may be clips **366** or other convenient provision for the attachment of an aluminum foil or plastic film **367** (e.g. a high density polythene film or polypropylene film) which which to cover at least the bottom and sides of plate **351** temporarily so that it never directly touches the food. After use the aluminum foil or plastic film **367** is dispensed with. If the bottom of the plate **351** is not plane, cylindrical or undulated but dimpled or of any other shape not developed from a plane, the aluminum foil or plastic film **367** is premoulded into the same shape in order to fit snugly over the bottom of the plate.

There may be provision to strip any food adhering to the aluminum foil or to the plastic film **367** after heating when the lid is lifted. This provision can be a blade or an edge **368** which can be moved over the foil or past which the foil is pulled out, and the foil or film then may be thrown away, soiled but without more than at most a thin layer of food on it.

Instead of securing a foil or film **367** to the plate **351** a piece of aluminum foil or a plastic film **369** FIG. **35** can be placed on the food **353***a* directly and the lid be placed with the plate **351** in direct contact with the foil or film, which after the heating cycle is taken off the food at any convenient time after the lid has been lifted.

Provision is always made e.g. handles **371** for handling the lid and there may be a pilot light **372** or other signalling provision preferably on or near the control device **357** which is operated by the thermostat **356**.

A preferred design makes the lagging constituted by the cover **361** of such low density that the overall density of the whole lid including plate **351** is lower than that of boiling water so that the lid can only sink into any liquid food to less than its full height. In any case this would only occur if the bolts **363** or equivalent were wrongly adjusted.

The functioning of the lid which is hot when placed on the food **353** with the aluminum foil or film **368** or **369** intervening is that of supplying to the food first of all the heat stored in the plate **351** which is at the maximum temperature to which the foil may be raised without detriment, and to supply to it further all the best which can flow into it through the difference of temperature between the plate **351**, the temperature of which is kept more or less constant by the thermostat **356**, and that of the food **353**. Thus as large an amount of heat can flow into the food at the maximum safe temperature as the food itself can conduct away from the plate **351**. The plate surface is therefore made as large as practically feasible (by curving, undulations, dimples, etc.) and compatible with intimacy of contact with the intervening aluminum foil or plastic film **368** or **369** and the possibility of stripping it off easily after the heating cycle. The safe temperature of the plate when acting on food containing liquid is always above 100° C. The level of the bottom surface of the plate may be inclined or arcuate in order to avoid trapping vapors which apart from causing other difficulties obstruct good conduction of heat. The good heat conductivity of the material of plate **351** and its relatively large mass ensures an even temperature of the plate over its whole surface even if heat conduction into the food is temporarily locally obstructed. There is no hot spot danger.

The lid always remains clean because the aluminum foil or film **368** or **369** prevents it from coming in direct contact with the food. It should be left switched on during brief intervals in its active use. Its power consumption when the plate **351** is in free air, is only very small as the thermostat **356** holds it at the set temperature.

A preferred method of producing the plate **351** is to die-cast it in aluminum and to anodized it.

As above mentioned the present invention also provides for the heating of a substance while it is carried on a common support such as a tray which carries other substances which are not to be heated. In broader terms this development relates to electric resistance heating of a material or of a defined space which is in close proximity to other materials and/or spaces which are cold and must remain cold during the whole heating period. The special requirements are the absence of thermally insulating enclosures of the material or space to be heated adequate to permit the ready use of available well-known heating appliances and the further requirement of cutting down costs and handling efforts to a very minimum, particularly in view of the need to effect the heating of a number of units of the materials or spaces simultaneously and to separate the materials and heating devices after the heating period quickly or provide the devices in an unobtrusive manner.

The present developments for the purpose will again be described with reference to an example of a particular food heating arrangement without implying that the scope of the invention is restricted to such food heating. Heating of any material or spaces in proximity of other cold materials and spaces on any structure falls within the scope of the invention.

The present example is the heating of food in a dish while it is on a tray surrounded by dishes of cold foods such as pats of butter, cold sweets, cheese, etc. A large number of such trays are stacked in vertical columns, e.g. in a cupboard on an airplane, coach, in vending machines or along the counter in self-service restaurants. While the trays are in the column and/or while the cupboard doors are closed the food is to be heated without any appreciable heat, vapor or smell reaching the cold dishes on the trays. When all trays or a single tray becomes accessible (by opening the doors of the cupboards or by inserting a coin in the vending machine or by an equivalent arrangement) the more removal of the tray from the column without any, or with only a negligible minimum of, additional manual actions are all that is required to obtain possession of the completely laid tray with the hot and cold food in place (and whatever else there is on the tray, i.e. cutlery, serviettes, condiments, etc.).

The present development combines the provisions set out below. For other cases the combination may be varied by employing other means themselves well known for giving the same effect for the respective integer of the combination.

The two essential usual items of the assembly, i.e. the dish and the tray, are so shaped or selected that in addition to their function of containing the food, so that it may be eaten from it by the use of the cutlery (which is the function of the dish) and of supporting and locating this and other dishes (which is the function of the tray), they provide a maximum of thermal insulation between the hot and the cold foods themselves. If possible, a dish is selected the sidewalls of which with the optional exception of the wall or walls along the edges or corners of the tray, are of thermally insulating material or are covered on their outside with highly thermally insulating material such as a tick plastic foam layer. The preferred and cheapest way however is to provide according to the present invention the location of the dish in the tray in such a way that there are at least two air gaps filled with static air separating the hot food dish from any other dish on the tray. To achieve these air gaps the coordination of two other members of the arrangement is necessary, namely the tray itself and a cover of the hot dish.

One preferred embodiment is illustrated in FIGS. **34** and **35**. In this example the tray **371** is preferably a moulded plastic tray with hollow ribs **372** surrounding and locating the food dish **373** to be heated. The ribs are as high as the walls of the hot food dish and either themselves have secondary transverse ribs or dimples such as **374** on the side facing the hot food which space the latter from this inner rib side or achieve the spacing by their position and form as seen in plan view. The main ribs also stiffen the tray very considerably which is important, as will be shown later, for keeping the tray flat and able to take the contact pressure in a direction in its main plan.

From the above it will be understood that the inner wall of the rib **372** separates two airgaps: the one **375** between the hot dish wall and the inner rib wall, and the other **376** within the rib itself between its inner and outer wall. The first gap is open at the top and may have a constant or varying width as defined by the plan view of the dish and rib. The shaping of dish and rib leave therefore some freedom for artistic design. The covering of the open top of this first airgap **375** will be dealt with below. The second airgap **376** is formed by the hollow main rib itself and in a moulded tray is generally open at the bottom of the rib. While the trays are stacked in a vertical column this second airgap is kept closed by a cover **377** on the hot food dish **373** in the tray below. This cover **377** extends beyond the walls of the hot food dish far enough to close the open bottom end of airgap **376** in the hollow main rib of the tray **371** resting on it.

Where the column consists of trays not stacked upon each other but resting on shelves, these shelves will close the bottoms of the airgaps in the hollow main ribs.

Alternatively to both these arrangements, the main rib in the tray can be hollow or be filled with thermally insulating material without having an open bottom; these simple flat trays of plastic, wood or other material, with hollow main ribs or ribs of plastic foam or of other cellular material which are fixed on its surface, are perfectly satisfactory and provide an effective second airgap between the hot food dish and the cold dishes.

The first airgap **375** between the hot food dish and the main rib which is open at the top, is kept closed by the hot food dish cover **377** at least during the heating period while the trays are in the column. The cover is preferably of cardboard with a foil cladding **378** which can be decorated, by advertisements or otherwise, if it is left to the public to finally remove it from the hot food dish. It rests on the walls of the hot food dish which are higher than the food in the dish, and on the main rib of the tray which are of a height equal to that of the walls of the hot food dish. Its size and shape are therefore at least equal to the area of the tray which is separated by the main rib from the cold area, i.e. the cover reaches from the top of the main rib to at least the other end of the hot food dish. Where it also serves to keep the second airgap closed it must extend to the bottom end of the outer wall of the main ribs. A margin around this area is also necessary.

An important feature of the cover for the purposes in view is that it should be possible to slide it off the dish and remove it even before the trays are taken out of the column. Further it is preferably a dispensable item for a single use forming a top cover for the food after it is filled in the food dish during freezing, storage and transport. Thus the preferred foil clad cardboard cut to the required shape, including, if desired, gripping tongues fills all requirements price wise, mechanically, and as thermal insulation.

When the food in the hot food dish is higher than its walls the cover is dish-shaped with its edges bent or folded down so as to prevent the food being subjected to pressure and to enclose the hot food dish. In this case the edges of the cover form part of the sidewise thermal insulation. Furthermore, the cover can be made with two or three edges spaced from each other by an airgap or gaps. These edges by resting on the tray can replace and perform the thermal insulating function of the rib **372** on the tray and can be made, for instance, from foil clad paper mache, folded corrugated paperboard cardboard or plastics.

The heating of the food can be carried out by permanent electric heating elements of thin shetlike character placed in the tray, in the cover, underneath the hot food dish or even fixed to the dish. They must be smaller in area than the inside bottom area of the hot food dish and readily washable. However the preferred method and means of heating are those described in my U.S. Pat. Nos. 3,100,711 or Ser. No. 301,488 (now Pat. No. 3,296,415) or Ser. No. 102,820, filed Apr. 13, 1961, or above herein. The heating element is preferably a film as described in my U.S. Pat. No. 3,283,284.

A point of the present invention is that the heating element, be it a dispensable film or a permanent flat heater of conventional construction, is so arranged that it slides out, or can be readily pulled or taken out, from its heating position in, underneath and/or over the hot food dish and from the tray when the tray is removed from the cupboard and the current is switched off. Thus the repeatedly used heating element, or the dispensable heating film preferably has a cold zone extending beyond the walls of the hot food dish and of the tray so that it can easily be gripped there by the fingers of an attendant or of a device. This zone can be the terminals of the element or film.

Cover and heating element or film exemplified by an upper film **379** and lower film **381** preferably form a fork or loop open at the end near the main rib **372** and this fork or loop included in or with the food dish during freezing, storage and handling, ready for assembly on the tray. If as exemplified in FIG. **34** heating films are provided which are positioned inside the hot food dish at its bottom as well as on top of the food, they readily form a loop which extends at **382** over the wall of the dish for contact and gripping purposes. As shown the extension **382** which incorporates the terminals of the heating film is preferably folded over the rim of the tray thus getting the necessary support for a pressure contact with supply bus bars or terminals **383** while remaining easily grippable when the film has to be slipped out.

A particularly suitable form of the heating film arrangement is that with the film inside the hot food dish at its bottom. When it is slipped out over the edge of the wall of the dish the cover **377** is still in place and presses on the film thus ensuring that no, or only a negligible quantity of food, is removed with the film, and the edge of the tray is not soiled. (See my Ser. No. 102,820 filed Apr. 13, 1961). The use of the film for such immersion type heating offers high efficiency and ensures that the least amount of heat goes elsewhere in the column and the maximum percentage of the heat emitted from the film goes into the food itself. It thus eases the problem of thermal insulation by minimizing the energy which has to be prevented from reaching and possibly spoiling the cold food and brings the walls of the hot food container itself into the role of the first of the thermal barriers. This thermal function of the dish is additional to that of keeping the food hot during serving, that is during the period between taking the tray off the column and consumption of the food. Where possible, the cover should be removed only immediately prior to consumption; in any case after the heating film has been slipped out.

As already stated the trays are held in a column (or in several columns) in a cupboard which may have rails, or shelves **385** for sliding the trays in or out, or side supports only for guiding the columns of stackable trays. The shelves may be simple sheets for support purposes only, or they may include features for assisting in the thermal insulation problem of preventing the spread of heat from the heater or hot food dish to the cold food on the tray, for instance by keeping the cold food cold prior and during heating. These features include hollow shelves having cold water or other coolant flowing through them. The shelf area can be only a strip underneath the main rib of the tray or extend over the whole tray area other than that occupied by the hot food dish. Underneath the hot food dish the shelf should have a cutout.

Cooling the cold food areas of the trays can be also achieved by stacking the trays so that only the hot food area enclosed by the main ribs are so to speak sealed off while cold air can circulate round the cold food areas. The air is cooled by, for instance, a refrigeration unit in the cupboard, or a fan blowing cold air from outside or any other convenient ventilating provisions well known in themselves. In FIG. 35 it is assumed that the cupboard **385** is either a refrigerator or connected to one, with a cold air inlet and cold air outlet at the rear. The trays are disposed with the food dishes to be heated on the left and that part which carries the cold food on the right. To provide adequate support for the right hand parts of the trays and allow for air circulation, either parts of the rims of the trays are higher on the right by the thickness of the covers **377,378** or at least one container of cold food in each tray is of equivalent height so that it supports the tray above.

The above arrangement provides for simultaneous heating and cooling in an enclosed space such as a cupboard, container or refrigerator not necessarily structurally subdivided or featuring any provision such as thermal insulating walls, separate ventilating ducts or the like for heated and cooled compartments. According to the present invention these compartments are formed and the thermal barriers between them are provided essentially by the objects themselves which are heated and kept cool.

The electrical contact to the heating film terminals folded over the rim of the tray is made by provisions in the cupboard. In the simplest case the bus bars **383**, e.g. Neoprene or otherwise elastically backed foil strips are carried on the cupboard door **386** and press on the heating film terminals **382** as long as the door is closed, the trays abutting against the back wall of the cupboard. The trays can be taken out by letting them emerge from an open top or bottom of the cupboard if controlled means are provided to push the column up or let it drop; alternatively they can be taken out by opening the cupboard doors. These doors may be partitioned as indicated in FIG. **35** so that only a few trays are switched off and can be taken out at once - or even only one at a time - while the others remain switched on. In such an arrangement the stiffness of the tray has to resist the contact pressure and the provision of ribs in the tray is beneficial to its stiffness.

The operation of taking out a tray generally comprises the pulling out of the heating film first, dropping the film into a receptacle provided next to the cupboard, then doing the same with the cover of the hot food dish if it is to be served without cover, and finally drawing or lifting the tray off the column. If pulling out of the heating element is done manually, the trays in the cupboard are positioned with the hot food dish at the front. If the pulling out of the heating film is done automatically by a device or by the action of drawing the tray out, the tray is located so that the hot food dish is at the rear or side of the tray.

Examples of automatic pulling devices are spring-loaded contact clips holding the terminals of the heating film and springing away from the tray edge when released on starting the drawing out of the tray. Another example is contact rollers clamping the terminals of the heating film which are made to rotate and thereby pull the film out at the end of the heating period. It can usually be arranged that the films drop into a receptacle.

The mere action of pulling the tray out can cause the automatic pulling out of the heating film if the latter is clamped between stationary contacts arranged on the walls of the cupboard. Naturally the loading of a cupboard with trays in columns featuring automatically removable heating films requires more attention during loading than with trays from which the heating films are pulled out manually. However, the amount of work can be greatly reduced by providing that the terminals of the heating film form a loop. Such a loop is formed, for instance, by simply having the film bent back onto itself where it extends over the wall of the hot food dish (as described above with reference to FIG. **34**) unless the film already loops over into a cover sheet which in this case would be pulled out together with the film whereby any food adhering to the film between film and cover is squeezed back into the dish. The contact clips have a bar which goes through the loop and is easily pushed through. This operation can be performed simultaneously on all heating films in a column.

Making the inside of the back or sidewalls of the cupboard easily accessible is a further help towards minimizing the loading and cleaning work. For this purpose these walls can be made to slide or swing out, or be removable and again be readily put in place. One step further is the replacement of the cupboard itself by a dispensable container for the column, such as a cardboard or fibre container, with foil strips for electric contact purposes. When designing the cupboards and contact arrangements for aircraft one can rely upon the fact that all loading and cleaning operations are done on the ground and prepacking of exchangeable or dispensable cupboards or cupboard replacements is in principle welcome.

The embodiment illustrated in FIGS. **36—41** features a more elaborate cupboard to be loaded into the galley of an airliner, trays with plug-in sockets and contact clips and a suitably decorated table mat type of heating film which may be reused by the airline, but be left on the tray for the passenger to see and, if he wishes, take as a souvenir. It is usable in his car on 12 volts as a warming pad while it will become fairly hot on the voltage supplied to it in the aircraft (e.g. varying up to 28 volts.).

The container or cupboard **387** (FIG. **36**) takes 12 moulded plastic trays **388**. The rims **396** of the trays slide in grooved fittings **397** in the cupboard, FIG. **37**. Each tray is fully prepared in the airport kitchen, that is to say everything is put on it which does not protrude over its edge. An empty coffee cup and perhaps a roll and a pat of butter are to be added before the actual serving.

The containers are loaded into the galley, handles **389** being provided to facilitate manipulation and plugged into the supply by fittings not shown. All 12 pilot lamps **391** should then light up, indicating that on each tray the main dish is being warmed up.

Each tray is accessible by lifting a flap **392**; these flaps are hinged in such a way that they swivel on pins **393** fixed in the cupboard and can then be pushed back by the aid of slots **394** in lugs **395**, FIG. **38**.

FIGS. **39** and **40** show one tray with a wide rim **396** along a sidewall and various compartments **399**, **401**, **402**, **403** defined by ribs. The compartment **403** for the hot main dish **404** has two clips **405** making contact with the heating film **406** on which the main dish to be warmed up is placed. A paper cover **407** ensures that the warmth is mainly confined to this compartment **403**.

As shown in FIG. **41** the clips **405** are connected by metal inserts **408** in the tray to two metal sockets **409** which in turn make contact with two slotted pins **410** in the cupboard when the tray is pushed into the cupboard. The pins **410** are insulated from the backwall of the cupboard if of metal by means of an insulating strip **411**.

In both embodiments shown in FIGS. **34** to **41** attachments to the trays such as legs, hooks or provisions to suspend the trays from the shoulders or otherwise support them on the human body have not been illustrated. Such attachments are only desirable where the trays are dispensed to consumers who have no table or equivalent support for the tray so that they are free to use both hands for or while eating from the tray.

Reference has been made above to the serving of food in aircraft, canteens and the like, but little has been said about the nature of the food itself. A further development of the invention is concerned with the preparation of the food prior to its being sent out in the package for subsequent heating. In particular the invention provides for the packaging in dispensable containers usually incorporating a dispensable heating film of food which includes at least one comminuted ingredient, in single or multiple portions up to what may be called family size portions e.g. suitable for six persons, which has been processed in accordance with the recipe and method of a skilled cook so that after heating in the package, the processed food has the same quality as food originally prepared by the cook.

To this end the cook manually processes the food in accordance with his recipe and method and every step, in particular the quantities and form of each ingredient, the times, temperatures and rates at which these are added, and the time and intensity of the mechanical manipulations and movements of the ingredients whereby they are mixed are recorded. The plant in which the food to be packaged is prepared is equipped with a controllable-speed conveyor which carries the containers through a succession of stations and during their passage through the apparatus contact is made to the externally accessible terminals of their heating films whereby each can be supplied with current which can be regulated as a function of the position of the container and time. The stations are equipped with controllable devices for discharging ingredients in predetermined quantities at predetermined temperatures, and controllable devices for mechanically moving thereby mixing the ingredients in the containers for predetermined times and at predetermined intensity. (The containers will generally be open topped and may for example be of the forms illustrated in FIGS. **1** to **6**, or FIGS. **20** to **24** or FIGS. **27** to **33**). The position and nature of the equipment at the stations and of discharge pipes and the like will in general be adjustable so that time intervals can be adjusted having regard to the speed of the conveyor and the positions of the stations. The equipment also includes a programme controller for simultaneously actuating the control means of the conveyor, the electrical supply and the various discharging and mixing devices, so that the equipment follows a master programme. The master programme may for instance be embodied in a punched tape or punched cards. Such a controller and such tape or cards are in themselves well known, and the devices used in the equipment can also be of well-known kind, so that they do not need to be described herein.

The record taken from the cook's manual operations is analyzed and from this analysis an edited master programme is prepared for the programming control. Editing is necessary because in general the cook's operations are effected at different positions from those which must be employed in the equipment. For example he will perform at one place a sequence of operations which in the automatic equipment will be performed at several different stations. Thus the programme needs to be edited to translate certain of the timings of the cook's operations into movements of the conveyor. Other factors may also need editing. Once the master programme has been prepared and applied to the equipment, and the proper materials are used the equipment automatically follows the cook's original recipe and methods. It will be clear that the equipment can be used to follow a variety of different recipes and methods within the range of its adjustment. It is simply necessary to change the master programme.

The equipment and programme may be arranged so that when the containers first enter the plant, before any ingredients are discharged into the containers, they are sterilized by a heat flash imparted by the aid of the heating film. At the other end of the plant a hermetic cover is applied to the container or the container is otherwise hermetically closed, and it is then cooled down, cooling preferably being speeded by the conveyor carrying the sealed containers through a cooling chamber. This automatically reduces the pressure within the containers which in effect become vacuum packages.

An elementary form of a plant on the above lines is illustrated in FIG. 42. A conveyor **173** carries the containers **174** through seven stations I to VII. Their terminals contact with one continuous bus bar **175** and another bus bar **176** divided into sections (corresponding with the stations though further subdivisions may be employed if necessary) separately connected to the programming controller **177**. At station I flash sterilization is effected by raising the heating film to a high temperature for a short time. At Station II, two ingredients are added from vessels **178**, **179** having control valves or the like linked to the controller. The vessels are mounted to move with the container the necessary distance (arrow A2) for the time necessary to deliver the controlled quantity of the ingredients at the controlled rate, and then to return ready for the arrival of the next container. At section III the ingredients are mixed by a stirrer **181** which moves along the path A3 so that at the end of the predetermined mixing time the stirrer is lifted and returned to the starting point where it is lowered into the next container. At station IV another ingredient is added from a vessel **182** with a control valve or the like linked to the controller and at the same time mixed by a stirrer **183**. The vessel and stirrer move in the path A4 so that the stirrer is lifted before returning to the starting point. It is not essential that the vessel **182** should also be lifted and it is a matter of convenience where it does or not. At station V the ingredients are again agitated by a stirrer **184** following the path A5. At station VI the container has a cover applied by a device **185** which takes the path A6 and at the last station VII the sealed container is passing through a cooling chamber **186**.

It is assumed that the stirrers and sealing devices are electrically operated and the conveyor electrically driven by a motor **180** and all these devices also connected to the controller.

It will be obvious that any number of stations could be provided, and the number and nature of the devices at each be suited to the operations to be performed, and that the paths of the devices may be adjustable to suit the time they need to be in action. Again if any particular ingredient has to be processed for example minced, just prior to delivery the necessary devices will be provided associated with the delivery means. Also if any particular ingredient is added in portions at different stations, a stationary single storage vessel may have several flexible discharge pipes with control valves or the like. Indeed any of the storage vessels may be stationary and discharge through a flexible pipe to allow for the movement of the container.

The example assumes a continuously moving conveyor on which the containers are carried at equal spacing related to the stations. The containers may be placed on and removed from the conveyor by hand or devices of known kind can be used to effect these operations automatically.

It would also be possible to use a conveyor which moves intermittently at regular intervals in which case horizontal movements of the devices at the stations would not be necessary. In either case if the ingredients only need to be maintained at a particular temperature without addition or agitation i.e. cooked, at certain stages in the sequence of operations, this can be effected at corresponding stations by removing or by putting out of action by the controller, any devices available at these stations. A single station equipped with a stirrer, filling devices and a variable power supply all run by a controller, can be used in restaurants, households and for preparation of various chemicals in laboratories. The food or substance is automatically filled into the container, mixed and heated according to an edited master programme and the food, or chemical may be consumed or used immediately. The restaurant, home, or laboratory may hold a great number of such recorded master programmes in store and thus be equipped to prepare any of a great number of fishes or chemicals on demand.

Reference has been made to films embodying a pattern in the heating film which is in two parts with three terminals in all. FIGS. **43** and **44** illustrate a clip which provides for connection to such a film, having terminal areas disposed as indicated in FIG. **45**.

There is a full length terminal **48** common to both branches of the pattern and insulated from it, the two further terminals **49, 51** one belonging to each branch. The terminals **49, 51** are of half length in line with one another but out of line that is staggered longitudinally with respect to one another and laterally with respect to the terminal **48** and are on opposite sides of the insulating layers. Correspondingly the clip has one long contact **48***c* and two half length contacts **49***c*, **51***c* staggered longitudinally with respect to one another and laterally with respect to the contact **49***c* and on opposite jaws so that when the jaws are closed on the end of the film they engage the respective terminals. Contacts **49***c* are provided on both jaws so that provided the film is insulated on the surface opposite the terminals **48** proper contact will be made whichever way the clip is closed upon the terminals while if the clip is closed without a film in position each of the contacts **49***c*, **51***c* being opposite an area of the other jaw which will be of insulating material will not cause short circuiting. The coming into contact of the two contacts **48***c* with one another obviously will not cause any difficulty. If the film has a terminal corresponding to **48** on both sides or if other provision is made to ensure that the clip is always applied the same way round the contact **48***c* need not be duplicated. Desirably the contacts may be serrated as indicated in FIG. **43**. The pivot **52** on which the jaws are pivoted together is hollow and may be made longer than indicated. It can thus be used to accept springs or other devices e.g. tubes described above in connection with the heating of liquids. The clip is also equipped with a single pole change over switch actuated by a sliding knob **53** and a Spencer type thermostat with a resetting knob **54**. Details of the thermostat are shown in FIG. **46**. The thermostat disc **55** normally takes the form shown in which it bridges upper contacts **56**. When the heating effect of the current passing through it reaches a certain value it reverses its curvature and takes the dotted line position in which it bridges contacts **57** but it remains in this reversed position even when it has cooled down until the resetting knob **54** is depressed to snap it back to its original curvature.

The corresponding circuit arrangement is shown in FIG. **47**. The switch **58** operated by the knob **53** in the position shown connects one pole of the supply **59** to the contact **48***c* which is connected to the common terminal **48** of the two branches of the heating film marked **61, 62** respectively. These two branches are connected by the terminals **49, 51** and contacts **49***a*, **51***a* to the two contacts **56** of the thermostat. One of these contacts is connected to the other pole of the supply **59**, and the other of these contacts is connected to one of the contacts **57**. It will be seen that as long as the disc **55** is in the normal condition the bridging the contacts **56** both branches **61, 62** are connected in parallel across the supply **59**. At the end of a period determined by the parameters of the heating film and disc, the disc snaps over to bridge the contacts **57**. The branch **61** then remains connected across the supply so that heating continues at a lower rate while the branch **62** is switched off. Thus this arrangement permits a high rate of heating for a predetermined period followed by a lower rate of heating. If with the thermostat disc still bridging the contacts **57** (where it will remain even though the current has fallen until the button **54** is depressed) the switch **58** is changed over the upper pole of the supply **59** is disconnected from the common terminal **48** and is connected to the lower contact **57**. In this position the two branches **61, 62** will be in series across the supply so that an even lower rate of heating will be obtained. If with the change over switch in this position the resetting button **54** is depressed thus bringing the disc back to normal position where it bridges the contacts **56** the circuit will be completely interrupted and may only be restored by returning the change over switch to its first position.

It will be seen that whatever manipulations are effected by the user he cannot set up any dangerous condition or override conditions determined by the thermostat. This particular scheme constitutes an electrical interlock which only permits mutually compatible schemes of connections to be set up. It would be possible to provide a mechanical interlock having the same effect and to develop more elaborate schemes by the use of a film with more than two branches and three terminals.

When a low-voltage supply is used as is preferred for example 12 volts as in the case of a motorcar battery, the current required is relatively heavy and requires the use of supply conductors of such cross section that if ordinary stranded cables were used they would be heavier than desirable. The invention therefore makes economical and convenient provisions for enabling the clip to be given freedom of spatial and directional position within the limits of the length of the cable while supporting at least the major part of the weight of the clip. To this end the cable which may be of considerable length is made flexible in at least one transverse direction so that it can be rolled on a drum if need be or rolled on itself after the fashion of a measuring tape on a spring reel. This may be achieved by making the conductors at least over part of the length of foil form. This enables the clip to be manipulated in at least one direction while the cable supports the weight of the clip.

The other end of the cable is connected to the supply by a plug and socket arrangement which provides freedom of rotation about two axes at right angles to one another both lying in the plane in which cable can flex. As shown in FIG. **48** in which the insulation of the cable is omitted the two foil conductors **64, 65** are held by an insulated rivet **66** from one another but in good electrical contact with respective conductors **67, 68** which communicate with two separate coaxial contacts **69, 71** on an insulating support **72**. This plug coacts with a corresponding socket shown in FIG. **49** having contacts **73, 74** to cooperate with the contacts **69, 71**. The active parts of the contacts **73, 74** may be inwardly sprung tongues and one pole of the supply is connected by a further tongue such as **75** to the contact **73**. The earth return is provided for the contact **74** the socket being metallically connected to a metal panel **76** by a conventional nut **77**. The contact **74** is continuous with the part of the socket which contacts with the panel **76**. The cable conductors **64, 65** can be rotated in relation to the plug about the axis of the rivet **66** while the plug can be rotated in the socket about its own longitudinal axis.

Desirably the plug is provided with an indicator lamp **78** permanently connected across its two contacts and protected by a glass or plastic lens or cover **79** so that a visual indication is given whenever the plug is connected to the supply.

It is possible in some cases to make a container in which a substance is to be heated of the heating film itself and the film may be no more than a laminate of patterned foil e.g. aluminum foil and a paper or a plastic film. The choice of plastic film depends - apart from the usual packing considerations (compatibility with contents, vapour-permeability, price, strength, facility for decoration, etc.) on the temperature endurance of the particular plastic. When the intended heating temperature is low enough it permits the use of ordinary polythene film, polyvinylchloride, regenerated cellulose (Cellophane) and even paper. Where higher temperature plastic films are needed, irradiated or high density polyethylene-, polypropylene, polycarbonate-, or polyester film is chosen while others may become available in the course of time.

If, for instance, a bag is made from this two-layer material, the aluminum foil is first patterned by any known convenient process, such as that described in my U.S. Pat. No. 3,283,284 or by punching slots. The pattern provides one (or more) continuous aluminum line(s) with very small gaps between them and covers nearly the whole area of the bag except for certain strips which are not connected with the continuous heater line(s). As shown by way of example in FIG. **50** the continuous lines are produced by rows of apertures **187** and long slots **188**. Consideration will show that this results in a number of meandering paths in parallel being produced between a terminal area **189** and a terminal area **191** of each portion of the patterned area. Between each such patterned area and not connected with the continuous heater lines are transverse strips **192** which form edge reinforcements on the fold when the material is folded into a bag. It will be understood that a repeating pattern is produced on a continuous length of insulating support **193** which is severed at the dot lines and folded at the dot and dash lines. Another strip **194** also not connected with the continuous lines is arranged along each edge. This is a narrow line with many holes or notches to increase its resistance. When the materials is folded into a bag, the longitudinal edges are folded over and these fine line patterns **194** are connected to a suitable voltage supply to provide the necessary sealing heat. The overlaid plastic film edges weld together in the areas of the gaps between, within, and around the metal lines **194**. The hot metal lines themselves also become adherent to the plastic. This procedure is, of course, only possible where the heat-sealing temperature lies well above the designed maximum operating temperature of the bag and where the seal is not affected by operating temperature.

With the particular arrangement shown, when the bag is completed there are two separate patterns, one on each side, each having two terminal areas. A device similar to that shown in FIG. 4 of my U.S. Pat. No. 3,296,415 may be used but with each of the two rubber packings **23** carrying two contacts extending over a little less than half length. The foil contacts opposite one another on the two rubber backings will be of the same polarity so that when the device is closed without a bag in position, there is no short-circuiting.

The pattern of the continuous heater line or lines is usually a meander with very small gaps, wide and short areas covering nearly the whole area available as shown in FIG. **50**.

The pattern of the heating film may incorporate a safety device by which the circuit is broken when the desired temperature or a temperature reckoned dangerous is reached. There may be a fuse for instance in the foil pattern of the heating film itself. Such provision is made by narrowing the width of the continuous line at a convenient place in the film so that this part of the pattern constitutes a fuse which will blow at a certain current. Another way to provide a fuse is to connect a tiny link in the pattern which consists of two pieces of foil under tension held together with a solder or other fusible adhesive. The tension may be that which is present in any event in such an article as a filled bag of flexible heating film or by development of vapor pressure during heating of the foodstuff. If the solder of fusible adhesive has a low melting point it will also break on being overheated by any means.

The containers above described in general have adequate stiffness and strength to withstand the necessary handling while permitting easy access to the contents. A further development which has sidewalls of particularly good stiffness and heat insulating qualities employs a laminated structural material of high stiffness but low weight. This material is generally sandwiched between two flat films or foils of which the inner film may be or may support the thin plastic-heating film with the metallic pattern and the outer a decorated paper, plastic film or metallic foil. Between and to these thin, smooth skins a thick, airy, buckling-resisting layer is stuck consisting for instance of corrugated paper or cardboard, stiff plastic foam, honeycomb construction, paper mache or a similar, cheap and lightweight stiffening filler. There is no need to make the whole package from this laminated material. It is, for instance, sufficient to have it on the four low sidewalls of shallow box- or traylike food packs, thus constituting a stiff frame of the stressed skin type, while the large bottom area or top and bottom areas are formed only by the heating film proper. Thus as shown for example in FIGS. **51** and **52**, the sides of the container are made of corrugated paper **195** having the usual base paper **196** and another paper **197** stretched over and secured to the crests of the corrugations so that a composite material of the stressed skin type results which is stiff in planes normal to the corrugations as well as along the corrugations which are here set perpendicular to the top and bottom of the container. The heating film **198** forms the top and bottom, with tabs **199** carrying the terminal areas projecting sideways. and this assembly containing the food **201** is contained in a usual cardboard box **202** recessed at the bottom to protect the film and contents. Such packs can be safely stacked on one another and can be connected in circuit when so stacked, e.g. as above described with reference to FIGS. **34** to **41**.

The films above described have all had the resistive path formed by a meander patterned foil. The invention provides other forms of resistive path which can be made sufficiently thin and flexible and sufficiently cheaply to be dispensable In these the surface pattern includes at least two large surface areas of thin metallic layers forming the terminals and also forming adjacent electrodes, and a carbon film which extends over said electrodes and forms the electrical path between them.

One form which such a resistive path can take is shown in section in FIG. **53**. This comprises three sheets of metallic foil, e.g. tinfoil or aluminum foil. Two sheets **161**, **162** (in this example of the same width) are spaced apart while the third sheet **163** is wide enough to extend over the other two sheets. All three sheets constitute electrodes of large area while parts of the sheets **161**, **162** also constitute terminal areas. A film **164** incorporating carbon, e.g. graphite, particles as the conductive ingredient is interposed between the sheets **161**, **163** and another carbon film **165** between the sheets **163**, **162**, the current flow being through the thickness of these films but along the foil sheets as seen in FIG. **53**. To control the current distribution and thus the heat development, the thickness of the films **164**, **165** may vary along them. Uniform distribution, which will usually be wanted, requires the thickness to increase towards the adjacent edges of the sheets **161**, **162** as is indicated in the drawing.

The carbon, e.g. graphite particles are held in place in the film by a so called plastics material or some other binder such as is used in the resistors used in electronic apparatus. Choice of the nature and proportion of the binder enables the resistivity of the film to be given the value required for the particular supply voltage or loading in view.

The structure shown in FIG. **53** will need insulation (not shown) on one or both faces, which may be of paper, lacquer, or other thin flexible material, appropriate terminal areas being left bare for making connection, suitably by a clip as above described. In the case of a metallic canister, the third sheet **163** may be constituted by the wall of the canister itself.

It will be seen that this structure has the path in two distinct branches in series between the terminal areas. The two branches are shown equal but they could be unequal whether in width or thickness. The sheet **163** can also serve as a common terminal and the film can be used in the same circuit arrangement as described above for example with reference to FIG. **47**.

Another form in which the resistive path is a carbon, e.g. graphite, film between electrodes is illustrated in FIGS. **54** and **55**. Here there are two comblike members of metallic foil having their respective limbs **166**, **167** intermeshed while their continuous parts **168**, **169** constitute terminals. Space is left between the limbs and continuous parts which is bridged by the carbon film **171**, and the current flows through it in the plane of the carbon film. The resistivity of the metallic foil may be substantially negligible compared with that of the carbon film so that each electrode and terminal member is at substantially the same potential at all parts and the voltage drop and therefore the heat development will be substantially limited to the carbon film. Choice of the spacing between the electrode limbs enables the heat distribution to be controlled.

This structure needs a layer of insulation **172** on the back of the carbon film **171**. This can be a separate sheet, for example of paper, or if the part of the container to which the film is applied is of insulating material it may be constituted by the container wall. There may also be a sheet of insulation over the metallic foils, leaving adequate terminal areas bare or accessible.

It will be clear that both forms of resistive paths illustrated in FIGS. **53** and FIGS. **54** and **55** can be produced in long lengths and pieces of the required length be cut off to make individual heating films before or after the application of insulation.

I claim:

1. A package including a dispensable container containing a substance to be heated while in the container and thereafter to be removed from the container, a thin low voltage heating film having a surface pattern presenting a resistive electrical path between at least two terminals, said film being of metal foil which is integral with at least one unpatterned marginal portion of at least the same width as the pattern and which is folded over the pattern to constitute an impervious cover layer, the film also including a thin electrically insulating layer between the folded over portion and the pattern said film being incorporated in the package with the terminals accessible for connection to a supply without removing the substance from the container, the path between said film and the substance being of low thermal resistance and said surface pattern being so dimensioned that when connected to a supply at a predetermined voltage the difference between the heat dissipated into the substance in the container from any area of the surface of the heating film and the wattage supplied to said area is less than 4 watts per square inch of said area, and means including thermal insulation between the film and the external surface of the complete package insuring that when the film is energized more heat is dissipated into the substance than reaches the external surface of the complete package.

2. A container as set forth in claim 1 in which the heating film is contoured and located so that the unpatterned marginal portion forms an inner wall of the container, and the container includes a thermally insulating layer of stiff fibrous material on the outside of said film.

3. A package including a dispensable container containing a substance to be heated while in the container and thereafter to be removed from the container, a thin low voltage heating film having a surface pattern presenting a resistive electrical path in two sections with one terminal common to both sections and each section having another terminal so that there are three terminals in all, said film being incorporated in the package with the terminals accessible for connection to a supply without removing the substance from the container, said terminals being relatively arranged in a staggered formation to enable single, series or parallel connection to be made merely by positioning a set of three contacts in relation to the terminals without change in the relative position among themselves of the three contacts, the path between said film and the substance being of low thermal resistance and said surface pattern being so dimensioned that when connected to a supply at a predetermined voltage the difference between the heat dissipated into the substance in the container from any area of the surface of the heating film and the wattage supplied to said area is less than 4 watts per square inch of said area, and means including thermal insulation between the film and the external surface of the complete package insuring that when the film is energized more heat is dissipated into the substance than reaches the external surface of the complete package.

4. A package including a dispensable container containing a substance to be heated while in the container and thereafter to be removed from the container, a thin low-voltage heating film having a surface pattern presenting a resistive electrical path between at least two terminals, the surface pattern of said film including at least two large surface areas of thin metallic layers forming said terminals and also forming adjacent electrodes and a carbon film which extends over said electrodes and forms the electrical path between them, said film being incorporated in the package with the terminals accessible for connection to a supply without removing the substance from the container, the path between said film and the substance being of low-thermal resistance and said surface pattern being so dimensioned that when connected to a supply at a predetermined voltage the difference between the heat dissipated into the substance in the container from any area of the surface of the heating film and the wattage supplied to said area is less than 4 watts per square inch of said area, and means including thermal insulation between the film and the external surface of the complete package insuring that when the film is energized more heat is dissipated into the substance than reaches the external surface of the complete package.