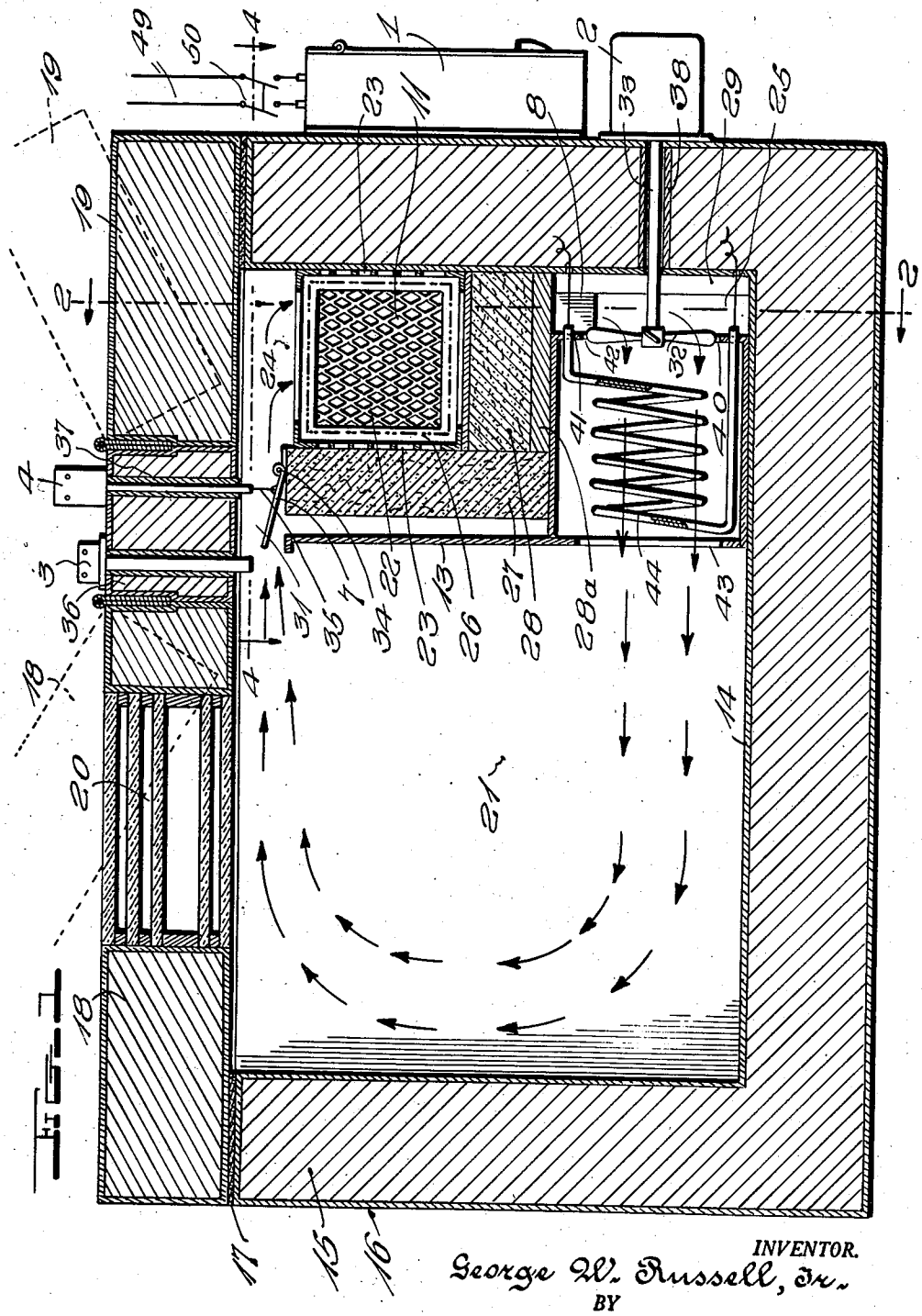
Oct. 10, 1944. G. W. RUSSELL, JR 2,359,796

METHOD AND APPARATUS FOR REFRIGERATION

Filed May 26, 1943 3 Sheets-Sheet 1



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Fig. 3

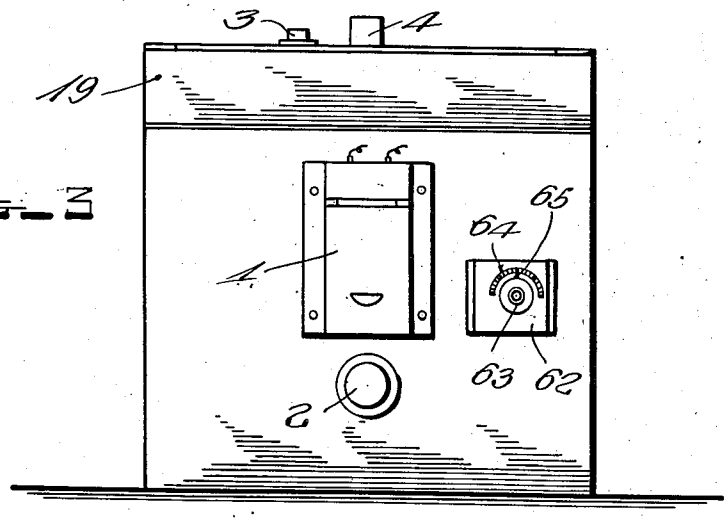
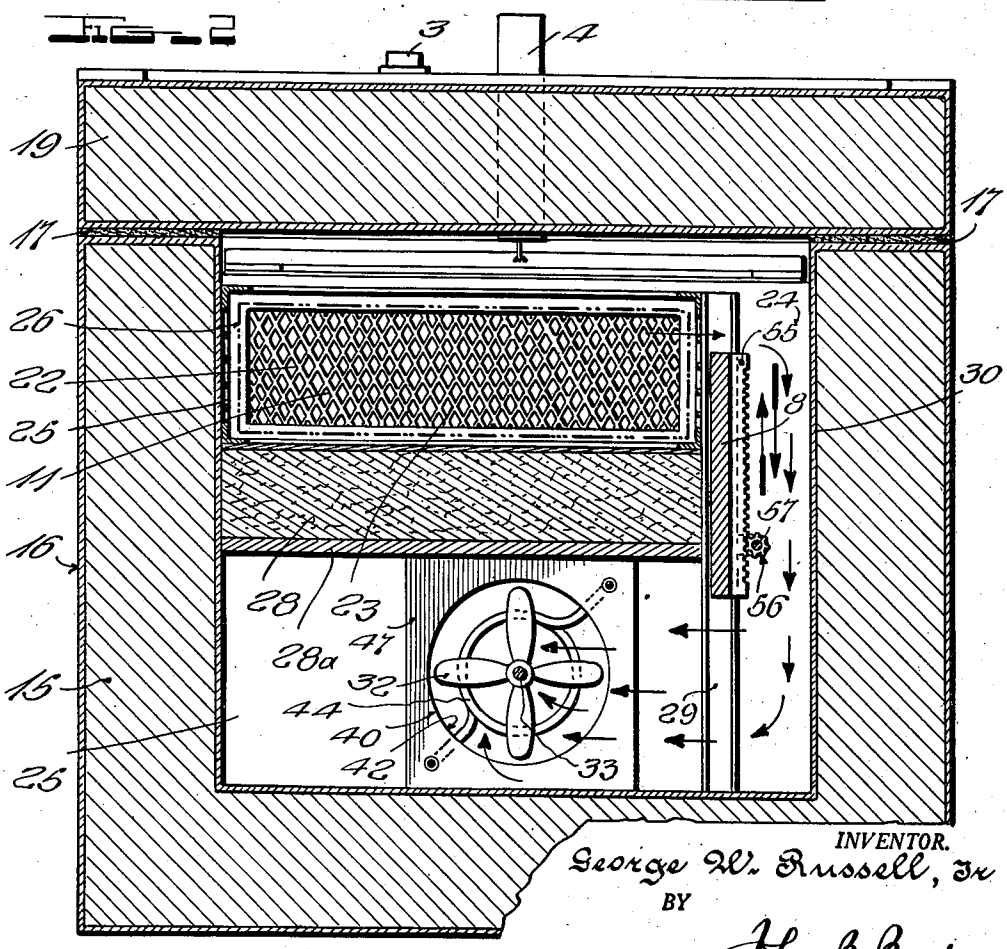


Fig. 2



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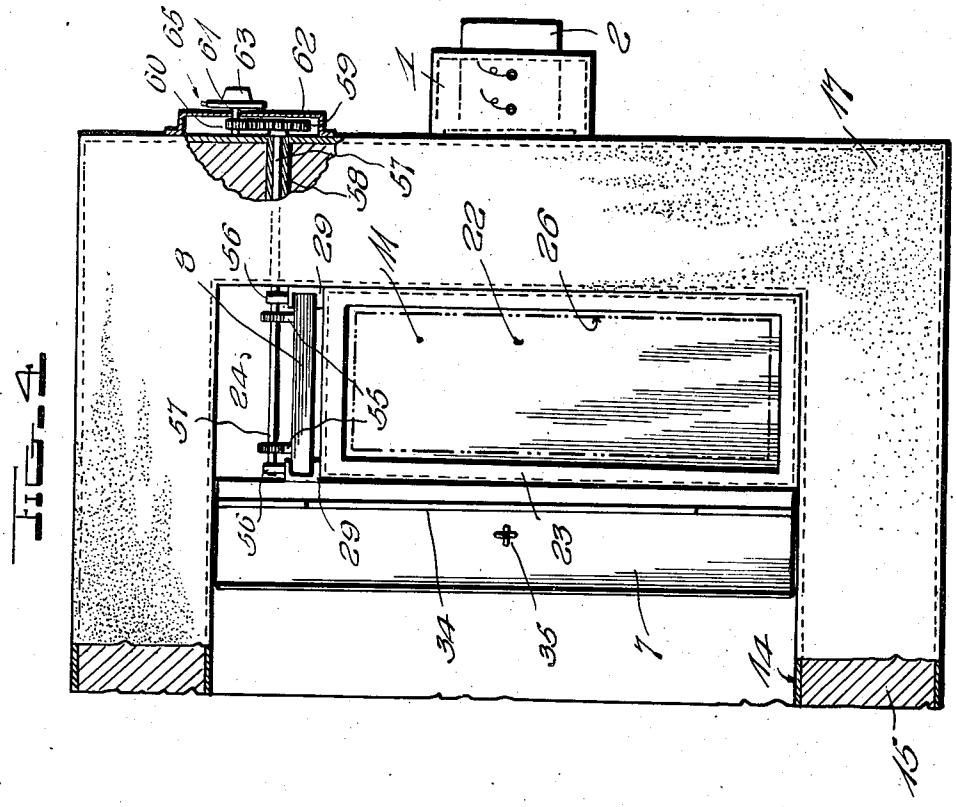


FIG. 4

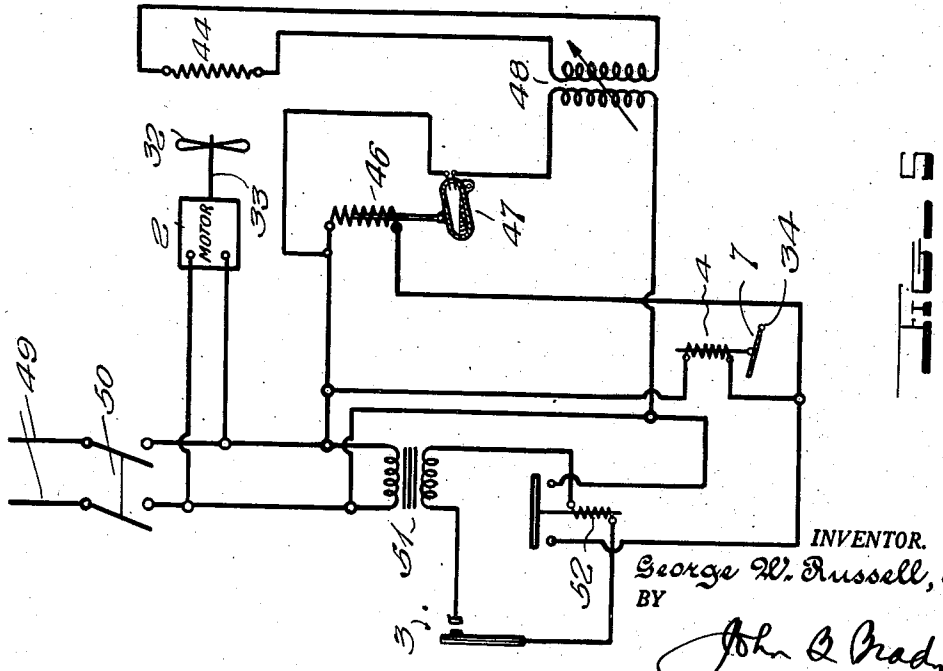


FIG. 5

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Patented Oct. 10, 1944

2,359,796

UNITED STATES PATENT OFFICE

2,359,796

METHOD AND APPARATUS FOR REFRIGERATION

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Application May 26, 1943, Serial No. 488,579

5 Claims. (Cl. 62—91.5)

My invention relates broadly to refrigeration and more particularly to a system for selectively controlling refrigeration temperatures.

One of the objects of my invention is to provide a method of selectively controlling refrigeration temperatures at relatively low temperature ranges.

Another object of my invention is to provide a method of controlling refrigeration temperatures by selecting strata or zones of a circulating gaseous mixture about a refrigerating source and effectively utilizing a selected strata or zone of the gaseous mixture for refrigeration

Still another object of my invention is to provide a system of refrigeration particularly adapted for effecting refrigeration at controlled temperatures with ordinary commercially available dry ice.

A further object of my invention is to provide a system of refrigeration having means for selecting strata or zones of a circulating gaseous mixture moving about a mass of chemically prepared dry ice for the precision control of temperatures by stratification of the gaseous mixture.

Other and further objects of my invention reside in a method and apparatus for selectively controlling temperatures in a dry ice cabinet as set forth more fully in the specification hereinafter following by reference to the accompanying drawings, in which:

Figure 1 is a cross-sectional view taken through a dry ice cabinet embodying the principles of my invention; Fig. 2 is a transverse section through the dry ice cabinet taken substantially on line 2—2 of Fig. 1; Fig. 3 is a front elevation of the dry ice cabinet illustrated in Figs. 1 and 2 showing the calibrated temperature control means adjustable from the exterior of the cabinet; Fig. 4 is a fragmentary plan view of the dry ice compartment of the dry ice cabinet taken substantially on line 4—4 of Fig. 1; and Fig. 5 is a schematic wiring diagram of one form of control circuit employed in the refrigeration system of my invention.

My invention is directed to a method and apparatus for refrigeration utilizing commercially available blocks of dry ice. A dry ice compartment is arranged adjacent a low temperature or working compartment in which the low temperatures are utilized. The dry ice compartment is divided into sections with a container for dry ice arranged in a substantially central section or position within the compartment with passages for the circulation of a gaseous mixture both above and below the substantially central section. A force fan circulator for the gaseous mixture is located in one section of the dry ice compartment. A temperature controlled regulator is arranged in the working compartment and is operative to control a main damper in a passage or by-pass adjacent one section of the dry ice compartment for controlling the circulation of the gaseous mixture through the dry ice compartment and through the by-pass. By circulating the gaseous mixture through the dry ice section of the dry ice compartment, temperature conditions over a range of from 5° F. above zero to 110° F. below zero have been successfully developed in the refrigeration system of my invention. The particular feature of my invention resides in the arrangement of a sliding damper adjacent the dry ice section of the dry ice compartment. This sliding damper selects the strata or zone of the gaseous mixture adjacent the dry ice section of the dry ice compartment which may be selectively circulated through the working compartment. By adjusting the position of the sliding damper, various stratifications or zones of air adjacent the dry ice section of the dry ice compartment may be selected and the gaseous mixture effectively circulated around the dry ice section and through the working compartment for effective utilization at predetermined temperatures. That is to say, my investigations have shown that for different settings of the sliding damper relative to the dry ice section of the dry ice compartment different strata of cold gaseous mixture are selected and the selected strata when circulated produce refrigeration in the working compartment corresponding to the temperature of the selected strata. The temperature gradient adjacent the dry ice section of the dry ice compartment is directly dependent upon the displacement or position of the sliding damper adjacent the dry ice section of the dry ice compartment. The sliding damper may be set in a predetermined position for the selection of the strata of the circulating gaseous mixture adjacent the dry ice compartment. In lieu of the presetting of the sliding damper in a permanent selected position, I may provide a suitable actuator operated by remote control from a position external to the cabinet. The damper may thus be selectively displaced in position to select that strata or zone which will effect the desired refrigeration for the particular conditions required. The remote control adjusting mechanism may be suitably calibrated so that the temperatures adapted for the particular presetting

of the position of the damper may be readily determined.

The refrigeration system of my invention provides means for effectively utilizing commercially obtainable blocks of dry ice for obtaining low temperatures for such industrial purposes as rivet cooling, the testing of aircraft instruments, synthetic rubber testing, the shrinking of connecting members for forming tight fits, and for other purposes.

My invention also has application in the quick freezing of foods and in the preserving of certain vegetables by the freezing process. In addition to the industrial applications mentioned, my invention is also applicable in certain domestic refrigeration systems.

My invention will be more fully understood by detailed reference to the drawings wherein the working compartment of the refrigeration apparatus is represented at 21 and the dry ice compartment is represented at 22. The compartments are formed within a laminated heat insulation wall structure designated generally at 15. The compartments are separated by a main baffle or partition 13 containing passages adjacent both the top and bottom. A steel liner 14 is provided for the two compartments adjacent the insulated laminated wall 15. The exterior of the insulated laminated wall structure 15 is covered by an external cover material represented at 16. The upper peripheral edge of the insulated wall structure is covered by a layer of felt designated at 17. The working compartment 21 is closed by a working compartment lid 18 while the dry ice compartment 22 is closed by a dry ice compartment lid 19. Thermo-pane window 20 is provided in the working compartment lid 18. This window is formed by a multiple stack arrangement of glass plates spaced by a peripheral separator of sheet metal and silica gel with the space between the glass plates dehydrated, thus forming a transparent window which prevents the loss of any appreciable amount of refrigeration.

The working compartment 21 is adapted to receive the articles or foods to be subjected to the extremely low temperatures developed in the refrigeration system. The dry ice compartment 22 is divided into sections including a central section 23 and end sections 24 and 25. The central section 23 includes a support 11 for blocks of dry ice indicated generally at 26. The support 11 is formed from a suitable open mesh screen allowing the circulation of air between the blocks of dry ice deposited in the support 11. The support for the dry ice is insulated at one side by insulation sheet 27 and along its bottom throughout a portion of its length by insulation sheet 28, supplemented by additional sheet 28a which may be wood or other suitable material. The support or carrier 11 is constructed from open mesh sheet metal having substantial rigidity while allowing free circulation of the gaseous mixture around the dry ice contained therein. At one end of the support or carrier 11 for the dry ice, I provide a pair of vertically extending guide rails 29 which form guides for a vertically adjustable sliding damper 8. The vertically adjustable sliding damper 8 constitutes an end closure for the carrier for the dry ice shown at 11 and is selectively movable to different positions adjacent the end of the carrier.

The vertically sliding damper 8 is provided with a pair of rack members 55 projecting from one face thereof. The vertically extending guide rails 29 have standards 56 mounted thereon which serve as bearings for the adjusting shaft 57. The adjusting shaft 57 is journalled in the bearings formed by the standards 56 and extends through the insulated laminated wall structure 15. A heat insulating sleeve member 58 forms a casing surrounding the shaft 57 preventing appreciable loss of the low temperatures developed in the dry ice compartment 22. The projecting end of shaft 57 carries a gear 59. An auxiliary gear 60 carried by control shaft 61 journalled adjacent the gear 59 meshes with gear 59 and provides an adjusting means therefor. A casing 62 surrounds the gear system forming a gear housing for the gears. A control knob 63 connects with shaft 61 and serves as a manual grip device for effecting adjustment of the damper 8. The casing 62 carries a calibrated dial represented at 64 over which the indicator 65 sweeps for adjusting the slidable damper 8 to a particular strata or zone of the gaseous mixture within the dry ice compartment 22. The calibrated scale 64 enables the damper 8 to be set, adjusted and reset to a selected position.

By shifting the sliding damper 8 to different positions, a selected strata or layer of cold gaseous mixture may be segregated and circulated through the dry ice compartment over a predetermined temperature range. By shifting sliding damper 8 to a position near the upper extremity of the dry ice compartment 22 so that section 24 of the dry ice compartment becomes a relatively narrow passage, temperatures in the range of 5° F. above zero may be selected and maintained whereas upon lowering the sliding damper 8 to a position which substantially exposes the end section of the dry ice container 11, temperatures in the range of 110° F. below zero may be selected and maintained.

The sections 24 and 25 are interconnected through the passage 30 at the end of the dry ice compartment and beyond the sliding damper 8. A circuitous path around the dry ice section 11 is completed through passage 31 adjacent the top of partition 13, intermediate the working compartment 21 and the dry ice compartment 22 and through the confined passage 40 in section 25. A circulating fan 32 is located in the confined passage 40 in the section 25 of the dry ice compartment 22 and is driven by motor 2 arranged externally of the cabinet structure. The confined passage 40 has an end plate 41 which is apertured at 42 for the entry of circulating fan 32 therethrough. The other end of confined passage 40 opens through aperture 43 in partition 13 into the working chamber 21. A drive shaft 33 extending from motor 2 drives fan 32 for effecting forced circulation of air through the dry ice compartment according to the path indicated by the circulating lines in Figs. 1 and 2. For the purpose of controlling the circulation of air around the dry ice compartment, I arrange a main damper 7 in the section 24 of the dry ice compartment. Main damper 7 is constituted by a valve plate pivotally mounted along one longitudinal edge thereof as represented at 34 and arranged to be displaced in position for varying the opening for the gaseous medium through passage 31 in partition 13 and through section 24 of the dry ice compartment. The main damper 7 is varied in position through a connection 35 extending to a solenoid actuator 4 which is in turn controlled by the operation of a relay circuit controlled by thermostatic regulator 3. The mechanism of the relay circuit and system is con-

veniently housed in container 1 mounted on one side of the cabinet.

Fig. 5 shows one form of circuit arrangement for the control system of my invention. In all instances where the control mechanism is carried through the cabinet structure, I provide heat insulation to prevent leakage of heat from the exterior of the cabinet to the interior thereof. For example, around regulator 3 which extends through the insulated wall of the cabinet, I provide a heat insulating sleeve represented at 36 and around the damper actuating mechanism represented at 35 I provide a heat insulation sleeve 37 while around motor drive shaft 33 there is a heat insulation member 38.

A heating coil 44 is arranged in the confined passage 40 and supported from terminals mounted in end plate 41. The heating coil 44 may be cut into and out of the circuit under control of actuator 46 that operates suitable switch 47 for supplying current through adjustable transformer 48 for energizing heating coils 44. It will be observed that motor 2 drives fan 32 continuously for circulating the gaseous medium through the working compartment 21 and the control is brought about by control of position of the main damper 7 and/or the energization of heating coils 44. Power is supplied to the cabinet through mains indicated at 49 through switch 50. Transformer 51 furnishes reduced potential for control of the button relay circuit indicated at 52 through thermostatic regulator 3 and also the potential required for operation of solenoid actuator 4 that controls main damper 7.

While I have described my invention in certain preferred embodiments, I desire that it be understood that modifications may be made and that no limitations upon my invention are intended other than may be imposed by the scope of the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States is as follows:

1. In a system of refrigeration, the method of controlling temperatures which comprises supporting a cold body in a confined passage for a gaseous mixture in which the temperature maintained by the cold body varies from a high adjacent the top of the cold body to a low adjacent the bottom of the cold body, selecting strata of the gaseous mixture in the course of its passage over the cold body and forcibly circulating the selected strata of the gaseaus mixture in a confined path around the cold body.

2. The method of controlling temperatures, which comprises suspending a cold solid in a confined gaseous atmosphere in which the temperature adjacent the cold solid varies in accordance with the effective dimensions of the solid, selectively exposing different dimensional portions of the cold solid to the gaseous atmosphere for selecting stratifications of different temperatures adjacent the cold solid, and forcibly circulating a selected strata of gas around said cold solid for maintaining a temperature within said confined space dependent upon the temperature of the selected strata of gas adjacent the cold solid.

3. In a system of refrigeration, a container for receiving a cold solid, means for mounting said container within a confined atmosphere, a slidable damper arranged adjacent the cold solid and shiftable to expose selected portions of the cold solid to the confined atmosphere, and means for forcibly circulating a gaseous mixture around the selectively exposed portion of the solid.

4. In an apparatus for effecting refrigeration, a cabinet for confining a gaseous mixture, a container for a cold solid, a passage for the gaseous mixture extending adjacent said container, a damper intermediate said container and said passage, said damper being shiftable to selected positions for selectively exposing selected portions of said solid to the gaseous mixture in said passage, and means for forcibly circulating the confined gaseous mixture around the exposed portion of said cold solid for maintaining temperatures proportional to temperatures corresponding to the exposed portions of the cold solid.

5. In an apparatus for effecting refrigeration, a cabinet for confining a gaseous mixture, a container for a cold solid, a passage for the gaseous mixture extending adjacent said container, a damper intermediate said container and said passage, said damper being shiftable to selected positions for selectively exposing selected portions of said solid to the gaseous mixture in said passage, means for forcibly circulating the confined gaseous mixture around the exposed portion of said cold solid for maintaining temperatures proportional to temperatures corresponding to the exposed portions of the cold solid, and means for separately controlling the flow of the gaseous mixture adjacent the exposed portion of the cold solid.

GEORGE W. RUSSELL, JR.