

May 30, 1944.

R. C. OSBORN

2,350,249

REFRIGERATION

Filed Sept. 4, 1941

4 Sheets-Sheet 1

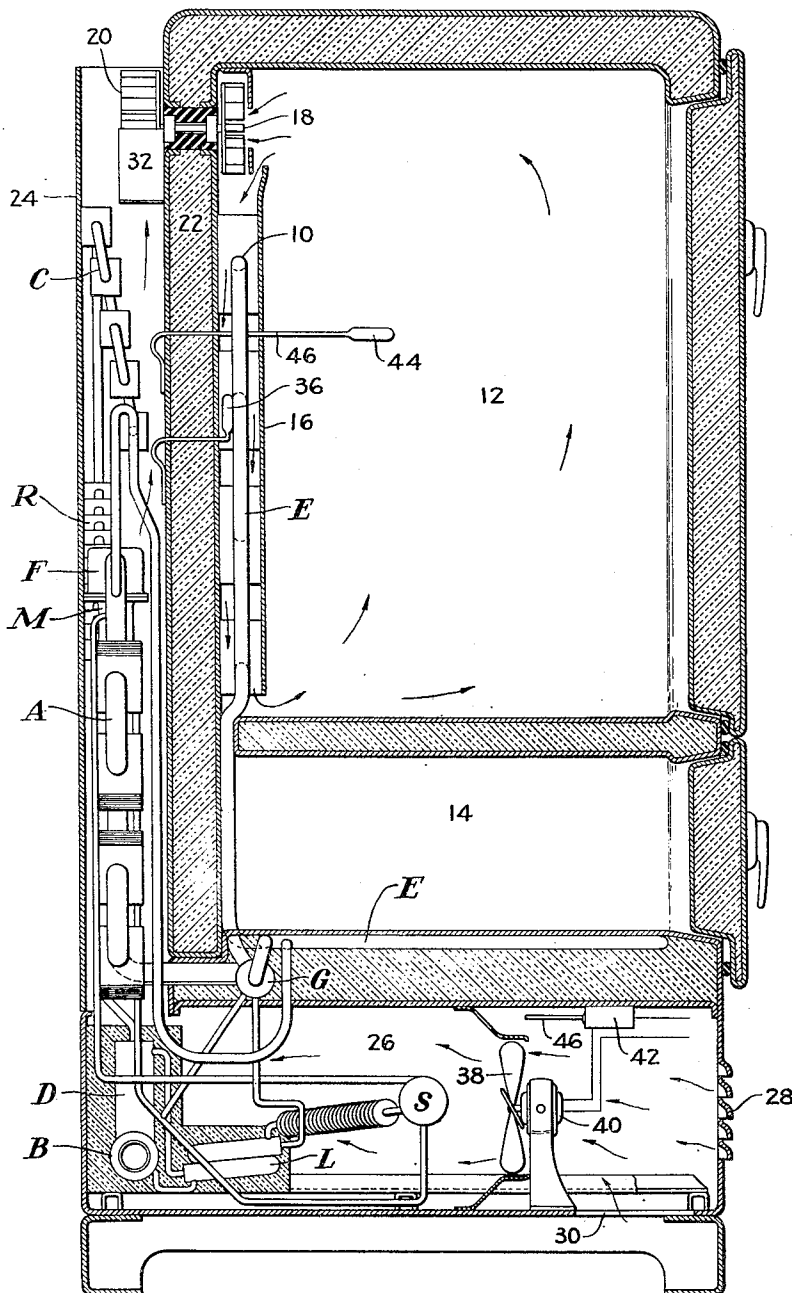


Fig. 1

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4 Sheets-Sheet 2

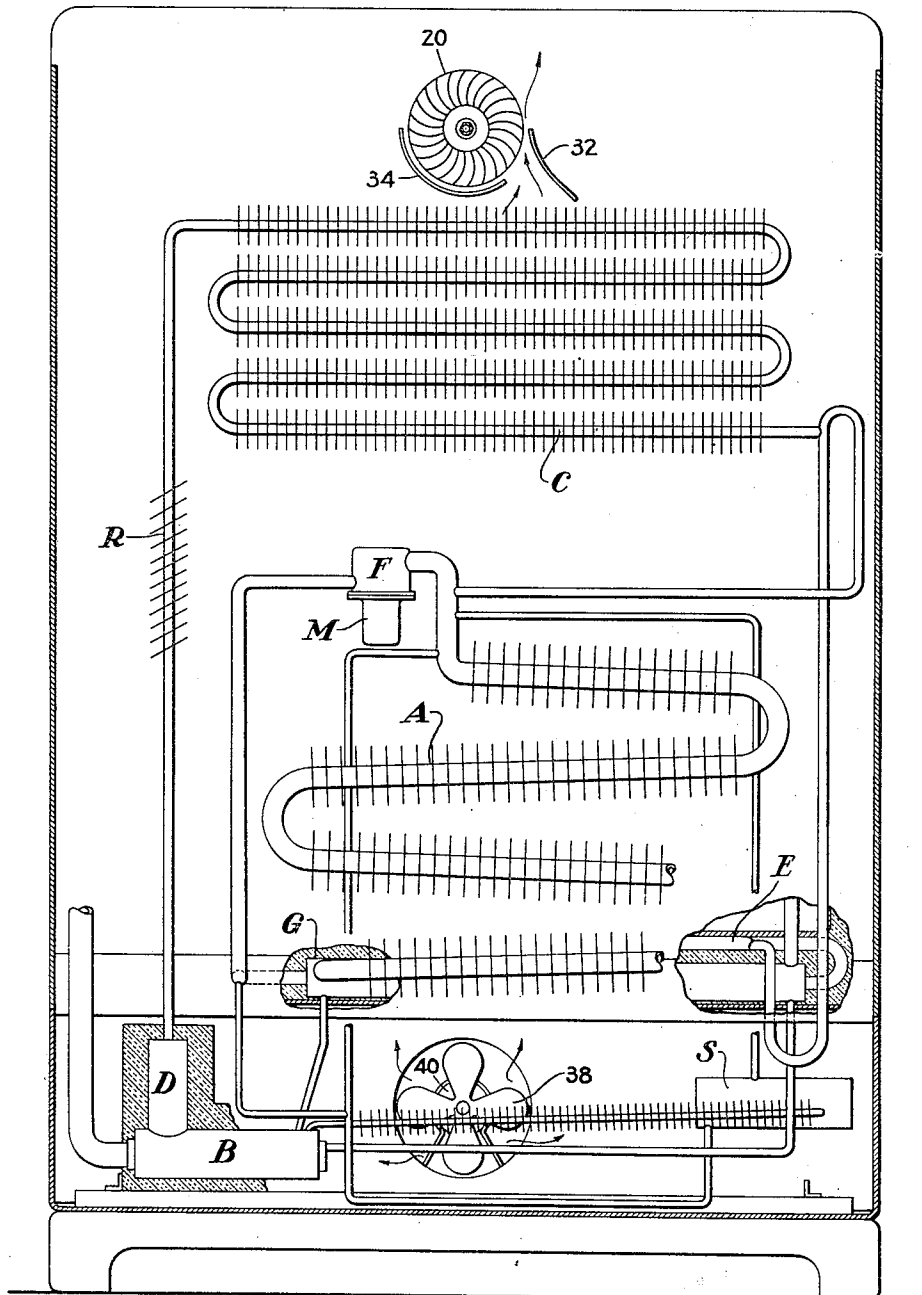


Fig. 2

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4 Sheets--Sheet 3

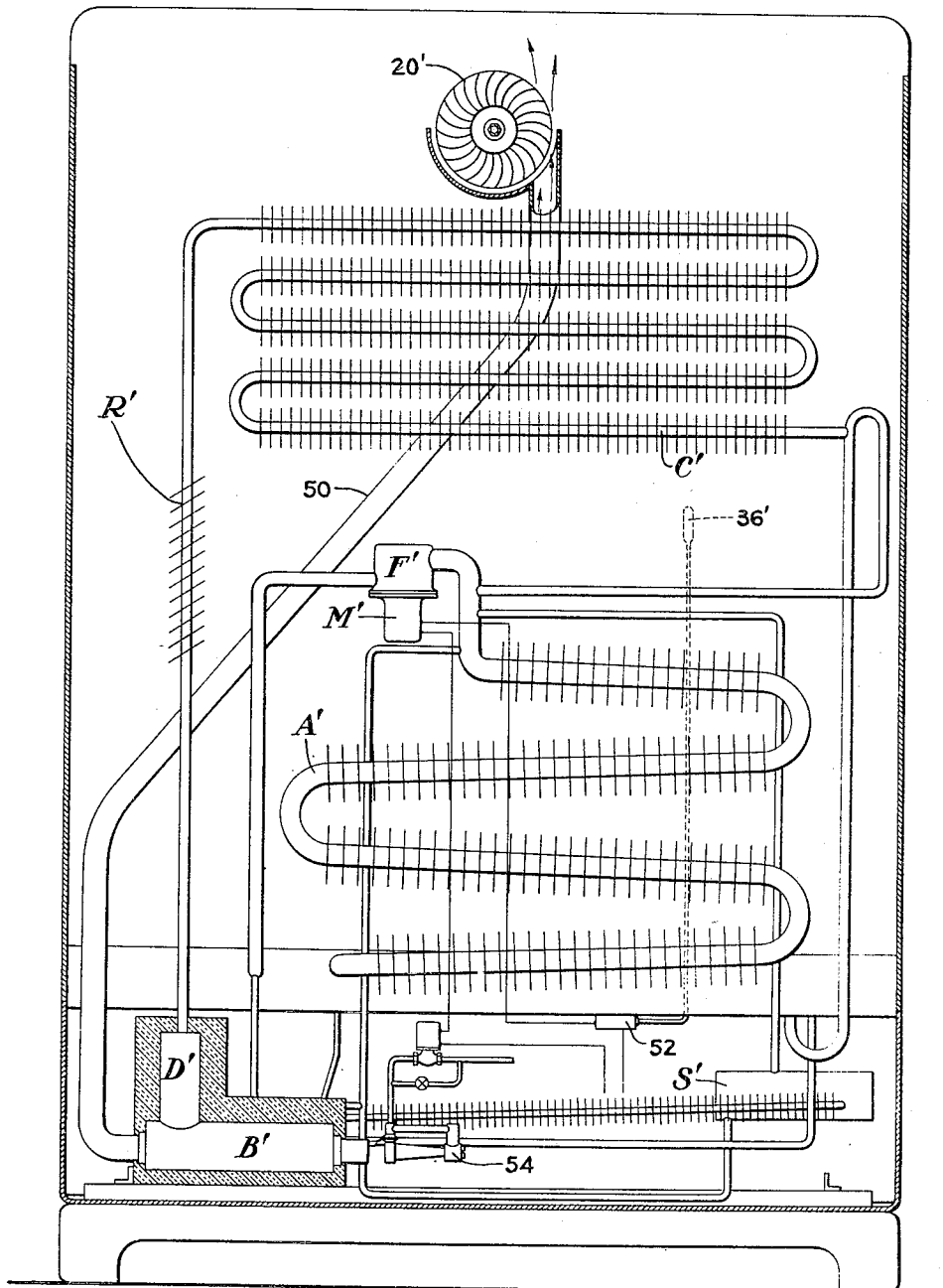


Fig. 3

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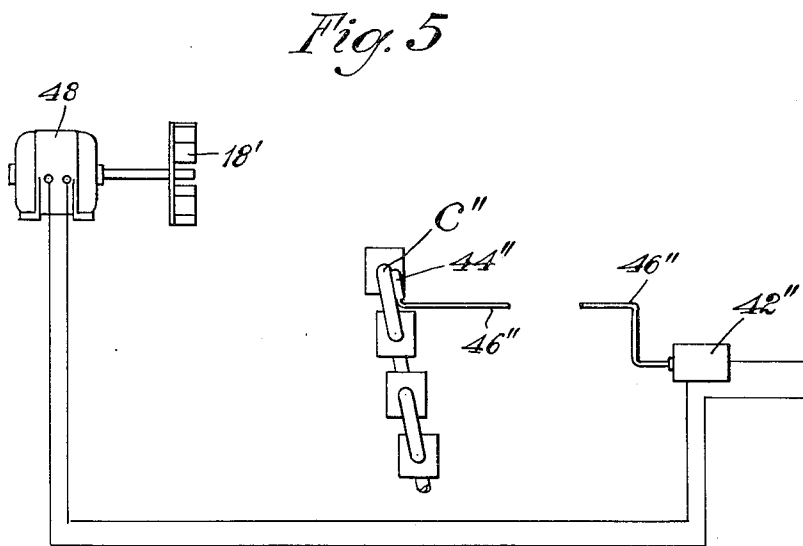
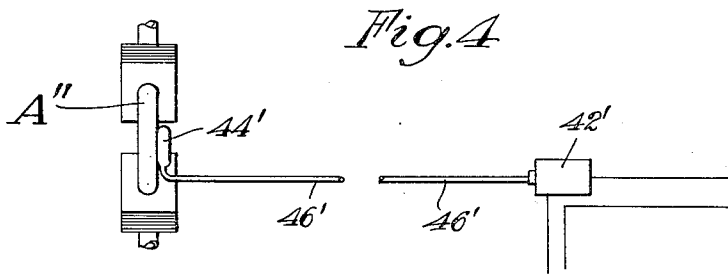
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4 Sheets-Sheet 4



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2,350,249

REFRIGERATION

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Application September 4, 1941, Serial No. 409,448

17 Claims. (Cl. 62—5)

This invention relates to refrigeration and more particularly to a means for circulating air in the food compartment of a domestic refrigerator cabinet whereby all parts of a food storage compartment will be maintained at their proper value and the cooling capacity of the evaporator will be utilized to its fullest extent for cooling the air in the food compartment.

In domestic refrigerating apparatus it is usual practice to rely on convection circulation of air over the evaporator for cooling the air in the food compartment. Such apparatus operates satisfactorily but the air circulation is slow and there is a considerable lag between the temperature of the air in the food compartment and that of the evaporator. This renders it necessary to operate the evaporator at a temperature which sometimes goes below the freezing point of water whereby the water vapor which condenses on the evaporator will be frozen so as to necessitate periodic defrosting of the evaporator.

It is known to operate the air cooling portion of the evaporator of domestic refrigerators at a temperature above the freezing point of water, and to positively circulate air thereover to minimize the lag between the temperature of the air in the food compartment and that of the evaporator. This eliminates the necessity of defrosting the air cooling evaporator and at the same time makes it possible to maintain the air in the food compartment at the desired degree. However, such prior devices required the use of separate power consuming devices with a consequent increase in the consumption of energy and the addition of heat to the food storage compartment.

It is therefore an object of this invention to provide a means for positively circulating air over the evaporator of a domestic refrigerator to maintain the air in the food storage compartment at the desired low temperature without maintaining the evaporator at extremely low temperature in which it is unnecessary to provide any additional power other than that required to operate refrigerating apparatus itself.

In modern domestic refrigerating apparatus it is usual to provide a cabinet having a food storage compartment and an apparatus compartment in which the apparatus compartment is made in the form of an air passage for circulating room air over the heat rejecting parts of the apparatus. This air may be positively circulated through the air passage or the heat rejecting parts of the apparatus may be so positioned as to induce a convection circulation of

air through the air passageway. This air flowing through the air passageway has considerable kinetic energy which usually is wasted.

According to this invention the kinetic energy of the air which is used to cool the heat rejecting parts of a domestic refrigerating apparatus is utilized for circulating air over the evaporator in the food storage compartment.

In domestic refrigerating apparatus of the absorption type which are gas fired, a flue is provided for carrying away the products of combustion. The action of the burner and the heating of the flue creates a considerable draft through the flue with the result that the flue gases have kinetic energy which is usually wasted.

It is another object of this invention to utilize kinetic energy of the flue gases of a gas fired absorption refrigerating apparatus for circulating air over the evaporator in the food storage compartment.

In domestic refrigerators the refrigerating apparatus is usually controlled by a thermostatic bulb positioned against the evaporator. Where a fan is utilized to circulate air over the evaporator in such machines the fan should be operated for a period after the refrigerating apparatus is de-energized because the temperature of the air in the cabinet lags considerably behind that of the evaporator. If that is not done, considerable of the refrigerating capacity of the apparatus would not be utilized.

According to this invention the delay in the stopping of the air circulation over the evaporator is brought about by a delay in stopping the flow of the air circulation for cooling the heat rejecting parts of the apparatus.

In refrigerating apparatus, especially in those of the absorption type, it takes a considerable period of time after the apparatus is de-energized for the heat rejecting parts of the apparatus to cool down. In the case where the heat rejecting parts are positioned to induce a convection circulation of air thereover, this circulation of air as a consequence continues for a considerable period after de-energization of the apparatus.

According to this invention this continuation in the circulation of air over the heat rejecting parts of the apparatus is utilized to continue the circulation of air over the evaporator for a period after the apparatus is de-energized.

In order that there will be no delay between the energization of the boiler of an absorption refrigerating apparatus, and the time when refrigerant vapor is being delivered to the con-

denser, these machines are sometimes operated on a high and a low flame. That is, when there is a demand for refrigeration, the flame is at a maximum, and when this demand ceases the flame is not entirely extinguished but is maintained at a height just sufficient to keep the boiler at substantially operating temperature. The heat which is supplied to the boiler when there is no demand for refrigeration is largely wasted by the discharge of the products of combustion from the boiler flue.

According to this invention, this heat is utilized to circulate air over the evaporator during the off period so as to maintain the temperature of the food compartment the same throughout.

Other objects and advantages of this invention will become apparent as the description proceeds taken in connection with the accompanying drawings in which:

Figure 1 discloses a refrigerating apparatus according to this invention in assembled relationship with a domestic refrigerator cabinet which is cut away to show the relationship between the various parts of the apparatus;

Figure 2 is a rear view of the apparatus shown in Figure 1 with the back wall partly broken away to show the arrangement of the various parts of the apparatus;

Figure 3 is a modified form of a refrigerating apparatus according to this invention;

Figure 4 is a modified form of control depicting how the motor may be controlled responsive to the temperature of the absorber; and

Figure 5 is another modified control showing the air circulator driven by a separate motor, and controlled by the temperature of the condenser.

Referring to the drawings, there is disclosed a three-fluid absorption refrigerating system comprising a boiler B, an analyzer D, an air-cooled rectifier R, a tubular air-cooled vertically positioned condenser C, an evaporator E, a gas heat exchanger G, a tubular air-cooled absorber A, a solution reservoir S, a liquid heat exchanger L, and a circulating fan F which is driven by an electrical motor M. The above described elements are interconnected by various conduits to form a plurality of gas and liquid circuits constituting a complete refrigerating system.

The above described system and the arrangement of the various parts thereof constitute no part of the present invention. This system and the arrangement of the various parts with relation to a domestic refrigerator cabinet are fully described in an application for Letters Patent by Louis K. Acheson, Serial No. 378,162, filed February 10, 1941.

It is not believed necessary, to an understanding of the present invention, to describe in detail the construction and operation of the refrigerating system chosen to illustrate this invention. It is fully disclosed in the application for Letter Patent above referred to, and is not essential to the operation of this invention. This invention could be applied to refrigerating systems of other types, absorption as well as compression. Suffice it to say that the portion 10 of the evaporator E in the food storage compartment 12 is maintained at a higher temperature than that portion in the freezing compartment 14. Preferably the portion 10 of the evaporator E is maintained above the freezing temperature of water so that water vapors condensing thereon are not frozen and it is not necessary to defrost the evaporator. Any suitable means

may be provided for removing the condensed water vapor from the food storage compartment 12.

In refrigerating apparatus of this type in which the evaporator is maintained above the freezing temperature of water, it is desirable that air be circulated over the evaporator so as to maintain the temperature of the air in the food compartment substantially the same throughout and nearer to the temperature of the evaporator than would be the case if there was no air circulation or merely a convection air circulation.

The rate of air circulation need not be fast and is preferably comparatively slow but there should be a constant circulation all during the time that refrigeration is being produced in the evaporator and sometimes after the production of refrigeration by the evaporator has ceased. In any event this circulation should continue for a period after the production of refrigeration has ceased because the evaporator temperature is always below that of the air in the food compartment. If the air circulation were not continued at least for a period after the termination of production of refrigeration the refrigerating effect would not be utilized to its fullest extent. Furthermore it is not harmful if a slow circulation of air continues during the entire period the apparatus is shut down. This will equalize the temperature throughout all parts of the food compartment without requiring any more refrigeration and will utilize the full refrigeration effect produced.

In order to circulate air over the portion 10 of the evaporator E positioned in an air duct formed by the partition 16, a centrifugal fan 18 is provided. This fan is directly connected by a shaft to a turbine 20 on the exterior of the food compartment 12. The shaft extends through the insulated wall 22 of the food compartment 12. The turbine 20 is positioned in a passageway for the circulation of air over the heat rejecting parts of the refrigerating apparatus which comprises an air flue, formed by the back wall 24 of the apparatus compartment and the insulated wall 22 of the food storage compartment together with the apparatus compartment 26 positioned below the refrigerated cabinet proper. At the front the apparatus compartment is provided with louvers 28 and at the bottom with an opening 30 for the entrance of cooling air. Air vanes 32 and 34 are provided for properly directing the air over the blades of the air turbine 20.

The supply of electricity to the motor M and the supply of gas to the gas burner (not shown), for the boiler B is controlled by a thermostatic bulb 36 in contact with portion 10 of the evaporator E which is positioned in the food compartment 12. The bulb 36 may be connected by a capillary tube to a bellows (not shown) for operating the control for the gas valve and an electric switch in the manner shown and described in U. S. patent to C. C. Coons 2,223,343 of January 14, 1941, and especially Figure 4 of that patent.

In operation the bulb 36 and control operate to cyclicly operate the refrigerating system in accordance with the temperature of the portion 10 of the evaporator E. When the machine is in operation the condenser C and absorber A become heated and induce an air circulation in the air circuit formed by the compartment 26 and the flue at the rear of the cabinet previously described. This air acts to cool the condenser C and the absorber A and to thereby carry away

the heat of condensation and the heat of absorption. The circulation of this air is quite rapid because it is heated and expands considerably in the narrow flue. This increases the velocity of flow so that by the time the air reaches the vanes 32 and 34 it has acquired considerable kinetic energy. This circulating air comes into contact with the vanes 32 and 34 and is directed against the blades of the turbine 20 so that its kinetic energy operates to rotate the turbine 20 and the fan 18 so as to circulate air over the evaporator 10.

When the machine is de-energized the temperature of the portion 10 of the evaporator will be below that of the air in the food compartment 12. However, since the condenser C and the absorber A are still hot the convection circulation of air in the cooling air circuit will continue until they have cooled down considerably. Thus the turbine 20 and fan 18 will continue to rotate after the de-energization of the system and continue to circulate air over the portion 10 of the evaporator and thus utilize all the refrigerating effect produced thereby.

When the control again calls for refrigeration it will operate to energize the boiler and the motor M as previously explained. At this time the condenser C and absorber A will be cooled and no convection circulation of air in the cooling air circuit will be taking place. However, since it takes some time to heat the boiler up to operating temperature there will be no liquid refrigerant supplied to the evaporator until the boiler becomes heated. By that time the condenser and absorber will have become heated and the circulation of air over the portion 10 of the evaporator will take place as previously described. Thus air is not circulated over the portion 10 of the evaporator until refrigeration takes place therein and the circulation of air is continued for a period after the de-energization of the apparatus so as to utilize all the refrigerating effect produced in the evaporator for cooling the air in the food compartment 12.

If desired the convection circulation of air in the cooling air circuit can be augmented by fan 38 driven by an electrical motor 40. In this case the leads on the motor 40 are connected by conductors to a control 42 of any suitable construction. A thermostatic bulb 44 is positioned in the food compartment 12 in the path of the circulating air therein and is connected by a capillary tube 46 to the control 42 in any suitable manner well known in the art. The control 42 is set for the desired temperature in the compartment 12. Thus when the refrigerating system proper is de-energized the fan 38 will continue to circulate air through the cooling air circuit and operate the turbine and consequently the fan 18 to circulate air over the portion 10 of the evaporator as long as the temperature of the compartment 12 remains above the minimum desired point. This control can be made to operate the fan continuously under normal conditions or adjusted to operate it only a short while after the system proper is de-energized.

From the foregoing it is evident that the circulation of air in the food compartment is dependent upon the temperature of the heat rejecting parts of the refrigerating apparatus which in turn is a measure of the cyclical condition of the apparatus. That is, the temperature of the heat rejecting parts of the apparatus is an indication as to whether or not there is any

refrigerating effect available for cooling the air in the food compartment. The temperature of the heat rejecting parts is thus utilized to control the circulation of air in the food compartment. When refrigerating effect is available for cooling the air the fan is rotated and when no refrigerating effect is available the fan remains stationary.

In the modification shown in Figure 3 the boiler flue 50 is extended upwardly along one side of the air circulating flue so as to dissipate the products of combustion into the room air. Instead of being positioned in the air circulating flue the turbine 20' is positioned in the boiler flue 50 so as to be driven by the products of combustion flowing upwardly through the flue. As in the first modification the turbine 20' is directly connected to a fan in the interior of the food compartment.

The thermostatic bulb 36' is connected by a capillary tube to a control 52 for supplying gas to a gas burner 54 and electricity to the motor M' as in the first modification. In this modification the control 52 is preferably set so that when there is a demand for refrigeration a maximum high flame is produced by the burner to heat the boiler at an optimum rate and when the demand for refrigeration ceases a low flame is produced by the burner of such value that the boiler B' is maintained at approximately operating temperature just below that temperature at which the refrigerant vapor would be evolved from the absorbent in the boiler. Thus when there is a demand for refrigeration and gas is supplied at the optimum rate refrigerant vapor will immediately be supplied for condensation in the condenser C'.

Since the boiler B' is maintained at approximately operating temperature during the period when there is no demand for refrigeration gas is always being consumed in the burner 54 and products of combustion will always be flowing through the boiler flue 50. These products of combustion have sufficient velocity to rotate the turbine 20' slowly and thus produce a slow circulation of air in the food compartment during the period when no refrigerating effect is being produced in the evaporator. When the control 52 operates to supply gas to the burner at the optimum rate the products of combustion will flow through the boiler flue 50 at a much faster rate and consequently rotate the turbine 20' and cause rotation of the fan in the food compartment at a much faster rate. Thus when refrigeration is being produced in the evaporator the air in the food compartment will be circulated comparatively rapidly while when no refrigeration is being produced the air will be circulated very slowly. This will maintain the temperature of the food compartment substantially uniform throughout at all times and all of the refrigerating effect produced will be utilized.

If desired, the modification of Figure 3 can be controlled in the same manner as the modification shown in Figures 1 and 2. In that case the control would be of the complete "on" or completely "off" type. When the control is set in that manner the burner is either operating at its maximum capacity or is completely shut off with a pilot flame if desired to ignite it.

During the "off" period the flue 50 will be cold and no air or products of combustion will be flowing therein. When the control operates to supply gas to the burner for maximum operation the flue 50 will remain cold for some time

so that the operation of the turbine 20' will lag behind the energization of the apparatus as in the first modification.

At the termination of an operating period the flue 50 and the boiler B' will remain hot for a period and will induce a flow of hot air through the flue even though no gas is being consumed. Thus the turbine 20' will operate for a period after the apparatus is de-energized as in the first modification.

As in the first modification air will be circulated in the food compartment only when refrigerating capacity is available for cooling it.

In Figure 4, the motor which drives the fan for circulating the cooling air is controlled by the temperature of the absorber A''. The bulb 44' is positioned against the tubes of the absorber A'' so as to be responsive to the temperature of the absorber A'', to operate the control 42', to start the motor for circulating cooling air when the temperature of the absorber A'' reaches a predetermined high temperature, and to stop the circulation of cooling air when the temperature of the absorber A'' reaches a pre-determined low temperature.

By this arrangement cooling air will not be circulated over the absorber and condenser until the absorber becomes heated, which will occur a short time after the apparatus is energized and cooling air will continue to circulate until the absorber again becomes cool, which will occur some time after the unit is de-energized. Thus, cooling air will be circulated only when it is required.

At the same time the circulation of cooling air will operate to circulate air in the food storage compartment only when the evaporator is cold.

In the modification of Figure 4, the control bulb 44' may be positioned in heat exchange with a tube of the condenser, the only requisite being that it be positioned to be responsive to the temperature of a heat rejecting part of the apparatus.

In the modification of Figure 5, a separate motor 48 is provided for driving the fan 18' for the circulation of air in the food storage compartment. The bulb 44'' is positioned in heat exchange with a tube of the condenser C'' so that control 42'' is operated in response to the temperature of the condenser C''. Thus the air within the food storage compartment will only be circulated when liquid refrigerant is being supplied to the evaporator.

It is also within the purview of this invention to place the bulb 44'' of Figure 5 in heat exchange relationship with the tubes of the absorber, the only requisite being that the motor 48 be energized and de-energized in response to the temperature of a heat rejecting part of the apparatus.

From the foregoing it can be seen that this invention provides a method of controlling the circulation of air over the evaporator in the food compartment so that the air will be circulated at the proper time when there is refrigerating capacity available for cooling it so that the temperature of the food compartment will be maintained uniform and all of the refrigerating effect available will be utilized.

While I have shown but a number of modifications of my invention, it is to be understood that these modifications are to be taken as illustrative only and not in a limiting sense. I do not wish to be limited to the particular structure shown

and described but to include all equivalent variations thereof except as limited by the scope of the claims.

I claim:

1. In a gas fired domestic refrigerating apparatus of the type utilizing a flue for the disposition of the products of combustion gases and having a food storage compartment sealed from the outside atmosphere, that improvement which consists in utilizing the kinetic energy of the products of combustion gases for circulating air in the food compartment.
2. In a domestic refrigerating apparatus of the type having a closed food storage compartment sealed from the outside atmosphere and a flue for the circulating of air over the heat rejecting parts of the apparatus, that improvement which consists in utilizing the kinetic energy of the air circulating over the heat rejecting parts for circulating air in the interior of the food compartment.
3. In a domestic refrigerating apparatus of the type having air circulating means in a food compartment sealed from the outside atmosphere and in which the temperature of the high temperature parts of the apparatus vary between operative and inoperative condition, that improvement which consists in controlling the operation of the air circulating means in accordance with variations in temperature of the high temperature parts of the apparatus.
4. In a domestic absorption refrigerating apparatus of the type in which heat is continuously supplied to the boiler but in which the amount of heat varies between high and low limits depending upon whether there is or is not a demand for refrigeration, that improvement which comprises utilizing heat applied to the boiler when there is no demand for refrigeration for circulating air in the food compartment.
5. In an absorption refrigerating apparatus of the type having an insulated food storage compartment, a gas fired boiler and a flue for conducting the products of combustion from said boiler, that improvement which consists in utilizing the products of combustion for circulating the air in the interior of the cabinet.
6. A domestic refrigerator comprising, a cabinet having an insulated food storage compartment and a separate air passage for circulating air over the heat rejecting parts of the apparatus, a turbine in said air passage constructed to be driven by air flowing therethrough, and a fan positioned in said food storage compartment and connected to said turbine to be driven thereby.
7. A domestic refrigerating apparatus comprising, a closed insulated food storage compartment and a flue for the passage of a gaseous medium, a fan positioned in said food storage compartment for the circulation of air therein and a turbine positioned in said flue to be driven by the gaseous medium flowing therethrough and connected to said fan to drive the same.
8. A domestic refrigerating apparatus comprising, a cabinet having a food storage compartment and an apparatus compartment, a gas fired refrigerator in said apparatus compartment, said gas fired refrigerator including a flue for the flow of products of combustion therefrom and means in said cabinet for circulating air therein, said air circulating means being responsive to the flow of products of combustion through said flue.
9. A domestic refrigerator comprising, a cabinet having an insulated food storage compart-

ment and a passage for circulating air over the heat rejecting parts of the apparatus, means for forcibly circulating air through said passage, an air turbine in said passage positioned to be driven by air flowing therethrough and a fan on the interior of said food storage compartment connected to said turbine so as to be driven thereby.

10. A domestic refrigerator comprising, a cabinet having an insulated food storage compartment and an air circulating passageway, a refrigerating apparatus assembled with said cabinet, said refrigerating apparatus comprising an evaporator in said food storage compartment and a heat rejecting member positioned in said passageway, means for circulating air over said heat rejecting member, a turbine in said passageway positioned to be driven by air circulating therein and a fan in said food storage compartment positioned to circulate air over said evaporator and connected to said turbine so as to be driven thereby.

11. An absorption refrigerating apparatus comprising, a cabinet, a boiler, means for continuously heating said boiler, means for controlling said heating means to heat said boiler between maximum and minimum limits and means for circulating air in the interior of said cabinet, said last mentioned means being responsive to the degree of the heating of said boiler.

12. A domestic refrigerator comprising, a cabinet having an insulated food storage compartment and a separate air passageway, a refrigerating apparatus assembled with said cabinet, said refrigerating apparatus comprising an evaporator in said food storage compartment and means for supplying refrigerant in liquid phase to said evaporator, means for circulating air in said passageway, means for circulating air over said evaporator, means responsive to the temperature of said evaporator for controlling the operation of said liquid supply means and means responsive to the temperature of said food storage compartment for controlling the operation of said first air circulating means, said second air circulating means being responsive to said first air circulating means.

13. A domestic refrigerator comprising, a cabinet having a food storage compartment and an apparatus compartment, a gas fired refrigerator in said apparatus compartment, said gas fired refrigerator including a flue for the flow of the products of combustion therefrom, power means operated by the flow of the products of combustion in said flue and means operated by said power means for circulating air in said food compartment.

14. A domestic refrigerator comprising, a cabinet having an insulated food storage compartment and an apparatus compartment, said apparatus compartment comprising an air circulating

passageway in the form of a chamber located beneath said food storage compartment and a flue extending upwardly therefrom along one side of said food storage compartment, an absorption refrigerating apparatus positioned in said apparatus compartment having heat rejecting parts located in said passageway, means in said chamber for circulating air through said passageway, power means in said flue positioned to be driven by the flow of air in said flue and means driven by said power means for circulating air in said food storage compartment.

15. A domestic refrigerating apparatus comprising an insulated food storage compartment and a separate flue for the circulation of a gaseous medium, power means in said flue positioned to be driven by the circulation of the gaseous medium therein, means in said storage compartment for the circulation of air therein and power-transmitting means extending through the insulation of said storage compartment and connecting said power means to said air circulating means.

16. A domestic refrigerator comprising, a cabinet having an insulated food storage compartment and an air circulating passageway, a refrigerating apparatus assembled with said cabinet, said refrigerating apparatus comprising an evaporator in said food storage compartment and heat rejecting members positioned in said passageway, means for circulating air over said heat rejecting members, a turbine in said passageway positioned to be driven by air circulating therein, a fan in the food storage compartment positioned to circulate air over said evaporator and connected to said turbine so as to be driven thereby, means responsive to the temperature of said evaporator for controlling the operation of said apparatus and means responsive to the temperature of said food storage compartment for controlling said air circulating means.

17. A domestic refrigerator comprising, a cabinet having an insulated food storage compartment and an air circulating passageway, a refrigerating apparatus assembled with said cabinet, said refrigerating apparatus comprising an evaporator in said food storage compartment and heat rejecting members positioned in said passageway, means for circulating air over said heat rejecting members, a turbine in said passageway positioned to be driven by air circulating therein, a fan in the storage compartment positioned to circulate air over said evaporator and connected to said turbine so as to be driven thereby and means responsive to the temperature of said food storage compartment for controlling said air circulating means whereby the operation of said fan is dependent upon the temperature of said food storage compartment.

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