ABSTRACT: A combination freezer-oven unit which provides for uniformly circulating hot air from electrical resistance coil means by a power driven centrifugal type fan and, alternatively, provides for uniformly circulating cold vapor into the unit by virtue of supplying liquid nitrogen at a distributing nozzle that is positioned to discharge adjacent to the periphery of the fan. A preferred arrangement has an electrical switch means on the access door to the oven chamber that connects with automatic valve means in the liquid nitrogen supply line to the nozzle so as to preclude cold nitrogen flow into the chamber at any time the oven door is open.
Figure 1

Liquid Nitrogen

Figure 2

Figure 3

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This invention relates to an improved form of freezer-oven unit which utilizes liquid nitrogen as a cold source for the freezer cycle. More specifically, there is provided a combination heating circuit for the unit which will maintain the temperature of cold nitrogen in the unit by having a liquid nitrogen nozzle discharge into the peripheral zone of an interiorly located motor driven centrifugal type fan.

It is realized that liquid nitrogen is known and used as a refrigerant or chilling medium. However, it generally has been used to provide a cold refrigeration zone or has beenbled into a freezer chamber in a noncirculating manner. Actually as far as is presently known, there has been no liquid nitrogen distribution in combination with a centrifugal type fan and with special baffling used so as to obtain a uniform recirculating vapor distribution, in addition to uniform heat distribution in a combination freezer-oven unit.

It may be considered a principle object of the present invention to provide a combined freezer-oven unit which utilizes special baffling and a fan operation to obtain uniform heat distribution and uniform cold vapor distribution from a liquid nitrogen supply.

It may also be considered an object of the invention to provide interior positioning of centrifugal fan and baffling means, as well as liquid nitrogen nozzle positioning so as to obtain uniform heating and cooling in the interior of the unit.

A still further object of the invention is to provide a door switch arrangement as part of the electrical circuitry for the improved freezer-oven unit so as to preclude any injection of liquid nitrogen into the chamber at any time the door to the unit is open.

Briefly, the present invention embodies a freezer-oven unit for accommodating both the freezing and cooking of foods, in a manner which comprises an insulated chamber with a food access door thereinto, at least one electrical resistance heating coil positioned adjacent to one of the inner walls of the chamber, a baffle positioned in said chamber to extend part way across the interior thereof and to be between said heating coil and the central portion of the chamber, fan means mounted in said chamber adjacent to said heating coil means and behind said baffle to effect heat distribution throughout and to the rest of the interior of said chamber, motor means connective with said fan means, a nitrogen distribution nozzle into said chamber which terminates adjacent to the periphery of the fan means whereby the resulting cold vaporized nitrogen will be rapidly distributed into said chamber, a liquid nitrogen supply line to said nozzle and valve means in such line to permit control of liquid nitrogen flow therethrough.

In a preferred arrangement, the unit utilizes a centrifugal type fan so as to effect the initial outward radial flow of the circulating air within the oven, as well as cold nitrogen, from behind the baffle to the peripheral and central areas of the entire oven unit. Also, the baffle means in a preferred construction shall have a central opening so that the circulating air and nitrogen within the recirculating hot air or nitrogen within the unit can be drawn centrally into the centrifugal fan zone and then peripherally forced outwardly in a continuous forced flow manner. As noted hereinafore, it is a particular feature of the present improved construction to have the liquid nitrogen nozzle terminate at a zone adjacent to the periphery of the fan so that as the cold nitrogen enters the interior of the freezer-oven unit there will be the continuous rapid forcing of the nitrogen around all of the walls of the chamber to effect uniform cooling in the entire chamber section.

The heating of the unit, during the cooking cycle, may be accomplished in various manners and varying types of heat controlled units may be embodied in the oven construction, however, generally there will be utilized conventional Calrod heating elements which, in turn, will be positioned peripherally adjacent the back portion of the oven chamber, between the baffle means and the rear wall of the oven so that all of the radiated heat will be continuously forced outwardly from behind the periphery of the chamber by the operation of the centrifugal fan which should be centrally located in the back portion of the oven chamber where desired, the heating elements, baffling fan and the liquid nitrogen nozzle will be adjacent a side wall, rather than back portion, but the back zone is normally preferable. Two or more Calrod units may be embodied in a preferred construction and operated responsive to thermocouple means in the oven so as to provide adequate control of heat with a temperature range up to the order of at least 500°F. Generally, electrical switch means and thermocouple or thermostate type elements will be utilized to effect the conventional control of the heating cycles including preheating, high, medium and low temperature ranges so that all aspects of heating may be accomplished. In any event, it is not intended to limit the oven operation of the present invention to any one type of electrical resistance heating coil means or to any one fixed control system.

The control means will, of course, selectively provide for the heating cycle or the freezing cycle so that the heating coils will be turned off during the periods of time that the freezing-oven unit is operating to maintain the freezing of foods, or other materials. The control means may, however, provide for an "override" operation, where the thermostate or thermocouple control means in the oven unit will provide for introducing heating into the unit in the event that the liquid nitrogen introduction is effecting an operation which is "too cold". Conversely, there also may be an "override" provision to have liquid nitrogen introduced into the chamber in the event that the operation is overheating during a conventional oven operation.

As a safety feature, the electrical control circuit shall include a door switch or other safety means which will preclude the introduction of liquid nitrogen into the oven chamber at any time the access door to the freezer-oven unit is open. Thus, there will be the prevention of the continuous introduction of liquid nitrogen over a period of time while the oven door is open.

Reference to the accompanying drawing and the following description thereof will serve to show one embodiment of the present invention as well as point out additional advantageous features in connection therewith.

DESCRIPTION OF THE DRAWING

FIG. 1 of the drawing is a sectional plan view of the freezer-oven unit and indicates fan and baffle means for effecting the uniform distribution of heat and liquid nitrogen into the main oven chamber. FIG. 2 of the drawing is a sectional elevational view for the rear portion of the freezer-oven unit, as indicated by the line 2-2 in FIG. 1. FIG. 3 of the drawing indicates, in a simplified electrical schematic manner, the utilization of a door switch operative to preclude liquid nitrogen injection into the freezer-oven unit at any time that the door is opened.

Referring now particularly to FIGS. 1 and 2 of the drawing, there is shown a freezer-oven unit 1 which should be of an insulated construction having an outer housing section 2, insulation means 3 and internal liner 4, which are also covered the use of a front door section 5 having hinge means 6 at one side or bottom thereof. Like the oven chamber, the door is of suitable insulated construction to permit the entire door to serve efficiently as a freezer unit or as an oven unit. Suitable door latching means will, of course, be utilized in combination with the door 5 and the housing 2 but for purposes of drawing simply prefed the latching means 7 are shown to be the same as the latch means employed on the oven chamber.

In the rear portion of the freezer-oven unit there is shown a baffle 7 which is spaced inwardly from the rear wall of the liner 4 so as to provide a space 8 which in turn may be utilized for the positioning of a centrifugal type fan unit 9 being powered by motor 10. There are also diagrammatically indicated the positioning of heating elements 11 and 12 in the
space 8 behind baffle means 7 so that there may be hot air flow outwardly around the peripheral edges of the baffle 7. As better shown in FIG. 2, the baffle 7 provides passageways 13 at each side of the baffle plate 7 so that there may be hot air, or cold nitrogen flow outwardly into the main oven chamber 14. There is also indicated an opening 15 within the central portion of baffle 7, and preferably in alignment with the center of fan unit 9 whereby the hot air or the cold nitrogen is recirculated and drawn centrally into the rear portion of the chamber for redistribution radially outwardly by the fan blade 9. For illustrative purposes, small arrows are shown in the plan view of FIG. 1 indicating outward flow of the air and nitrogen from fan unit 9 into passageways 13 and thence into the larger oven chamber 14 to be subsequently returned by way of the central opening 15 into the zone of the blade zone 9. This forced circulation insures the uniform heating and cooling of the entire oven chamber 14 to preclude "hot-spots" or cold zones in any portion of the chamber which could occur by lack of forced circulation.

During the freezing periods of operation, liquid nitrogen is intermittently introduced into the rear portion 8 of the oven chamber by way of outlet nozzle 16 which in turn receives liquid nitrogen flow from line 7 having control valves 18 and 19. The latter is preferably a solenoid type "on-off" valve which is utilized to stop flow at such times that a thermocouple may effect a shut-off, or the combination unit is on a heating cycle or, alternatively, at such times as the oven door 5 may be opened during a freezing cycle. In other words, by the use of a suitable spring operated contact button 20 for a door switch 21 there may be activation of the electrical circuitry such that solenoid valve 19 will stop liquid nitrogen flow when door 5 is opened during the freezing cycle.

In the present unit, the fan 9 will be operating continuously for both the heating and cooling cycles so as to insure the uniform distribution of the heating or cooling mediums. With respect to the cooling it is, of course, a feature of the present improved construction and arrangement to have the discharge nozzle 16 be closely adjacent the periphery of the fan blade 9 so that liquid nitrogen upon entering the freezer-oven chamber will be immediately vaporized and uniformly distributed outwardly and peripherally or radially through the entire rear zone 8 and thus distributed uniformly through passageways 13 into the main chamber 14 of the unit. The fan 9 is also of particular advantage in effecting the uniform distribution of heat from behind the baffle 7 outwardly and radially through zone 8 to passageway 13 and thence to the oven chamber 14. Preferably, the heating elements 11 and 12 are symmetrically spaced in the zone 8 behind the baffle 7 so as to provide uniform distribution of heat into the space 8, however, with the utilization of the high speed fan 9 there will be a substantially uniform distribution of heat from the rear zone of the chamber, regardless of the positioning of heating elements in the unit. For purposes of simplification in the drawing, the various electrical connections to the resistance coils 11 and 12 have not been shown but may be made in any convenient or conventional manner to assist in construction and assembly aspects. For example, Calrod units may be attached directly to the partition member 7 and the latter in turn clipped or plugged into place in a conventional socket means. On the other hand, where desired, the heating coil means may be attached directly to the rear portion of the internal liner 4 and the electrical connection and control means housed within a rear frame 16 indicated at the rear of the freezer-oven unit. In any event, it is not intended to limit the present improved combined unit to any one type of electrical resistance coil or to any one method of mounting the coils and controlling them.

As noted briefly herebefore, a preferred combined unit will have adequate control means and the electrical heating means housed within a rear frame 16 indicated at the rear of the freezer-oven unit. In any event, it is not intended to limit the present improved combined unit to any one type of electrical resistance coil or to any one method of mounting the coils and controlling them.

Where the selector switch 23 is operated to have control means 26 connect with line 32 there will, of course, be the breaking of the freezing cycle and the energizing of the heated coil means at 33, in which case the fan unit 9 will be operative to blow hot air in a continuous manner around the resistance coils to insure uniform distribution of heat to the entire freezer-oven chamber. It may again be pointed out that FIG. 3 is merely diagrammatic and that the heater means 33 may comprise two or more coils, (such as Calrod units 11 and 12 indicated in FIGS. 1 and 2) and additional thermocouple and regulation means incorporated whereby a closely controlled range of temperatures up to 500°F. or more may be accomplished in the combined freezer-oven chamber. A preferred construction will, of course, have thermocouple means in combination with the oven chamber and with the circuitry so as to provide a given desired temperature level. However, for purposes of simplification FIG. 3 has eliminated the thermocouple means and the accompanying relays and other control means required to effect the temperature stabilization. Still further, as noted herebefore, the preferred type of circuitry will permit an "override" of either the heat or cooling range of at least about -40°F. to 500°F. and the control circuitry should be such as to maintain any preset temperature. The placement of a thermocouple, thermistor or other temperature sensitive means and the electrical control system for maintaining a particular oven temperature has not been indicated in the present drawing inasmuch as such types of circuitry are common in the oven arts and need not be made part of the present invention. However, with respect to the control of the cooling cycle there may be provided electrical circuitry in combination with a thermistor such that heat can be added to the oven unit in the event that the intermittent flow of liquid nitrogen into the chamber is such as to maintain a temperature lower than that desired by a predetermined setting. Generally, the liquid nitrogen flow will be preset to be substantially uniform by means of valve 18 or other flow restricting means, with the controlled flow of liquid nitrogen then being permitted to enter through nozzle 16 responsive to the solenoid valve 19.

In FIG. 3 of the drawing there is indicated, in a very simplified schematic manner, the utilization of a selector switch 23 which provides for setting the valve to either the freezing or heating cycles. For example, as shown, there is an energizing flow of current from line 24 through line 25 to switch arm 26 and into line 27 and thence through door switch 21' to line 28 and solenoid coil 30 whereby the solenoid valve 19 is energized to provide flow of liquid nitrogen through line 17' to outlet nozzle 16' in turn discharging adjacent the periphery of a fan blade 9 in a manner consistent with the arrangement of FIGS. 1 and 2 of the drawing. Fan 9 is indicated as being continuously powered by means of motor 10' receiving electrical energy by way of line 25 and 31. Preferably, at all times the fan 9 will be maintained in a continuous operation for both the heating and the cooling cycles of the unit in order to effect the desired uniform distribution of heating or cooling in the oven chamber. Of course, where desired for full control purposes, suitable switch means may be provided in the circuit so as to permit the starting or stopping of motor 10' and fan 9 but under normal operating conditions the fan should not be stopped for either the operating cycles of heating or freezing.

It will be noted that the door switch 21' being in the power supply line to coil 30 or solenoid valve 19' would cause the closure of the latter at such time as there is an opening of switch 21'. The (') markings or numbers in FIG. 3 correspond to the same numerals in FIG. 1 so that the operation of door switch 21 shall be such that the opening of door 5 (as shown in FIG. 1) will effect a breaking of the circuitry and a closing of solenoid valve 19. Although, conversely, the circuitry may be such that the solenoid valve 19 operates to remain in the open position and the circuitry is broken. In such a case, the door switch means as well as the overall circuitry shall be such as to close the valve 19 upon the completion of the circuit.

Where the selector switch 23 is operated to have control means 26 connect with line 32 there will, of course, be the breaking of the freezing cycle and the energizing of the heated coil means at 33, in which case the fan unit 9 will be operative to blow hot air in a continuous manner around the resistance coils to insure uniform distribution of heat to the entire freezer-oven chamber. It may again be pointed out that FIG. 3 is merely diagrammatic and that the heater means 33 may comprise two or more coils, (such as Calrod units 11 and 12 indicated in FIGS. 1 and 2) and additional thermocouple and regulation means incorporated whereby a closely controlled range of temperatures up to 500°F. or more may be accomplished in the combined freezer-oven chamber. A preferred construction will, of course, have thermocouple means in combination with the oven chamber and with the circuitry so as to provide a given desired temperature level. However, for purposes of simplification FIG. 3 has eliminated the thermocouple means and the accompanying relays and other control means required to effect the temperature stabilization. Still further, as noted herebefore, the preferred type of circuitry will permit an "override" of either the heat or cooling...
cycles so that in the event of too high a temperature, there may be provision for the opening of the solenoid valve 31 and temporary introduction of liquid nitrogen from nozzle 16 in order to permit a rapid cooling of the chamber or, alternatively, during the cooling cycle there may be a short time completion of the heating unit circuitry so as to provide a tempering of the chamber and maintenance of a uniformly desired level in the chamber. Still other additional features not comprising a part of the present invention of the combined freezer-oven unit may embody other aspects such as "self-cleaning", where there is a high temperature cycle permitted to provide for the burn-off of oven accumulations. Such self-cleaning cycles are, of course, carried out during "off" periods where the oven is not being utilized for either heating or freezing of food stuffs or other materials. Also, self-cleaning oven constructions generally embody the utilization of special vent means whereby smoke and other fumes will be completely oxidized to preclude their passage into the galley or kitchen area.

Modifications with respect to cabinet design as well as internal equipment may well be made and still be within the scope of the present invention inasmuch as various baffle designs and arrangements are obviously possible as well as various baffle and fan locations. In other words, although the fan and baffle means are preferably mounted in the rear end portion of the oven chamber, it is entirely possible that they be positioned along a side or a top or a bottom zone, as long as the fan means is capable of effecting the uniform distribution of air currents in combination with the baffling for the entire freezer-oven chamber. Preferably, the fan means 9 will be of a centrifugal type of operation such as provided by a small squirrel gauge configuration or of a right angle, flat blade type, such as indicated in FIGS. 1 and 2 of the present drawing. Thus, air is continuously pushed radially from the fan unit 9 around the entire 360° portion of the rear zone 8 whereby there is, in turn, provided a uniform two-way, or 360° distribution around the centrally located baffle means 7. The fan 9 and its motor 10 shall also operate at sufficient speed to insure an adequate circulation of air within the freezer-oven unit so as to insure a rapid thawing of food and a rapid cooking subsequent to thawing. Generally, the amount of air being circulated may be critical and should be of the order of 150 to 200 cubic feet per minute or more to insure the uniform circulation through the entire chamber 14. However, the volume of the entire oven chamber will obviously affect the amount of air being circulated so that larger amounts and higher velocities may be required for large sized oven chambers as compared to the smaller sized ones.

The opening 15 in baffle 7 may be other than round in a modified baffle design, but generally will comprise a slot or other central opening which will feed recirculated air back into the hub zone of the centrifugal type fan 9. In still further modifications, the interior 14 of oven unit 1 may be of any desired shape and dimension and may have various shelves or internal racks, none of which are shown in the present diagrammatic drawing, in order to accommodate food trays or other items. While the foregoing description has indicated the freezer-oven unit to be used for freezing and cooking food stuffs, it is also to be understood that the unit might well be used for other materials or products.

We claim:

1. A freezer-oven unit suitable for accommodating both the freezing and cooking of foods, which comprises in combination, an insulated chamber with an access door thereto, at least one electrical resistance heating coil positioned adjacent to one of the inner walls of the chamber, a baffle having a central opening positioned in said chamber to extend substantially across the interior thereof and to be between said heating coil and the central portion of the chamber, said baffle providing peripheral passageways into said chamber, centrifugal type fan means mounted in said chamber adjacent said heating coil means and behind said baffle to effect heat distribution therearound and to the remaining interior portion of said chamber, motor means connective with said fan means, a nitrogen distribution nozzle into said chamber behind said baffle and adjacent to and discharging near the periphery of the fan means whereby the resulting cold vaporized nitrogen will be rapidly distributed into said chamber, a liquid nitrogen supply line to said nozzle and valve means in such line to permit control of liquid nitrogen flow therethrough, and control means to alternatively actuate said heating coil and said liquid nitrogen flow.

2. The freezer-oven unit of claim 1 further characterized in that said fan means is mounted centrally along and adjacent a wall of the unit and said central opening is in substantial alignment with the central portion of the fan means, said peripheral passageways comprising at least two opposing edges of the baffle and adjacent wall portions whereby there is a central flow of heating or cooling currents outwardly from the fan around the edges of the baffle to the central portion of the insulated chamber and a recirculation of air toward the fan through the central opening in said baffle.

3. The freezer-oven unit of claim 2 further characterized in that said heating coil is constructed and located to be symmetrically positioned with respect to said baffle and said centrifugal type fan means in said chamber provides for uniform outward radial flow around its entire periphery whereby to effect a uniform distribution of air flow over heating coil means as well as uniform peripheral distribution of nitrogen from said distribution nozzle to force air and nitrogen against encompassing wall surfaces and thence outwardly around said baffle.

4. The freezer-oven unit of claim 1 further characterized in that the valve means to the liquid nitrogen distributing nozzle is electrically controlled and switch means is provided in combination with said chamber and said access door thereto whereby upon the opening of the door there is an operation of the switch to effect the closing of said valve means and the stoppage of liquid nitrogen supply to said nozzle.

5. The freezer-oven unit of claim 1 further characterized in that said control means comprises an electrically operated control switch to selectively provide for alternative actuation of said heating coil and said valve means to introduce liquid nitrogen to said distribution nozzle whereby said chamber is selectively heated for cooking or for freezing of foods within said chamber.