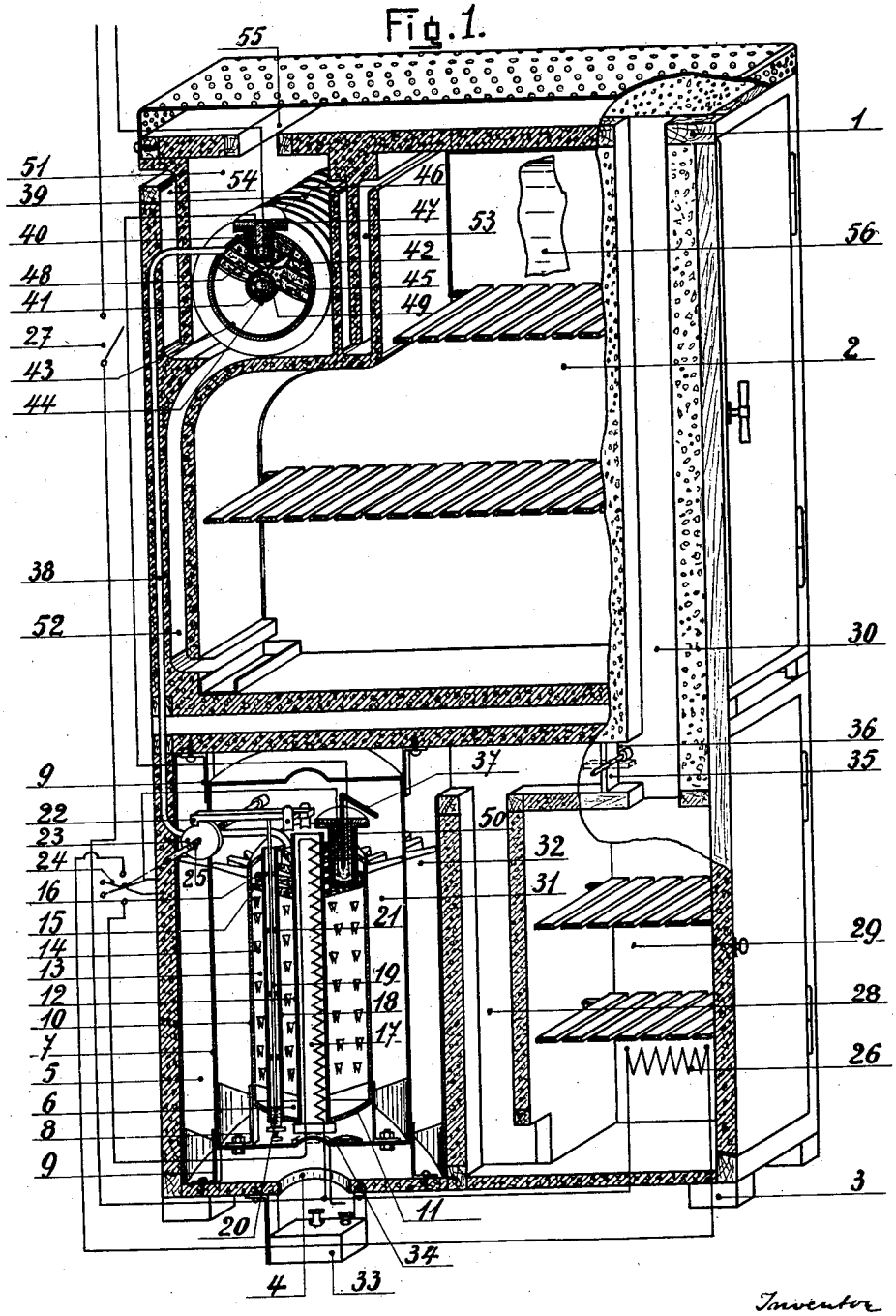
Sept. 4, 1934. W. B. NORMELLI 1,972,427

REFRIGERATING SYSTEM

Filed Jan. 9, 1928 4 Sheets-Sheet 1

Fig. 1.



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REFRIGERATING SYSTEM

Filed Jan. 9, 1928 4 Sheets-Sheet 2

Fig. 2.

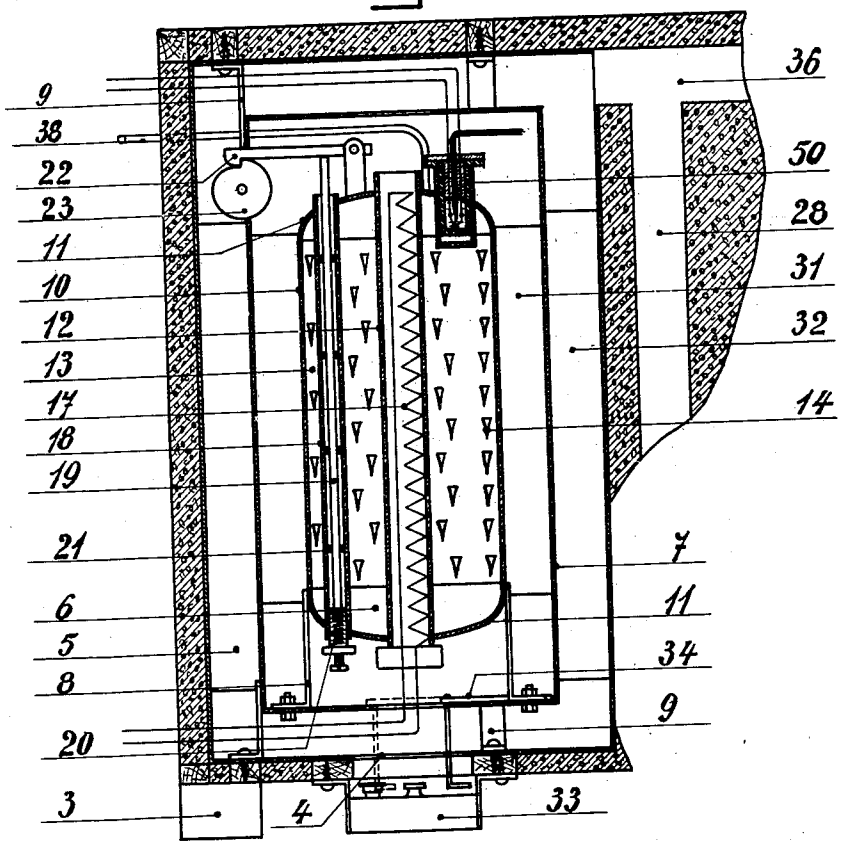
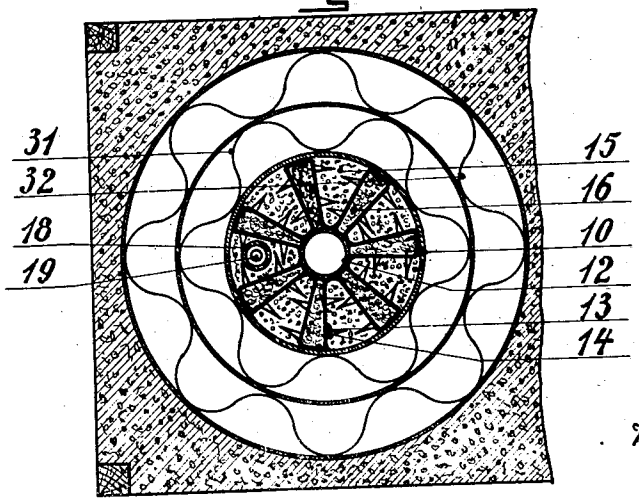


Fig. 3.



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REFRIGERATING SYSTEM

Filed Jan. 9. 1928 4 Sheets-Sheet 3

Fig. 4.

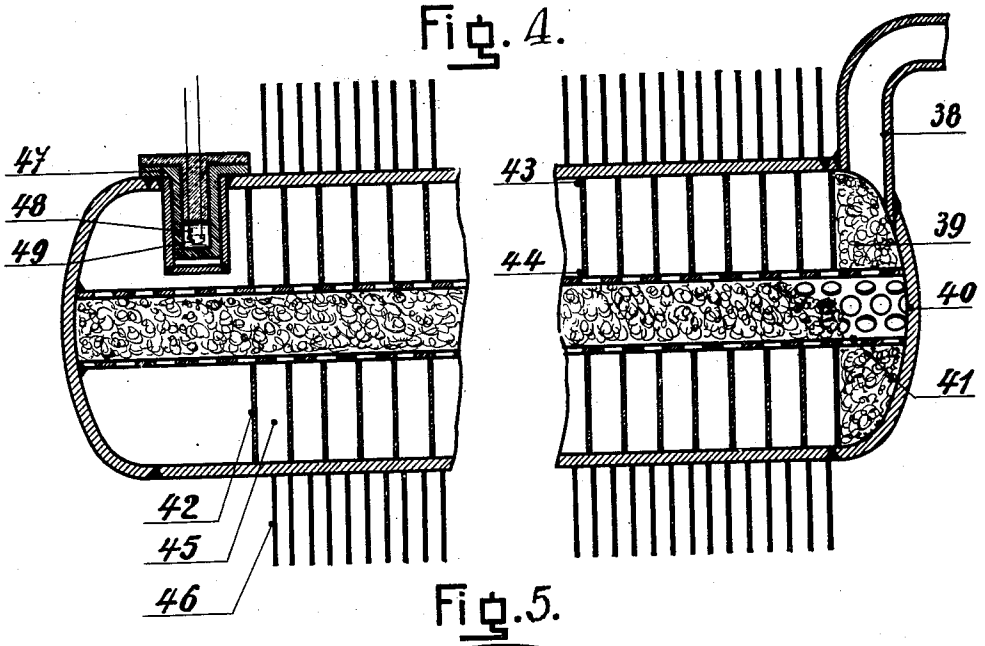
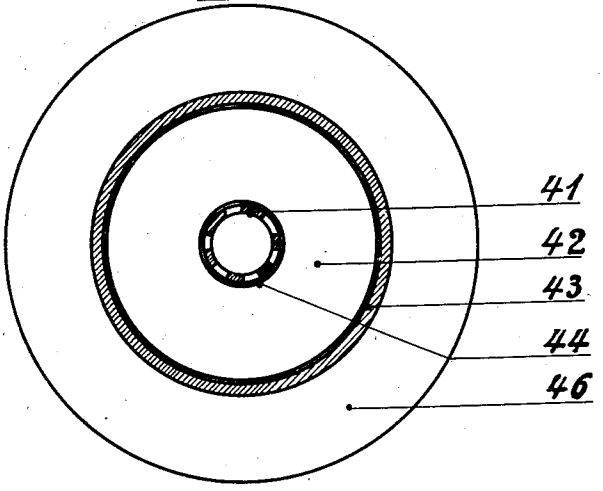


Fig. 5.



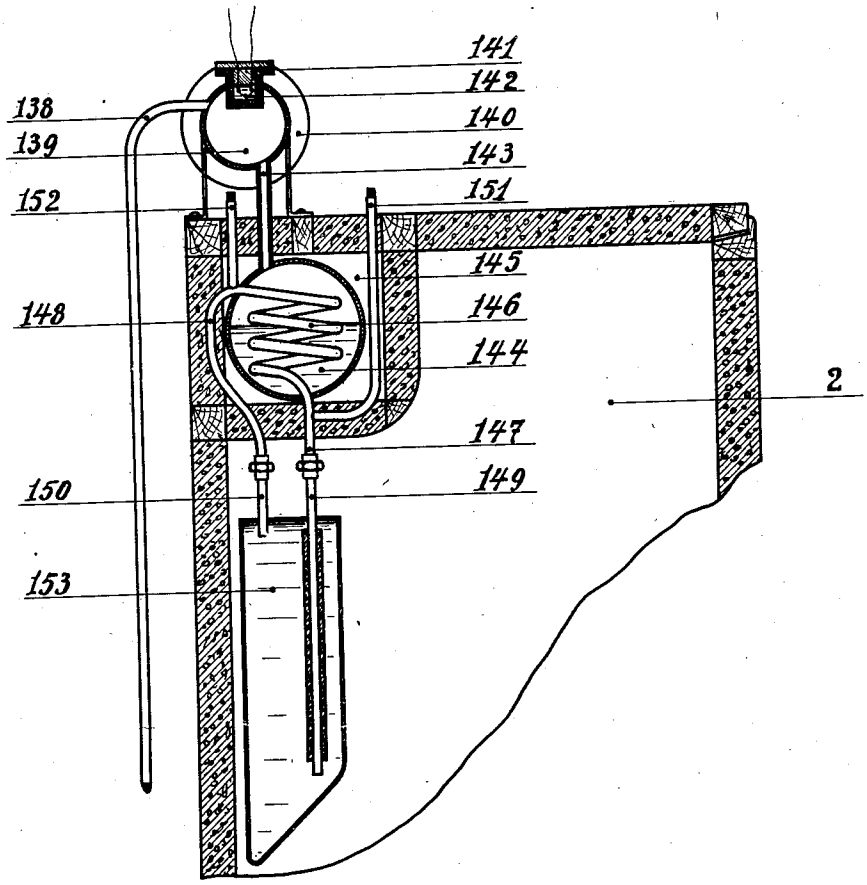
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Filed Jan. 9, 1928 4 Sheets-Sheet 4

Fig. 6.



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UNITED STATES PATENT OFFICE

1,972,427

REFRIGERATING SYSTEM

Wulf Berzelius Normelli, Schiltigheim, France

Application January 9, 1928, Serial No. 245,575
In Germany February 18, 1927

16 Claims. (Cl. 62—120)

My invention relates to an absorption refrigerating system and consists in the construction and combination of parts hereinafter fully described, illustrated in the accompanying drawings and pointed out in the claims.

In the drawings referred to:

Fig. 1 is a view partly in section and partly in elevation of a refrigerating system applied to a refrigerator, the system being illustrated more or less diagrammatically in order to disclose the circuit including the essential elements.

Figs. 2–3 are an enlarged longitudinal and cross sections through the thermal generator.

Figs. 4–5 are enlarged longitudinal and cross sections through the evaporator.

Fig. 6 is a longitudinal section of a modified form of the evaporator and refrigerator without the thermal generator which has not been modified.

Given these general statements of the objects and purposes of my invention, I will now proceed to describe the manner in which it is performed in its most favourable embodiment but without any limitative effect upon its form, particularities and uses.

1 is a refrigerator containing a cooling chamber 2; the refrigerator is supported upon legs 3 so as to raise it above the floor and to permit the air to pass through the opening 4 in its bottom into the chamber 5 which is situated in the lower part of the refrigerator. In the chamber 5 is located a thermal generator 6 which is alternately heated and cooled, whereby a refrigerant is released until a predetermined pressure in the system is attained and reabsorbed, when this pressure decreases.

The thermal generator consists of a cylindrical, hermetically closed vessel 6 in which a corrugated system of sheet metal 13 is fastened by means of a central pipe 12 forced into the system so as to ensure a tight contact between the system and the vessel walls. The vessel 6 is located in an identical manner as the aforesaid pipe 12 by means of a corrugated sheet metal system in a cylindrical casing 7 provided with openings at its top and at its bottom and the casing is held in the middle of the chamber 5 by a corrugated sheet metal system 9. By forcing the several concentric jackets one into the other, a most efficient contact will be obtained between the corrugated sheet metal systems and their outer and inner walls. The corrugated sheet metal system 13 also has in its radial branches series of pressed out tongues 14 which project into the cells 15 formed between said radial branches of the system in order to carry the heating effect right into the heart of the cells. These radial cells of different sizes extending throughout the whole body of the vessel are alternately filled up from above with layers of a solid absorbent, calcium-chloride ammonia for instance, and with fine metal filings or other porous matters of this kind, the latter being intended to prevent the salt from spreading laterally and to allow free passage to the gaseous ammonia.

In the pipe 12 is located an electric heater 17 producing the necessary warmth for the refrigerating process. In the thermal generator 6 is placed a pipe 18 for the thermostat 19, consisting of a metal rod fastened at its lower end to a regulating device. The thermostat 19 is provided with several metal rings 21 which hold it in the centre of the pipe 18 and it serves to disconnect the electric heater 17 when the temperature has reached a certain maximum. In this case the thermostat rod 19 expands as far upwards as to lift the lever 22, thus liberating the cam disc 23 and placing by the tension of the spring 25 the electric commutator 24 in such a position that the electric current to the electric heater is disconnected and connected to a small auxiliary heating device 26 used to start an air flow as will be explained hereinafter. From the upper part of the chamber 5, an air channel 28 leads downwards through the warming chamber 29 and from the latter a chimney 30 leads out to the free air. The opening of the air channel 28 is situated beneath the thermal generator 6.

If there is no electricity at the place where the refrigerator is to be used, the heating of the thermal generator may be attained by the petroleum burner 33. In this case the flap valve 34 is closed and the flap valve 35 is opened, whereby the chamber 5 gets into direct connection with the channel 30 through the channel 36, thus permitting the heating gases of the burner 33 to escape through the corrugated sheet iron 32 and the channels 36 and 30 into the open air. As soon as the thermometer 37 in the thermal generator 6 has reached a temperature of 110° Celsius, the petroleum burner is extinguished and the flap valve 34 is opened, whereby the thermal generator may cool.

The evaporator 39 consists of a vessel 40 in which a central and perforated pipe 41, filled with fine metal filings, is placed. The pipe 41 traverses parallel circular discs 42 which are separated from one another by layers of solid absorbent 43 and 44 and which extend to the wall of the vessel 40. The solid absorbent filled between

the discs may be magnesium-bromide ammonia. The evaporator 39 is provided externally with gills 46 and it, as well as the thermal generator, are combined with safety-fuses 47 to cut off the current when a certain maximum temperature is reached, in case of any unforseen failure in the function of the apparatus. The evaporator 39 is located in a chamber 51 placed in the upper part of the cooling chamber 2 and insulated from it in a suitable manner. The chamber 51 is in open connection with the cooling chamber 2 through the channels 52 and 53. Moreover, the lower part of the chamber 51 is connected with the open air through the channel 54, whose top opening is situated above the evaporator 39. A second channel 55 leads also from the upper part of the chamber 51 into the open air.

When the refrigerating system is put into action, the thermal generator and the evaporator are filled up with solid absorbents, saturated with refrigerants, and during the heating period, as the chamber 5 is but indirectly connected to the chimney 30, an accumulation of heat occurs within the thermal generator, thus ensuring an intense heating most favoured by the branched heat-transmitting system of the corrugated and cogged sheet metal. Ammonia is driven out and transmitted to the evaporator.

In the evaporator chamber 51, an increase of temperature is produced by the heat radiation of the evaporator and this increase of temperature automatically calls forth a circulation of air through the lateral channel 54 and the upper channel 55, thus ensuring an efficient cooling of the evaporator. By no means however will the warm air of less density descend into the cooling chamber 2. A circulation of air will but take place when, during the cooling period which follows, the temperature of the chamber 51 becomes lower than that of the cooling chamber 2, in which case cold air automatically sinks down into this chamber through the channel 52 and relatively warmer air is sucked through the channel 53.

In order to start the reabsorption or cooling period, it is necessary to create a reduction of pressure in the refrigerating system. This will be realized by cutting off the main heating device and by connecting the auxiliary heating device. This results in the production of a cold flow of air through the several cooling mantles of the thermal generator.

It will be apparent that the construction and arrangement of the thermal generator 6 and of the evaporator 39 and 139 which is described above and shown in Figs. 2, 3, 4, 5 and 6 is, as far as I know, a perfectly new refrigerating system, which differs from formerly employed systems in that there is no real refrigerant in the same sense as in other absorption refrigerating apparatuses, where a refrigerant is condensed under a development of heat and where it evaporates in a cold producing way; in the present invention, on the contrary, an absorption process, resulting in a chemical combination, takes place at a high pressure and this chemical combination is again decomposed at a lower pressure and the necessary heat to effect this cold producing decomposition is withdrawn from the surroundings. The decomposition of the combination of magnesium-bromide ammonia into ammonia needs a quantity of heat more than twice as great as the evaporating process of liquid ammonia and produces, at all events theoretically, a double refrigerating effect for the same quantity of ammonia which may be driven out.

Another advantage resides in the fact that it may be operated at a much higher temperature during the heating period which facilitates the use of an air cooling device. The employment of solid absorbents which undergo a chemical composition with the gaseous refrigerants in combination with a totally air-cooled apparatus and especially the use of calcium chloride ammonia as an absorptive element in a totally air-cooled refrigerating system is not known to my knowledge, although the use of calcium chloride ammonia in itself has been known for a very long time, and I may point out that, considering the entirely different character of the chemical process intervening in the production of a cooling effect, there cannot be any comparison with air cooled ammonia and water apparatus which in practice have even very defective results, especially in summer. The intervention of air cooling is of very great importance for household apparatus because there is no water supply needed for cooling purposes and the apparatus may be used everywhere. Moreover, the danger of explosion still inherent in water-cooled apparatuses is quite suppressed. Since my apparatus works at far higher air temperatures, it will be necessary, in order to avoid too large cooling surfaces and consequently too large a combined evaporator and condenser, to extend the heating period much longer than usual. Nevertheless, owing to the special arrangement of the evaporator within the cooling chamber, as previously described, no heating of said chamber is to be feared. The property of the solid absorbents to be bad thermal conductors produces no effect since, owing to the labyrinthical branches of the air-transmitting devices within the thermal generator and the evaporator, the heating as well as the cooling effects are brought to the very heart of the absorbent layers.

In Fig. 6 an example of construction is shown in which the cooling effect is brought from the evaporating chamber to the cooling chamber by means of a brine current instead of air. Furthermore, ammonia is not absorbed by magnesium, but is liquefied. In all other constructive details, the apparatus resembles the above described.

The pipe 138 connected to the generator 6 ends in the condenser 139 which is provided with gills 140. The ammonia which was driven out during the heating period condenses in 139 and its condensation warmth is led off by the gills 140. In the condenser 139 is a fuse plug 141 which is connected with the circuit of the electric heater of the thermal generator. The condenser 39 is connected by a pipe 143 with the evaporator 144 located in the thermal insulated chamber 145. The ammonia which was liquefied in the condenser 139 flows down through the pipe 143 to the evaporator 144 where it is stored. In the evaporator 144 is placed a pipe coil, the two ends of which, 147 and 148, are connected respectively by a screw device with the pipes 149 and 150. Moreover, two vertical pipes 151 and 152 for filling up the pipe coil 146, 147, 148 are branched on said pipes and the whole system is entirely filled up with brine. The pipes 149 and 150 end respectively at the top and bottom of a cold accumulator 153 which also is filled up with fluid. When the heating period is over and the thermal generator 6 has cooled, the pressure decreases in the apparatus, whereby the liquid ammonia which

has accumulated in the evaporator 144 is evaporated. As soon as the evaporator 144 gets colder than the cold accumulator 153, the brine contained in the pipe coil increases in specific weight and an automatic circulation of brine begins through the closed pipe system, thus communicating the cooling effect to the cooling chamber 2.

Many other salts which also absorb ammonia may be employed as an absorbent in the thermal generator and evaporator, especially such as swell up in combining with ammonia because a large absorbing surface constantly renewed is thus produced which is of great importance for a speedy absorption. Such materials are: halide combinations of lithium, calcium, strontium, barium, cadmium, zinc, magnesium, manganese, cobalt, nickel and lead, which mostly form also voluminous substances with ammonia and which in a general way require and liberate for their decomposition and composition at least 4 kgcal. per gramme molecule of the refrigerant more than the heat of evaporation per gramme molecule of said refrigerant. The maintenance of a solid state for the absorbents is very important for the absorption process.

In all the aforementioned cases, ammonia may be replaced by amines which also form chemical combinations with the above mentioned salts. Other refrigerating materials may intervene as, for instance, sulphurous oxide, alcohols, ketones, ether, ester, nitrines and so forth, in combination with suitable salts which, under diminished pressure, form easily decomposed mediums.

What I claim and desire to secure by Letters Patent is:

1. In a refrigerating system comprising an air cooled stationary thermal generator containing solid absorbents of the kind undergoing a chemical composition with the refrigerants and conserving their solid form during the refrigerating process, an air cooled condenser, an evaporator, means for transmitting the refrigerant from the thermal generator to the evaporator and vice-versa, means for heating the generator, means for cooling the generator and means for the practical use of the produced refrigeration effect, means to prevent the heating effect, during the heating period, from spreading into the rooms where the refrigeration is to be produced and means to transmit the cooling effect to those rooms during the cooling period, means in said rooms for storing the cooling effect.

2. A refrigerating system comprising a thermal generator filled up with solid absorbents, a corrugated sheet metal system in the generator vessel, laterally out-pressed tongues in the radial branches of the corrugated sheet metal system and a central body forced into the corrugated sheet metal system so as to press it firmly against the generator walls and said body.

3. A refrigerating system comprising a thermal generator filled up with solid absorbent, a cold generator, heat conducting elements in these generators which divide their interior into radial cells extending over the whole length of the generator vessels and solid absorbents in a part of these radial cells.

4. A refrigerating system comprising a thermal generator, a cold generator, heat conducting and perforated elements to divide the generator vessels into radial cells for conducting gases and extending over the whole length of said vessels and porous matters in said cells.

5. In a refrigerating system, the process of producing a refrigerating effect by driving, during the heating period gaseous refrigerants out of solid absorbents contained in the thermal generator, by absorbing those gaseous refrigerants in solid absorbents contained in the evaporator and by reabsorbing these gaseous refrigerants in the solid absorbents contained in the thermal generator during the cooling period.

6. An absorption refrigerating system of the intermittent type comprising a generator-absorber containing solid absorbents which form a chemical compound with the refrigerant, a condenser, an evaporator, means for conveying the refrigerant from the generator-absorber to the evaporator and vice versa, said generator-absorber being constructed and arranged in such a manner as to provide cooling means in which the inlet and outlet for the cooling medium, in contact with the heat radiating surfaces thereof are constantly open for continuous circulating of the cooling medium, means for heating the generator-absorber, and means for practically utilizing the produced refrigeration.

7. An absorption refrigerating system of the intermittent type comprising a generator-absorber containing solid absorbents which form a chemical compound with the refrigerant, a condenser, an evaporator, means for conveying the refrigerant from the generator-absorber to the evaporator and vice versa, said generator-absorber being constructed and arranged in such a manner as to provide cooling means in which the inlet and outlet for the cooling medium, in contact with the heat radiating surfaces thereof, are constantly open for continuous circulation of the cooling medium and the flow of the cooling medium is only caused by the upward acting force incident to the cooling medium taking up heat, means for heating the generator-absorber, and means for practically utilizing the produced refrigeration.

8. An absorption refrigerating system of the intermittent type comprising a generator-absorber containing solid absorbents which form a chemical compound with the refrigerant, a condenser, an evaporator, means for conveying the refrigerant from the generator-absorber to the evaporator and vice versa, said generator-absorber being constructed and arranged in such a manner as to provide cooling means in which the inlet and outlet for the cooling medium, in contact with the heat-radiating surfaces thereof, are constantly open for continuous circulation of the cooling medium, means for interiorly heating the generator-absorber, and means for practically utilizing the produced refrigeration.

9. An absorption refrigerating system of the intermittent type comprising a generator-absorber containing solid absorbents, which form a chemical compound with the refrigerant, a condenser, an evaporator, means for conveying the refrigerant from the generator-absorber to the evaporator and vice versa, said generator-absorber being located in a compartment through which a cooling medium flows for dissipating the heat of absorption, said compartment being provided only at the lower end thereof with openings for the inlet and outlet of the cooling medium so that the latter passes during the absorption period through a lower inlet opening along the heat-radiating parts of the generator-absorber to the upper part of said compartment and thence to a lower outlet opening, means for interiorly heating the generator-absorber and means for practically utilizing the produced refrigeration.

10. An absorption refrigerating system of the intermittent type comprising a generator-absorber containing solid absorbents, which form a chemical compound with the refrigerant, a condenser, an evaporator, means for conveying the refrigerant from the generator-absorber to the evaporator and vice versa, said generator-absorber being located in a compartment through which the cooling medium flows for dissipating the heat of absorption, said compartment being provided only at the lower end thereof with openings for the inlet and outlet of the cooling medium so that the latter passes during the absorption period through a lower inlet opening along the heat-radiating parts of the generator-absorber to the upper part of said compartment and thence to a lower outlet opening, driving means arranged in the path of the cooling medium which is actuated during the absorption period and put out of operation during the heating period, means for heating the generator-absorber, and means for practically utilizing the produced refrigeration.

11. An absorption refrigerating system of the intermittent type comprising a generator-absorber containing solid absorbents, which form a chemical compound with the refrigerant, a condenser, an evaporator, means for conveying the refrigerant from the generator-absorber to the evaporator and vice versa, said generator-absorber being arranged in a compartment provided with walls of heat-insulating material through which compartment the cooling medium flows, said compartment being provided at the lower end thereof with openings for the inlet and outlet of the cooling medium so that the latter passes during the absorption period through a lower inlet opening along the heat-radiating parts of the generator-absorber to the upper part of said compartment and thence to a lower outlet opening, means for interiorly heating the generator-absorber, and means for practically utilizing the produced refrigeration.

12. A generator-absorber for an absorption refrigerating apparatus of the intermittent type comprising a pressure-tight tank filled with solid chemical absorbents, a heating tube extending through said generator-absorber, cooling ribs provided on the outer pressure-tight walls of the generator-absorber and serving to transfer the heat of absorption to the cooling medium surrounding the generator-absorber.

13. A generator-absorber for an absorption refrigerating apparatus of the intermittent type comprising a pressure-tight tank filled with calcium chloride ammonia, a heating tube extending through said generator-absorber, cooling ribs provided on the outer pressure-tight walls of the generator-absorber and serving to transfer the heat of absorption to the cooling medium surrounding the generator-absorber.

14. An absorption refrigerating system of the intermittent type, comprising a generator-absorber containing solid absorbents which form a chemical compound with the ammonia serving as refrigerant, a condenser, an evaporator, means for conveying the refrigerant from the generator-absorber to the evaporator and vice versa, a heating tube extending through said absorber, cooling ribs being provided on the outer pressure-tight walls of the generator-absorber, said generator-absorber being arranged with the cooling ribs secured thereto in such a manner that the inlet and outlet of the cooling medium in contact with the heat-radiating surfaces thereof are constantly open for circulation of the cooling medium, and means for practically utilizing the produced refrigeration.

15. An absorption refrigerating system of the intermittent type, comprising a generator-absorber containing calcium chloride ammonia as absorbent which forms a chemical compound with the ammonia serving as refrigerant, a condenser, an evaporator, means for conveying the refrigerant from the generator-absorber to the evaporator and vice versa, a heating tube extending through said absorber, cooling ribs provided on the outer pressure-tight walls of the generator-absorber, said generator-absorber being arranged with the cooling ribs secured thereto in such a manner that the inlet and outlet for the cooling medium in contact with the heat-radiating surfaces thereof are constantly open for circulation of the cooling medium, and means for practically utilizing the produced refrigeration.

16. An absorption refrigerating system of the intermittent type, comprising a generator-absorber containing solid absorbents which form a chemical compound with the refrigerant, a condenser, an evaporator, means for conveying the refrigerant from the generator-absorber to the evaporator and vice versa, said generator-absorber being so arranged that its heat radiating surfaces are continuously exposed to the effect of a cooling medium, means for heating the generator-absorber, and means for practically utilizing the produced refrigeration.

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