March 9, 1943. J. LITHGOW ET AL 2,313,707

ABSORPTION REFRIGERATOR

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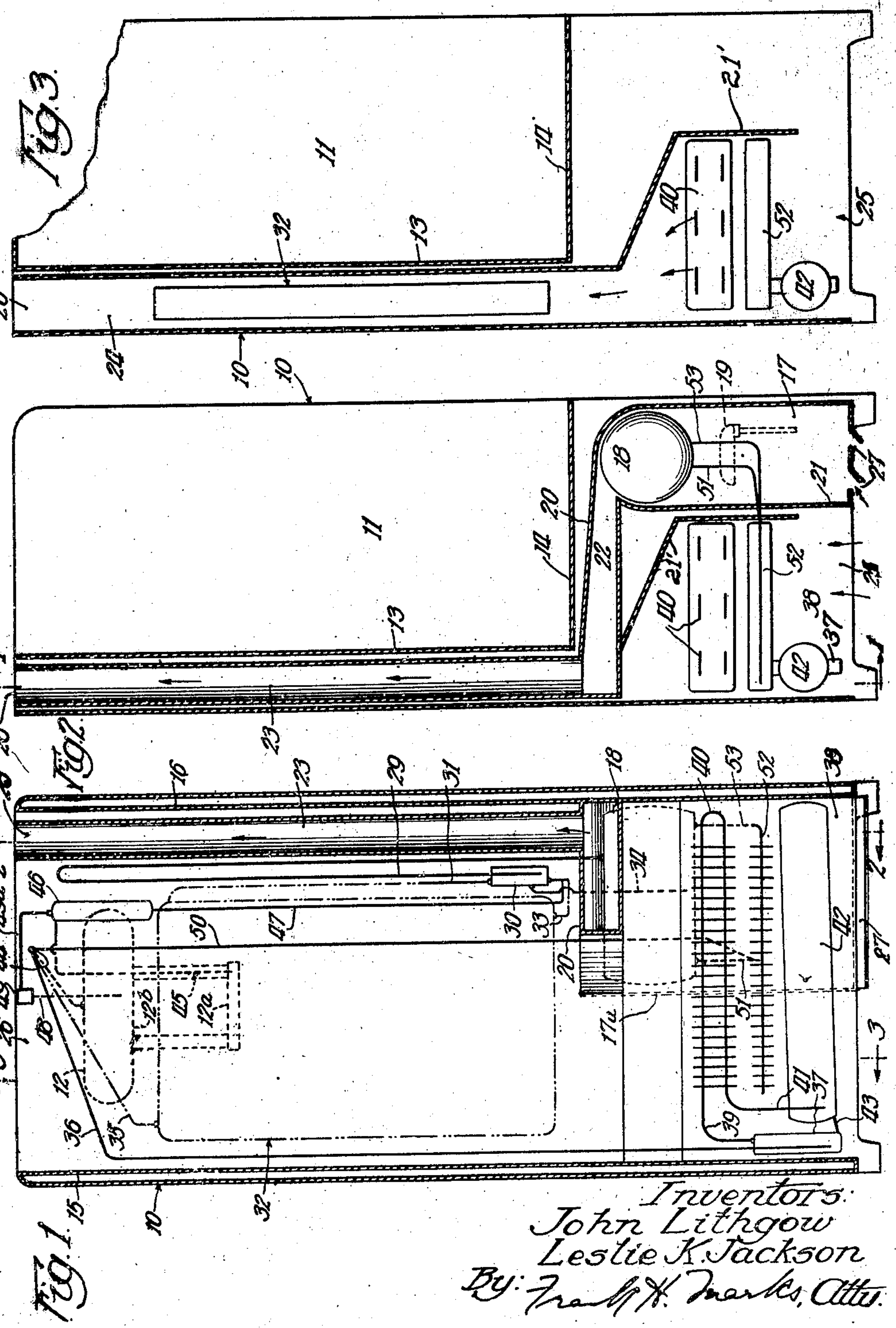

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ABSORPTION REFRIGERATOR

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Fig. 5

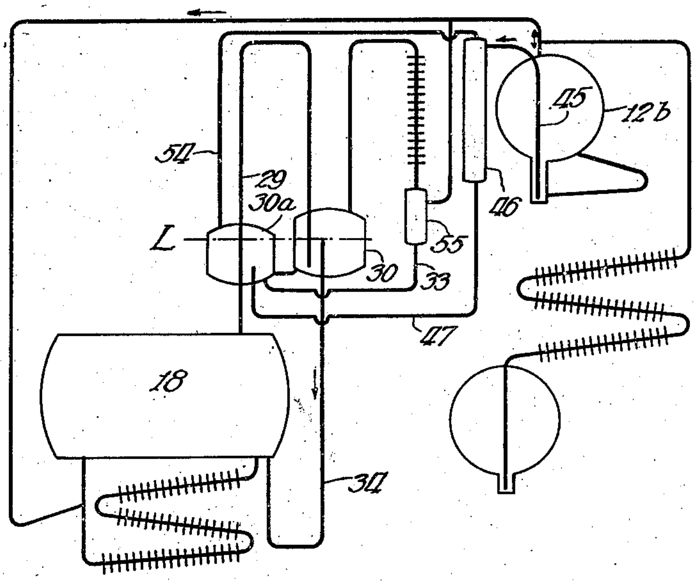

Fig. 4.

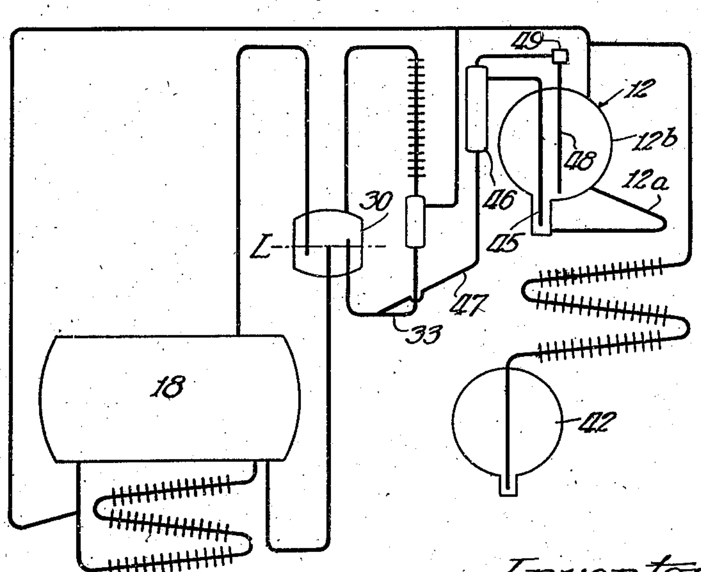

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Fig. 6.

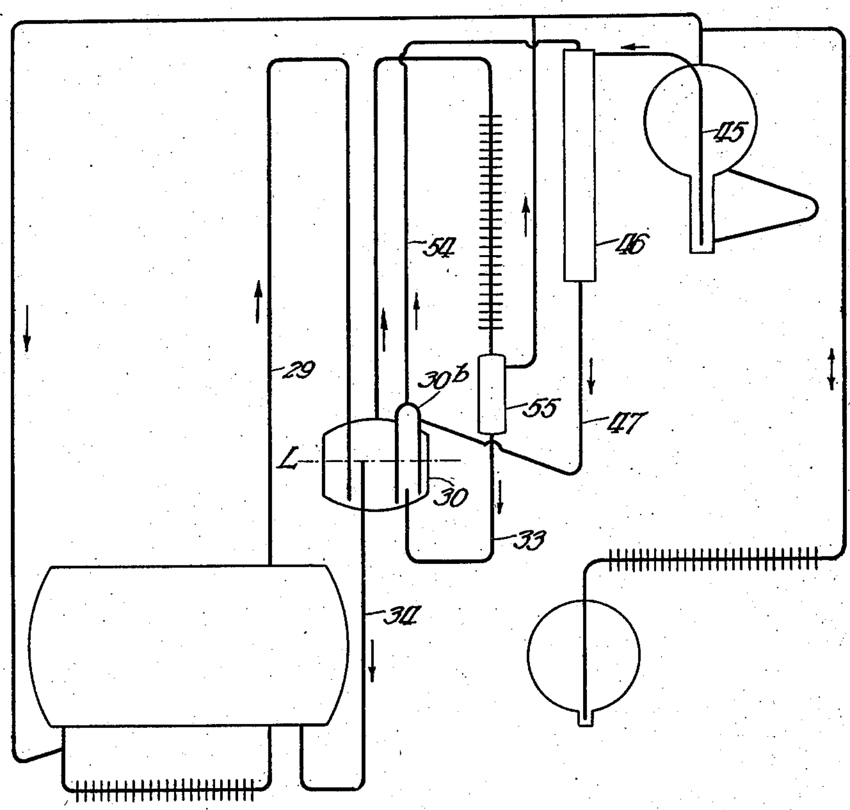

Fig. 8.

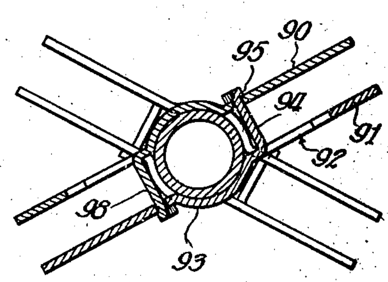

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Fig. 7.

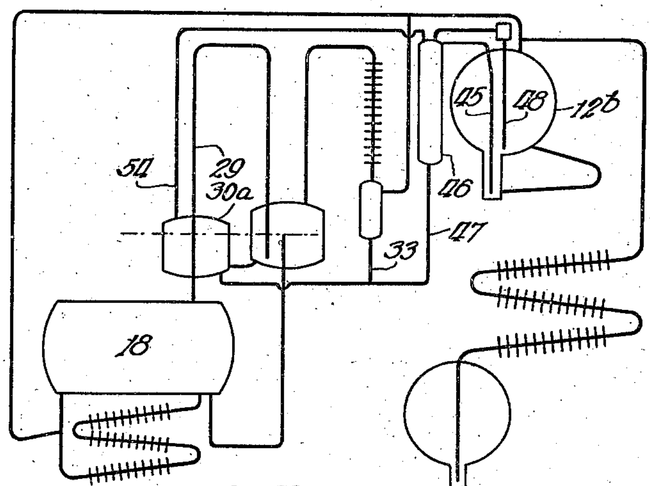

Fig. 9.

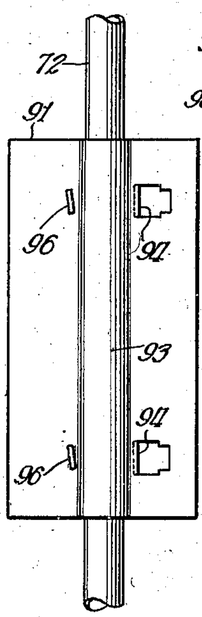

Fig. 11.

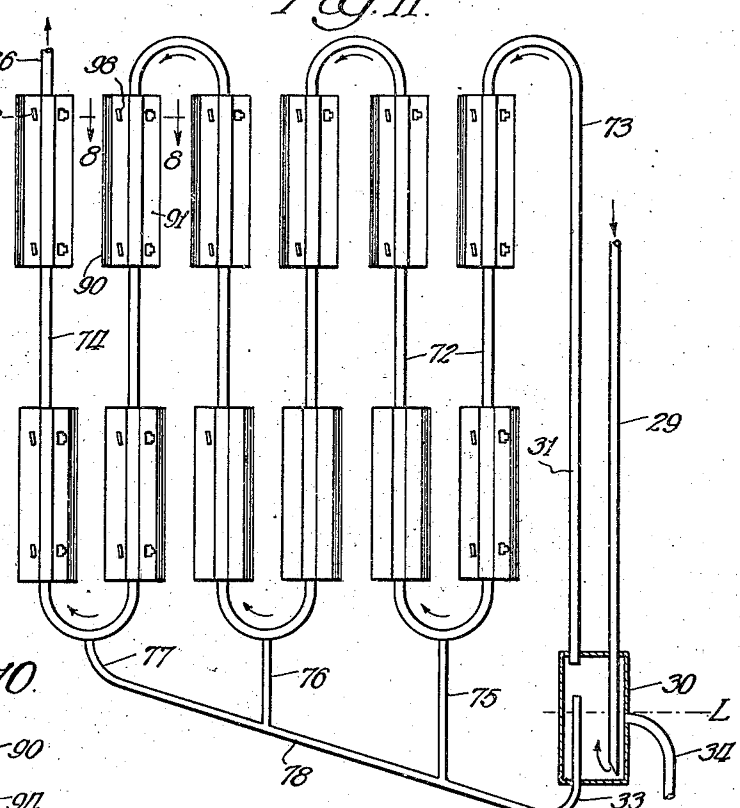

Fig. 10.

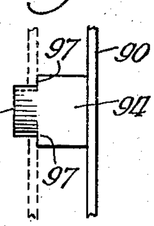

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Fig. 12

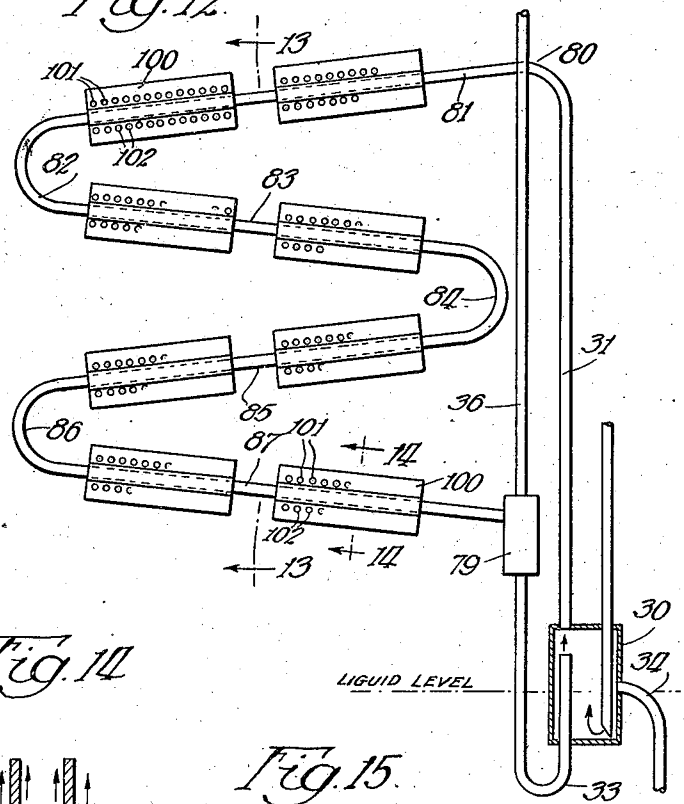


Fig. 13

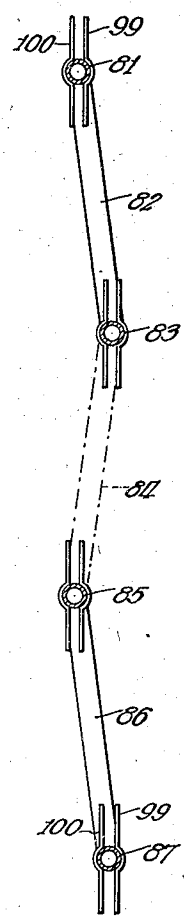


Fig. 14

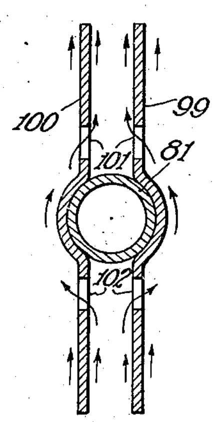
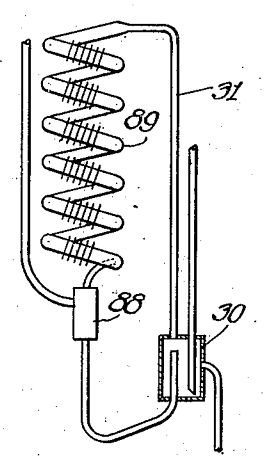


Fig. 15



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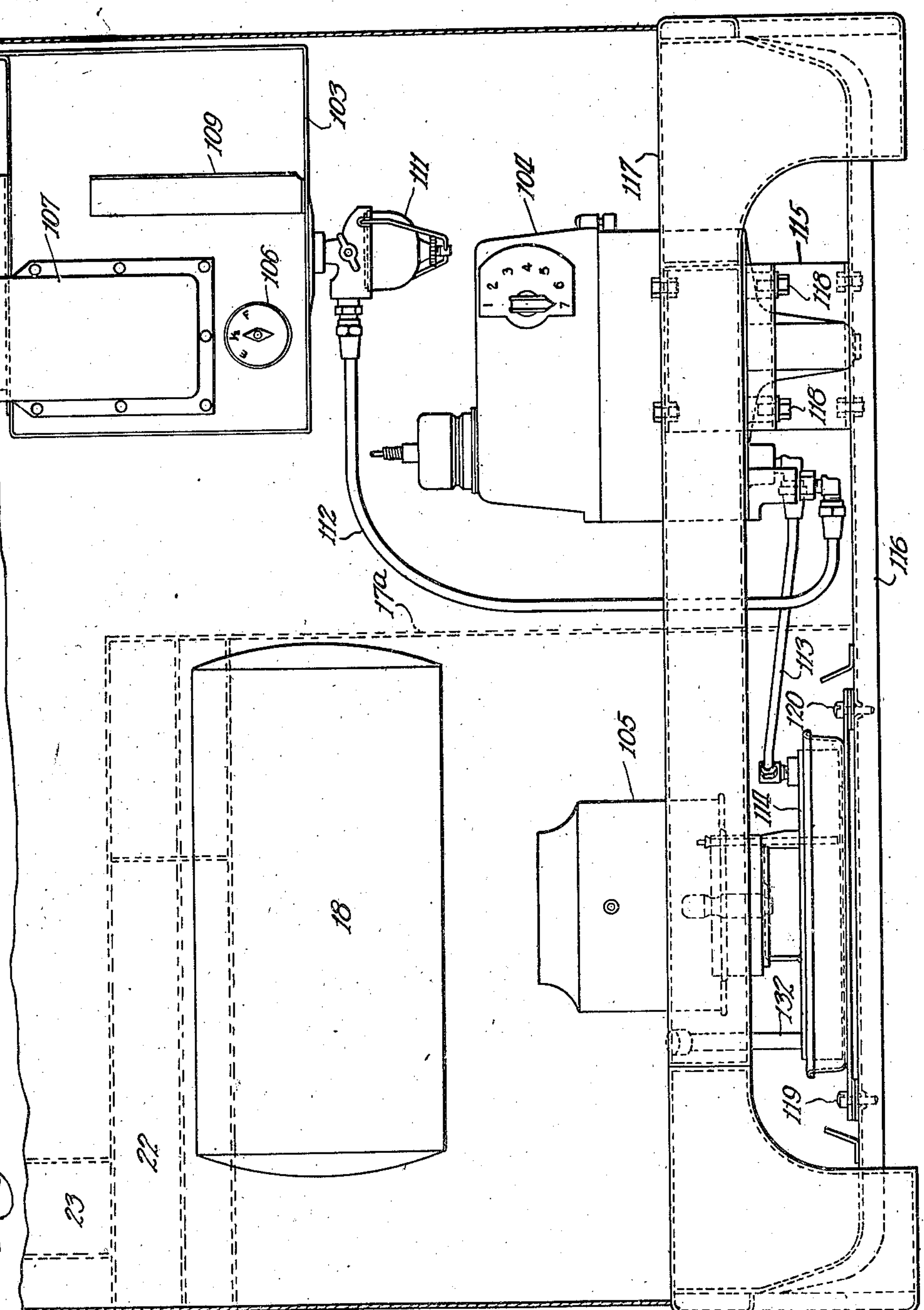

Fig. 16.

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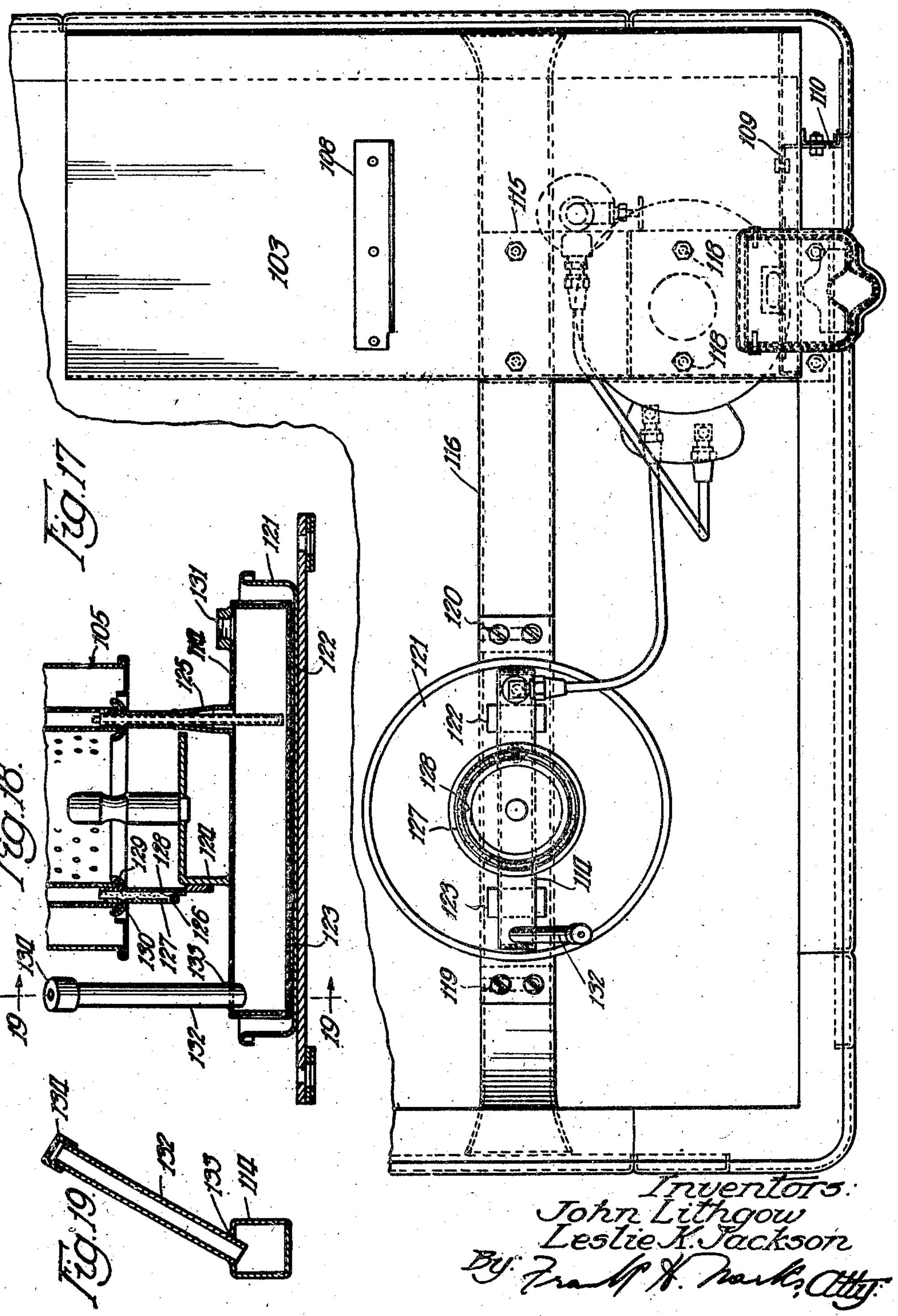

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UNITED STATES PATENT OFFICE

2,313,707

ABSORPTION REFRIGERATOR

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Application August 15, 1939, Serial No. 290,314

22 Claims. (Cl. 62—118)

Our invention relates to refrigerating apparatus and especially to household refrigerators of the intermittent air-cooled absorption type. More particularly, our invention relates to an intermittent absorption system of the type involving a dead end condenser, which type is known as the 1—3—2 system, where 1 designates the generator-absorber, 2 the condenser, and 3 the evaporator. In this type of system the flow of refrigerant during the generating cycle from the generator passes through at least a portion of the evaporator on the way to the condenser where it is collected.

Refrigerators of this particular type have been subject to many disadvantages. As a rule, they were extremely bulky as compared to the ordinary mechanical refrigerator. This was due largely to the necessary complicated arrangement of flues, condensers and the like within the refrigeration cabinet. Another disadvantage of the intermittent system was the lack of efficient dehydration which resulted in a large quantity of absorbent being carried over into the evaporator of the system during the generating cycle. Drains have been provided to get rid of the accumulated excess of absorbent so carried over, but these drains either did not drain enough of the absorbent or drained so efficiently and thoroughly that refrigerant was carried back to the generator or still-absorber of the system, with a resulting lack of economy. Another disadvatange of the prior systems of this type was the delay in the starting of the refrigeration cycle caused by an insufficient amount of refrigerant in the evaporator at the beginning of the cycle. Still another disadvantage of the intermittent absorption refrigerators of the prior art, and particularly those of the air-cooled variety, was the use of a common flue incorporating the still and the condenser of the system. Prior workers in the art believed that the incorporation of the still and the condenser in a single flue was necessary in order to promote the flow of air through the condenser. On the contrary, we have discovered that the incorporation of the still in the same flue with the condenser meant subjecting the still-burner to a large uneven volume of air. We discovered that this resulted in uneven burning and operation of the still and that it was necessary for efficient operation to completely separate the still and condenser.

The location of the still and condenser in a single flue gave rise to another disadvantage. In many instances, it is advisable or required because of fire regulations to attach an outlet or stove pipe to the unit to carry off products of combustion. The ordinary outlet to a flue which houses both the condenser and burner was too large to attach an ordinary stove pipe. When the ordinary flue outlet is constricted for this purpose, the draft through the condenser is likely to be interfered with. Where a kerosene burner is used, it is often especially desirable to lead off the products of combustion and fumes therefrom and this also was rendered rather difficult by prior constructions. These disadvantages were particularly noticeable in the air cooled intermittent absorption type of refrigerator because of the relatively large burner in this type of unit as compared to the continuous type.

It is an object of our invention, therefore, to provide in an apparatus of the type referred to, a novel arrangement of flues whereby the hot products of combustion from the burner and hot air passing from around the still will be completely separated from the main flue housing the condenser, the dehydrator and the absorber cooling coil of the unit.

A second object of our invention is the provision of a separate generator housing and a relatively small flue leading therefrom, the flue being especially adapted to connection to an ordinary stove pipe.

Another object of our invention is the provision of a novel supporting means for the burner control and fuel tank of an intermittent absorption refrigeration system which will enable the various units to be easily removed for adjustment and replacement.

A further object of our invention is the provision of a novel burner for an intermittent absorption refrigerator especially adapted for easy removal from the unit.

Still another object of our invention is the provision of a novel burner especially free from leakage.

Still another object is to provide a refrigerator mechanism having a novel arrangement of condenser and absorber cooling coil whereby the heat given off by the absorber cooling coil during the absorption period may be utilized to improve the efficiency of operation of the mechanism.

Another object is to provide a refrigerator mechanism wherein the condenser coil and the absorber coil are positioned in heat exchange relationship so that an increase of pressure will be effected in the condenser early in the refrigerating cycle which is effective to force refrigerant from the condenser to the evaporator.

A further object of our invention is to provide a mechanism of the type referred to which will occupy a minimum of space so as to leave a maximum amount of space for the refrigerating chamber.

Another object is to provide a dehydrator especially adapted to fit in a relatively narrow flue at the rear of the cabinet while at the same time providing a maximum heat exchange area.

A further object of our invention is to provide a drain conduit for absorbent liquor leading from the evaporator which will be effective to return such liquor to the still-absorber at the beginning of the generating period.

Another object is to provide a drainage system which will drain for a limited period and be substantially incapable of draining more than a limited quantity of weak liquor from the evaporator of the refrigeration system.

Still another object is to provide a novel arrangement of dehydrator conduits and fins attached thereto which may be easily assembled within a refrigerator cabinet.

Various other objects and advantages will become apparent from the subsequent description and drawings.

Referring to the drawings forming part of this specification and illustrating a preferred embodiment of our invention:

Fig. 1 is a vertical section of a refrigerator taken on the line 1—1 of Fig. 2.

Fig. 2 is a sectional view taken substantially along the line 2—2 of Fig. 1.

Fig. 3 is a sectional view taken substantially along the line 3—3 of Fig. 1.

Fig. 4 is a diagrammatic illustration of one form of the apparatus embodying our invention.

Fig. 5 is a diagrammatic illustration of a modification of our invention.

Fig. 6 is a diagrammatic illustration of a third modification.

Fig. 7 is a diagrammatic illustration of a fourth modification.

Fig. 8 is a detail section taken on the line 8—8 of Fig. 11.

Fig. 9 is a side elevation of a fin embodying our invention.

Fig. 10 is an enlarged detail of a tab attaching means for a fin.

Fig. 11 is an elevation of one form of our dehydrator.

Fig. 12 is an elevation of a second form of dehydrator.

Fig. 13 is a section taken substantially along the line 13—13 of Fig. 12.

Fig. 14 is a detail section of a fin structure taken along the line 14—14 of Fig. 12.

Fig. 15 is an elevation of a third type of dehydrator according to our invention.

Fig. 16 is a front elevation of the lower portion of a refrigerator showing the arrangement of the burner, fuel tank and control.

Fig. 17 is a diagrammatic plan view of the lower portion of a refrigerator partly broken away.

Fig. 18 is a vertical section of the burner.

Fig. 19 is a section of the burner taken on the line 19—19 of Fig. 18.

Referring to Figs. 1 to 3, the numeral 10 indicates a cabinet of any type suitable for housing the refrigerating mechanism of our invention and for providing a refrigeration space. A chamber 11, which may serve as a refrigeration space and also houses an evaporator 12, is bounded by a back wall 13 and a bottom wall 14 and suitable side walls 15 and 16. It will be understood that the walls of the refrigeration space are properly insulated in accordance with the accepted practice. However, for the convenience of illustration, the cabinet structure is indicated more or less diagrammatically, such details forming no part of our invention. It will be noted that the back wall 13 of the refrigeration compartment 11 is spaced from the back extremity of the cabnet 10 for the purpose of accommodating certain apparatus and to form a flue, as will hereinafter be described.

Below the refrigeration space 11 is a space 17 in which is disposed a still-absorber or generator absorber 18 heated by a burner 19 of any suitable type when distillation of refrigerant is desired. The space 17 is completely isolated from the remainder of the apparatus as by a side wall 17a and by a baffle or wall 20 disposed above and in front of the still-absorber 18 and extending downwardly in front of the still-absorber to the bottom of the cabinet, it being understood that a suitable door is provided to allow access to the still-absorber and the burner for the purpose of adjustment, etc. The rear of the space 17 is closed by wall or baffle 21 which extends upwardly in spaced relation to the baffle 20, while another baffle 21′ has a vertical portion parallel to baffle 21 and spaced therefrom to provide an insulating air space, this vertical portion starting above the bottom of the casing and then sloping upwardly and rearwardly, as seen clearly in Figs. 2 and 3, to form a rearwardly extending flue 22 communicating with flue 17. As will be seen from the drawings the baffles 20 and 21 conform at least in part to the shape of the still 18 so as to direct hot gases from the burner around the still to increase efficiency. The flue 22 communicates with a vertical pipe or flue 23 which serves to carry off to the atmosphere the products of combustion and excess heat from the burner 19. Surrounding the pipe or flue 23 and occupying the rest of the space between the wall 13 and the rear of the cabinet is a main flue 24 which, of course, like the flue 23, is well insulated from the refrigeration space 11. A relatively large inlet 25 is provided for the flue 24 at the bottom of the cabinet and a relatively large outlet 26 is provided for the flue 24 at the top of the cabinet.

The space 17 is provided with a series of baffled openings 27 in the lower portion thereof so as to supply air to the burner while eliminating any drafts which would tend to produce inefficient burner operation. The flue 23 terminates at the top of the cabinet in a relatively small opening 28 which preferably may be directly connected to any suitable outlet pipe or stove pipe if desired.

From the still 18 extends a conduit or steam tube 29 having an up leg and a down leg, the latter discharging into the lower portion of a trap 30. A vapor discharge outlet 31 rises from the upper portion of the trap 30 and is connected to a suitable dehydrator 32 of a type to be hereinafter described in detail. The lower portions of the dehydrator are connected to the trap 30 by a conduit 33 in order to permit the return thereto of water separated from the vapor, and the trap in turn communicates through a conduit 34 with the still-absorber, the conduit 34 serving to maintain a constant level of liquid in the trap.

The outlet end of the dehydrator communicates by means of a conduit 35 with the evaporator take-off 44. From the take-off 44 a conduit 36 communicates with the lower portion of a chamber 37, the latter being disposed in a space 38 bounded by the baffle 21 on the front and on the rear by the rear wall of the cabinet and extending from side to side thereof. From the upper portion of the chamber 37 extends a gas conduit 39 communicating with a condenser cooling coil 40 which may be of any suitable design, providing adequate heat radiating surface in contact with the air circulating through the flue 24, which communicates with the upper end of space 38. The condenser cooling coil discharges through a conduit 41 into the lower portion of a condenser receiver 42. The condenser receiver 42 has a conduit 43 communicating with the lower portion of the chamber 37.

A drain for absorbent from the evaporator is also provided, as is customary in an intermittent absorption system. Referring to Fig. 1 the drain comprises a tube 45 which extends upwardly from a well or sump in the evaporator coils 12*a* and communicates with an enlarged vessel 46, the latter discharging at the bottom thereof into a conduit 47 communicating with the trap 30. Another tube 48 extends upwardly from the evaporator receiver 12*b* and communicates with a chamber or enlargement 49. The chamber 49 is connected to the top of the enlarged vessel 46 by conduit 49*a*. The drain just described will be further described in detail as to function and operation in connection with the modification of the device disclosed in Fig. 4.

A gas return conduit 50 leads from the evaporator to the up leg 51 of an absorber cooling coil 52. This coil may be of any suitable design to dissipate the heat in the still-absorber. Preferably, it takes the form of a relatively flat horizontally disposed coil or series of coils located just below and in heat exchange with the condenser coil 40. As diagrammatically shown, the absorber coil 52 consists of a heat dissipating coil portion provided with fins, an up leg 51 and a down leg 53 communicating with the still 18, positioned in the space 38 between the condenser cooling coil 40 and the condenser receiver 42. The advantages of this arrangement will be hereinafter discussed.

During the heating or generating period, the burner 19 will function to heat the still 18, and the products of combustion will be discharged up the flue 23 and the outlet 28. Air for combustion will be drawn into the space at 27. Refrigerant gas, preferably ammonia, and some absorbent, preferably water, is distilled off in the still 18, passing up the steam tube 29 to the trap 30. A portion of the water vapor will separate out during the passage up the steam tube and will return to the still through the trap overflow 34. The remaining vapors of water and ammonia will pass into the dehydrator through conduit 31 where substantially all of the water will be separated and returned to the trap through conduit 33. The dehydrated ammonia will flow toward the evaporator through conduit 35. Since the evaporator receiver 12*b* is usually insulated, very little condensation of the ammonia will take place therein at this period, and substantially all of the ammonia in gaseous form will pass through the conduit 36 to the chamber 37. From the chamber 37 the ammonia gas will flow through 39 to the condenser coil 40 and be condensed therein. The condensed ammonia will flow through conduit 41 and be collected in condenser receiver 42.

At the beginning of the refrigerating period, the burner 19 will be turned off either manually or by means of a suitable controlling mechanism. The still 18 will then function as an absorber. The shut-off of the burner 19 will reduce the pressure on the still side of the system, and the pressure of liquid ammonia under ordinary temperature conditions will serve to force the liquefied ammonia in condenser receiver 42 back up the conduit 36 to the evaporator. This action is facilitated by the particular arrangement of the absorber cooling coil and condenser coil, in the following manner: Almost immediately at the beginning of this cycle, the reduction of pressure in the generator will draw gas from the evaporator, the gas returning to the still-absorber through conduit 50. This return of the gas will create a flow of liquid up absorber cooling coil leg 51, and, as a result, liquid will be drawn from the still down leg 53 and through the absorber cooling coil 52. This passage of hot liquid from the still through the absorber cooling coil will transmit some heat to the condenser coil 40 because of the heat exchange relationship between the condenser coil and the absorber coil. The heating of the condenser coil 40 will increase the pressure in the condenser coil. This increase of pressure will be transmitted to the condenser receiver and will facilitate the discharge of refrigerant from the condenser receiver to the evaporator. This quick discharge of refrigerant from the condenser receiver to the evaporator will greatly enhance the efficiency of operation of the apparatus. In actual tests this speedy return of the refrigerant to the evaporator lengthened the refrigerating cycle approximately twenty per cent.

It is to be noted that heat is transmitted from the absorber cooling coil to the condenser coil only during the refrigerating or absorption period, since the absorber cooling coil is so constructed that no current of fluid from the still-absorber is created except during the absorption period. This flow of fluid through the absorber cooling coil is instituted, as hereinbefore explained, by the flow of gas from the evaporator into the up leg 51 of the absorber cooling coil.

It is to be noted particularly that in the apparatus just described the flue 24 is completely out of communication with the flue 23. During the generating period, the draft of cooling air through the condenser is entirely generated by the flue action of the hot condenser coils and the dehydrator, and especially the latter. As can be seen particularly in Fig. 3, the dehydrator substantially fills the upper portion of the relatively narrow flue 24. Several advantages result from the disposal of the dehydrator in the relatively narrow flue above the condenser. This positioning of the dehydrator to receive the air warmed by passage through the condenser prevents undue condensation of ammonia in the dehydrator. In other words, the air, after passing through the condenser, has been heated to approximately the condensation temperature of ammonia, and, therefore, a minimum of ammonia will be condensed in the dehydrator. The dehydrator also acts as a regulating means for the air flowing through the condenser. In other words, if more ammonia passes through the dehydrator, the greater amount of heat given off will draw more air through the condenser to condense this increased quantity of ammonia.

Even though the greater part of the absorbent or water volatilized from the still is taken out by the dehydrator, as hereinbefore set forth, a certain amount of absorbent fluid or water passes over to the evaporator 12, and it is essential for the efficient prolonged operation of the machine that this water be periodically returned to the still. For this reason there is provided an absorbent return or drain. This absorbent return or drain, as shown in Fig. 1, comprises a conduit 45 having its lower end in a sump or low point in the evaporator coils 12a and a relief conduit 48 connecting with an enlarged portion 49, which has its lower end disposed in the lower portion of the evaporator receiver 12b. Both of these conduits communicate with the enlarged chamber 46, and the enlarged chamber, in turn, communicates with and is liquid-sealed in a conduit communicating with the trap 30. This type of drain is disclosed in detail in Fig. 4, where the still-absorber is represented by reference numeral 18 and the evaporator by reference numeral 12. The condenser and dehydrator are shown in this figure in a diagrammatic fashion and operate in a manner similar to the description as hereinbefore set forth.

The drain according to our invention operates in the following manner: During the initial portion of the generating cycle, the pressure in the system will be relatively high. At this time there will be sufficient fluid in the evaporator receiver 12b to seal the lower end of the conduit 48. The resultant pressure in the system will therefore tend to force fluid up the conduit 45. This fluid will spill over into the enlarged chamber 46 and will accumulate in the lower part of the enlarged chamber and in the conduit 47 leading therefrom. It will be noted that the conduit 47 terminates at its lower end in the conduit 33 which leads from the dehydrator. The flow of liquid returning from the dehydrator will assist the flow of liquid from the conduit 47. Any liquid present in the evaporator 12 and in the evaporator storabe 12B will therefore tend to drain through the conduit 45 until the end of the conduit 48 has been uncovered. As soon as the end of the conduit 48 has been uncovered, no further drainage can take place since the conduit 48 will transmit pressure to the enlarged chamber 46. The conduit 45 will, therefore, be in a pressure balance at both of its ends. No liquid can be forced up the conduit 45, and the liquid in the lower conduit 47 standing above trap level will drain into the trap.

During the generating cycle, it is understood that substantially no refrigerant will be condensed in the evaporator storage 12B since this storage is preferably insulated, and therefore, further drains will be minimized. This particular form of drain is advantageous since it maintains a constant supply of fluid in the evaporator coils 12a. The maintenance of a constant supply of fluid in the evaporator coils prevents the passage of ammonia through the evaporator coils during the generating period and therefore prevents any warming action on the refrigeration space at this time by the condensation of ammonia. It will be noted particularly that the upper portion of conduit 48 is located at a higher level than conduit 45. This positioning of the conduit 48 and the enlarged section 49 prevents drainage through the conduit 48. Since the water or absorbent in the evaporator is heavier than the ammonia, this arrangement insures drainage from the lowermost portion of the evaporator coils and therefore absorbent rather than refrigerant is returned to the still through the drainage system. It is essential that the lower end of the drain 47 be liquid-sealed during the evaporation period since this prevents drainage at this time. It will be noted that this effect is secured because the upper end of the conduit 33 is positioned above the normal liquid level L in the trap 30 and, therefore, some liquid from the dehydrator will be trapped in the conduit 33 at all times. The liquid sealing of the end of the drain will serve to balance the pressures in the drain system during the refrigeration period, and, therefore, no drainage can occur at this time.

Another type of drain in accordance with our invention is disclosed in Fig. 5. In this modification an auxiliary trap chamber 30a is provided, and the lower end of the drain 47 communicates with the auxiliary trap chamber below the liquid level L therein. This type of drain is also provided with an enlarged section 46 and a section 45 communicating with the lower portion of the evaporator. A pressure relief conduit is also provided in this type of drain, but in this instance the pressure relief conduit, instead of communicating with the evaporator receiver 12b, communicates with the upper portion of the auxiliary trap chamber 30a. This relief conduit is indicated as 54 in the drawing. It will be noted particularly that the auxiliary trap chamber 30a surrounds and is, therefore, in heat exchange with the steam tube 29 which leads from the still 18 to the trap 30. Drainage of absorbent or water from the evaporator also occurs in this modification at the beginning of the generating period. At the beginning of this period, water or weak liquor from the bottom of the evaporator coils is forced up the conduit 45 and spills over into the enlarged section 46, from there returning through conduit 47 to the auxiliary trap chamber 30a and through a conduit to the trap 30. From the trap 30 the weak liquid will overflow through the trap overflow conduit 34 to the still.

After the weak liquor has been drained from the evaporator tubes, a certain amount of condensation of ammonia will take place therein, and it is necessary to provide some means to prevent further drainage. This is provided by the arrangement shown in Fig. 5 in the following manner. It will be noted that the conduit 33 leading from the dehydrator enters the auxiliary trap chamber 30a. During the generating period, therefore, the water separated in the dehydrator will enter auxiliary trap chamber 30a before entering the trap 30 and overflowing to the still 18. This dehydrator liquid is comparatively rich in ammonia since a certain amount of ammonia is condensed in the dehydrator along with the separated water at normal dehydrator temperatures. Since the auxiliary trap chamber 30a is in heat exchange with the hot steam tube, the ammonia in the dehydrator liquid will be volatilized and the vapor driven up relief conduit 54 to the enlarged section 46 where it will oppose any drainage through conduit 45. In this modification also, the sealing of the end of conduit 47 will prevent drainage during the absorption period.

The drain modification disclosed in Fig. 6 is very similar in operation to that disclosed in Fig. 5. In this modification, however, the auxiliary trap chamber 30b is largely located within the tray 30 and is, therefore, surrounded by and in heat exchange with the hot trap liquor.

Drainage occurs in this modification during the early part of the generating cycle in a manner similar to that described in connection with Fig. 5, the weak liquor from the evaporator passing up conduit 45 through the enlarged chamber 46 and down conduit 47. The conduit 47 in this modification communicates with the upper portion of the auxiliary chamber or dome 30b. When the liquid is drained into the dome, a portion of it is flashed into gas by the heat of the trap **30**, and the volatilized gas returns to the enlarged chamber **46** through the relief conduit **54**. This return of gas equalizes the pressure in a manner similar to that described in connection with Fig. 5 and prevents further drainage of refrigerant through the drain conduit **45**. Liquid from the dehydrator returning through conduit **33** to the dome or auxiliary trap chamber **30***b* furnishes an additional supply of ammonia to be flashed into gas during the generating period. The ammonia thus continuously volatilized in the chamber **30***b* creates a back pressure through conduit **54**, in the enlarged chamber **46** and prevents any further drain through the conduit **45**, this manner of operation being similar to the operation of the modification disclosed in Fig. 5.

It will be noted that in each of the modifications of the device described in Figs. 4, 5, and 6, the dehydrator is provided with a spillpot or gas and liquid separating chamber **55**. The function of this gas and liquid separating chamber will be specifically described in connection with the modification of the dehydrator shown particularly in Figs. 12 and 15. The use of a chamber of this type is not essential in the dehydrator structure, and a dehydrator will be hereinafter described which communicates directly with the trap **30**. It is to be understood that where a drain of the type disclosed and discussed in connection with Figs. 4, 5, and 6 is used, the gas and liquid separating chamber is not essential.

In the modification of the drain shown in Fig. 7, there is incorporated the advantages of both the drain of Fig. 4 and the drain of Fig. 5. It is to be noted that the drain of Fig. 4 will maintain a certain amount of refrigerant in the evaporator coils inasmuch as the pressure relief conduit **48** will be effective to positively stop the drain as soon as the end thereof is uncovered. In this modification, however, if additional refrigerant is condensed in the storage **12***b*, a further drain can take place during the generating period. This is not true of the modification of Fig. 5, inasmuch as the pressure relief conduit **54** will be effective to balance the pressure in the enlarged chamber **46** by supplying refrigerant thereto during the generating period. This will effectively prevent any further drainage at this time. It is to be noted that both of the modifications shown in Figs. 4 and 5 are incapable of draining during the refrigerating period because their lower ends are liquid-sealed.

Referring to Fig. 7, it will be noted that an auxiliary chamber **30***a* is also provided in this type of drain. A pressure relief pipe **54** which has an entirely similar function to the pressure relief pipe **54** of Fig. 5 leads from the chamber **30***a* to the upper portion of the enlarged chamber **46**. This modification is also provided with the pressure relief pipe **48** having an entirely similar function to the pressure relief pipe **48** of Fig. 4. The lower portion of the drain **47** communicates with the conduit **33** leading from the dehydrator to the trap at a point below the normal liquid level in the trap and is therefore liquid-sealed at all times.

The operation of the modification shown in Fig. 7 is as follows: During the beginning of the generating period, liquid is forced from the lower portion of the evaporator up the conduit **45** and spills over into the enlarged section **46** until the lower end of the conduit **48** is uncovered. Uncovering of the lower end of the conduit **48** terminates the drain by balancing the pressure at both ends of the conduit **45**. The liquid in the enlarged chamber **46** and the conduit **47** then runs into the trap through the conduit **33** and the auxiliary trap chamber **30***a*. Due to the heat exchange between the chamber **30***a* and the steam tube **29**, a portion of the liquid fed through conduit **33** from the dehydrator will be continuously volatilized during the generating period and fed to the top of the enlarged chamber **46** through conduit **54**. The increase of pressure in the chamber **46** thus caused will prevent any further drainage through the conduit **45** or **48** whether or not the conduit **48** is liquid-sealed in the evaporator.

Referring particularly to Fig. 11, there is disclosed a dehydrator communicating with a trap **30** which is connected to the system as hereinbefore described. The steam tube **29** leading from the still enters the trap **30** adjacent the bottom thereof. An overflow conduit **34** is also provided leading from an intermediate section of the trap **30** and serving to return weak liquor from the trap to the still. The overflow **34** is effective to maintain the level of liquid in the trap as indicated at L. Leading from the upper portion of the trap **30** is a conduit **73** which is a part of a single large tube **72** which is bent in a serpentine formation, as indicated in the drawings. Preferably the straight portions of the conduit **72** lie in a single vertical plane so that the dehydrator as a whole is especially adapted to fit in a relatively narrow and wide flue at the rear of a refrigerator cabinet, as shown in Figs. 1 to 3. It is to be understood that instead of a single tube a plurality of welded together sections may be employed and that each reach may be considered a separate interconnected tube.

The vertical portions of conduit **72** are provided with fins shown in detail in Figs. 8, 9, and 10 to be hereinafter described. Each of the lower bends of the conduit **72** is provided with liquid outlets which are designated by the reference numerals **75**, **76**, and **77**, respectively. The last vertical conduit **74** communicates with the condenser and evaporator of the refrigeration system, as shown in the other figures of the application. The conduit **78** connects the outlets **75**, **76** and **77** with the trap so that the separated absorbent may be returned thereto. In order to bring out the positioning of the dehydrator in the system, the lower portion of conduit **73** has also been designated by the reference numeral **31**, the upper portion of conduit **74** by the reference numeral **36** and the portion of conduit **78** close to the trap by the reference numeral **33**.

The operation of the dehydrator shown in Fig. 11 is as follows: A mixture of low boiling refrigerant and high boiling absorbent enters the trap through the steam tube **29**. Any condensed absorbent will flow back to the still of the unit through the overflow **34**. The remaining refrigerant and absorbent will enter the dehydrator through the conduit **73** and will pass through the successive vertical reaches of the dehydrator where substantially all of the high boiling absorbent will be condensed and returned to the trap through the conduit **78** and the conduits **75**, **76**, and **77**. The refrigerant substantially free from absorbent will flow to the evaporator and condenser of the unit through the conduit **36**. It is to be noted that the usual refrigerant is ammonia and the usual absorbent, water and therefore the apparatus here disclosed is termed a dehydrator, although it is obvious that it can be used to separate any high boiling absorbent from a relatively low boiling refrigerant.

The dehydrator disclosed in Fig. 12 is also preferably formed from a single tube. This form of dehydrator, however, although bent in a serpentine formation, has its straight sections lying slightly inclined to the horizontal instead of vertical, as in the modification just described. The modification shown in Fig. 12 has but a single outlet for liquid and is further provided with a gas and liquid separating chamber 79. The couduit 31 leading from the trap 30 communicates with this type of dehydrator at 80. The dehydrator conduit proper is sloped in a downward direction from 80 and is indicated by reference numeral 81. The downwardly sloped portion 81 communicates by means of a U-bend 82 with another downwardly sloped portion 83 which, in turn, communicates by means of a U-bend 84 with a third downwardly sloped portion 85, the third downwardly sloped portion 85 communicating through a U-bend 86 with the downwardly sloped portion 87 which, in turn, enters the gas and liquid separating chamber 79 adjacent to its top. Each of the successively sloping portions 81, 83, 85 and 87 slopes downwardly in an opposite direction so that the dehydrator in general is of zig-zag formation. The gas and liquid separating chamber communicates at its upper portion with the conduit 36, leading to the evaporator and at its lower portion with the conduit 33 leading to the trap 30. Both of these conduits function as set forth in connection with the general description of the device. Each of the sloping relatively straight portions of this type of dehydrator is provided with a plurality of fins to be hereinafter described which are particularly designed to function in an efficient manner with this type of relatively horizontal tube structure. As shown in Fig. 13, each successive straight portion of this dehydrator is staggered from the next portion so that the group of fins just above one another will lie in a different plane. This staggering of the straight portions of the dehydrator is not essential, as all of the straight portions may lie in the same plane and the dehydrator in general will thus occupy a narrower flue.

Still another form of dehydrator according to our invention is disclosed in Fig. 15. This form is also provided with a gas and liquid separating chamber 88 which functions to separate the dehydrated gas from the separated absorbent in a manner similar to the gas and liquid separating chamber 79 of Fig. 13. The dehydrator proper is composed of a vertically disposed spiral coil 89 communicating at its upper end with the conduit 31 leading from the trap 30 and at its lower end with the gas and liquid separating chamber 88. The spiral coil may be provided with any suitable type of fin. This particular type of dehydrator is especially adaptable to a relatively small space of substantially square cross section. It is to be noted particularly that in all of the forms of dehydrator described herein the gas to be dehydrated is fed into the dehydrator at a high point and the separated liquid is removed from the dehydrator at a low point. All of them, therefore, are especially efficient since the liquid removed from the gas flowing in a downward direction wets the inside of the tubes.

The fin structure which is especially applicable to the form of dehydrator shown in Fig. 11 is shown in detail in Figs. 8, 9 and 10. As shown in these figures, the fin assembly comprises a pair of relatively flat plates 90 and 91, each plate being positioned on one side of a vertical tube. As shown in Fig. 8, each plate is provided with a relatively flat heat exchange portion 92 and an arcuate portion 93 adapted to conform to the dehydrator tube. These flat portions are adapted to be attached to the tubes so that they lie in a vertical plane and therefore present a large heat exchange surface to the vertical current of air passing through the flue 24 of Figs. 1 to 3. Each plate is provided with a tab 94 bent out of the plane of the plate and passing through a cooperating notch or slot 95 in an opposed plate. The end of the tab 94 is provided with a reduced section 96 which forms spacing shoulders 97. The reduced section 96 is twisted during assembly in order to lock the plates 90 and 91 together and to attach the same to a dehydrator conduit. The plate 90 is also provided with a tab 98 having an entirely similar function and provided with shoulders and a twisted reduced end portion. As may be seen in Fig. 9, the tabs are stamped out of the body of the plate proper. Although this type of fastening is preferred, it is obvious that the opposed parallel plates may be attached to a dehydrator conduit by means of bolts or other conventional means such as welding. The fin structure here disclosed is also adaptable to other heat exchange devices such as condensers and the like. As shown in Fig. 8, two of these fin assemblies at an angle to each other are preferably mounted on a single vertical dehydrator tube although it is within the scope of our invention to utilize any number of fin assemblies at any suitable angle on a single dehydrator tube or heat exchange element.

The type of fin structure just described is not as efficient when applied to the dehydrator shown in Fig. 12 as it is when applied to dehydrator of Fig. 11. A form of fin especially adapted for application to the dehydrator of Fig. 12 is shown in detail in Fig. 14. In this form of fin assembly, opposed plates 99 and 100 are provided, each fitting on opposite sides of the dehydrator tube 81. Each plate 99 and 100 is provided with two relatively flat portions connected by an arcuate portion adapted to fit the tube 81. Each flat portion is provided with openings 101 located just above the tube 81 and openings 102 located just below the tube 81. These openings are effective to allow the inlet and egress of air between the two opposed plates 99 and 100, the opening 101 serving as an inlet opening for the space above the conduit 81 and the opening 102 serving as an outlet for the space below the conduit 81. It is to be noted that although this arrangement of fins and openings is especially advantageous for use with a dehydrator such as shown in Fig. 12, it may be applied to other heat exchange structures of a similar nature. The plates 99 and 100 may be attached to one another and to the dehydrator tubes by means of a tab structure, as are the fins shown in Figs. 8, 9, and 10, or they may be attached to one another by bolts or other suitable attaching means.

The arrangement of the burner, control and fuel tank of the refrigeration unit is shown in Figs. 16 and 17 where the fuel tank is indicated in general by the reference numeral 103, the control designated by the reference numeral 104 and the burner by the reference numeral 105. The tank 103 is adapted to contain kerosene or some other suitable liquid fuel and is provided with a gauge 106 and a filling spout 107. The tank is supported from the lower wall 14 of the refrigeration space 11 of Figures 1 to 3 by means of a bracket 108 which may be welded or bolted to the top of the tank slightly to the rear of the center of the top thereof. The bracket 108 may be bolted to a suitable bracket depending from the bottom wall 14 or it may be of a U-shape having one leg bolted to the tank and the other to the bottom wall of the refrigeration space. In either case, the bracket 108 is bolted to the tank 103 and wall 14 in such a way that it can be easily removed. The forward end of the tank 103 is supported by a bracket 109 which is bolted to a side frame member 110 of the cabinet in such a manner that it may be easily removed therefrom. The support of the fuel tank in this manner enables the fuel tank to be easily removed, which is a wide departure from prior art constructions. Since the fuel tank may develop leaks, the advantages of this type of support are quite pronounced. The bottom of the fuel tank 103 communicates with a filter 111 which in turn communicates as by conduit 112 with the control 104. The control 104 communicates by means of a conduit 113 with the pilot reservoir 114 of the burner 105. The control 104 is carried by a saddle 115 bolted to and supported at its rear end by a bottom brace 116 carried by the refrigerator cabinet and spanning the bottom of the cabinet from side to side thereof. The forward end of the saddle 115 is bolted to a sill or front brace member 117. The control 104 is fastened to the saddle by the bolts 118 and 118 so that it may be easily removed therefrom. The burner unit 105 is also carried by the brace 115 and is fastened thereto for easy removal by the bolts 119 and 120.

The burner unit is of an integral, welded or brazed construction and consists of a drip pan 121 which is welded or brazed to the pilot reservoir 114, as at 122 and 123. Also welded to the pilot fuel tank is a supporting member 124 and a tube 125 which functions as a pilot wick casing and as a feed tube for the channel 126 carrying the main wick. The channel 126 is formed from two annular members 127 and 128. The members 127 and 128 are bent to form supports for the burner tubes at 129 and 130. The pilot reservoir 114 is provided with a threaded inlet 131 and a cleanout tube 132. The tube 132 is soldered or brazed into the top of the pilot reservoir 114, as indicated at 133, and is provided with a perforated cap 134.

It is to be noted particularly that the upper or free end of the clean-out tube 132 is located at a point considerably above the normal fuel level in the burner. In prior art constructions, a clean-out plug was provided below the normal fuel level and this type of construction was subject to leakage. As is shown particularly in Fig. 19, the clean-out duct is slanted forwardly. This facilitates the attachment of a suction line when drainage of the pilot reservoir is necessary. By attaching an air line to the clean-out tube 132 or the inlet 131, the pilot reservoir may be conveniently blown or cleaned.

It is to be noted that the fuel burner herein disclosed is a completely self-contained unit. It may therefore be easily removed through the door of the casing which surrounds the generator and burner of the unit. Referring to Fig. 16, it is to be noted that the wall 17a, the passage 22 and the flue 23, shown in Fig. 1, are indicated in dotted lines.

We claim:

1. In an intermittent absorption refrigeration apparatus operating according to the 1—3—2 system and including a still-absorber and evaporator connected in operative relation and an absorber coil adapted to receive hot fluid from the still-absorber at the beginning of the absorption period, a condenser connected to said evaporator for passage of refrigerant to and from the evaporator and condenser, said condenser including an air-cooled coil positioned in air flow relation with said absorber coil so that air heated by said absorber coil will flow through and transmit heat to the condenser coil whereby refrigerant within said condenser coil will be increased in pressure so as to expedite the discharge of refrigerant from said condenser at the beginning of the absorption period.

2. In an intermittent absorption refrigeration apparatus operating according to the 1—3—2 system and including a still-absorber and an evaporator and an absorber coil adapted to receive hot fluid from the still-absorber at the beginning of the absorption period, a condenser connected to said evaporator for passage of refrigerant to and from the evaporator and condenser, said condenser including a coil positioned adjacent and above said absorber coil and in heat exchange relation therewith so as to receive heat from said absorber coil whereby refrigerant within said condenser coil will be increased in pressure so as to expedite the discharge of refrigerant from said condenser.

3. In an intermittent absorption refrigeration apparatus operating according to the 1—3—2 system and including a still-absorber and an evaporator and an absorber coil adapted to receive hot fluid from the still-absorber at the beginning of the absorption period, a condenser connected to said evaporator for passage of refrigerant to and from the evaporator and condenser, said condenser comprising a condenser coil positioned above and adjacent said absorber coil, and a condenser receiver positioned below said absorber coil, the positioning of the condenser coil being effective to increase the pressure in the condenser coil and expedite the discharge of refrigerant from the condenser receiver at the beginning of the absorption cycle.

4. In an intermittent absorption refrigeration apparatus operating according to the 1—3—2 system and including a still-absorber and an evaporator connected in operative cycle, and an absorber coil connected to the still-absorber and adapted to receive hot fluid from the still absorber at the beginning of the absorption period, a condenser assembly comprising a condenser cooling coil, a condenser receiver and a sump, said condenser cooling coil being connected to the sump at its inlet end and to the receiver at its outlet end and said condenser receiver being connected to said sump adjacent the bottom thereof, said condenser cooling coil and said condenser receiver being positioned above and below the aforementioned absorber coil respectively, and said sump being connected at its lower portion thereof with the evaporator so that during the generating period refrigerant to be condensed will be supplied to the sump, condensed in the condenser cooling coil and stored in the condenser receiver, and during the absorption period the pressure in the condenser cooling coil will be increased so as to expedite the discharge of the collected refrigerant from the condenser receiver through the sump to the evaporator.

5. In a refrigerator of the intermittent absorption type including a still-absorber, an evaporator and means to connect the same in opera-

tive cycle, mends to remove absorbent accumulating in the evaporator at the beginning of the generating cycle, said means terminating at one end in the evaporator and communicating at the other end with the still-absorber, and means to equalize the pressure in said second mentioned means shortly after the beginning of the generating cycle, said last mentioned means communicating with the second mentioned means at a point intermediate its ends.

6. In a refrigerator of the intermittent absorption type including a still absorber, an evaporator and means to connect the same in operative cycle, means to remove absorbent accumulating in the evaporator, said means terminating at one end in the evaporator and communicating at the other end with the still-absorber, means to equalize the pressure in said second-mentioned means shortly after the beginning of the generating cycle, and additional means to equalize the pressure in said first-mentioned means continuously throughout the generating cycle, both of said last-mentioned means communicating with the second-mentioned means at a point intermediate its ends.

7. In a refrigerator of the intermittent absorp type including a still-absorber, an evaporator and means to connect the same in operative cycle, means to remove absorbent accumulating in the evaporator at the beginning of the generating cycle comprising a conduit having an enlarged section intermediate its ends and connected to a low point in the evaporator at one end and to a trap interposed in circuit between the still-absorber and the evaporator, at the other end, and means to equalize the pressure in said conduit shortly after the beginning of the generating cycle, said last mentioned means communicating with the conduit at its enlarged section.

8. In a refrigerator of the intermittent absorption type including a still-absorber, an evaporator and means to connect the same in operative cycle including a trap, and a dehydrator connected to the trap, means to remove absorbent accumulating in the evaporator comprising a drain conduit connected to the evaporator by a plurality of conduits terminating at different levels therein and liquid sealed at its other end in the connection leading from the dehydrator to the trap.

9. In a refrigerator of the intermittent absorption type including a still-absorber, an evaporator and means to connect the same in operative cycle including a trap and a dehydrator connected to the trap, means to remove absorbent accumulating in the evaporator comprising a drain conduit connected to the evaporator by a plurality of conduits terminating at different levels therein and liquid-sealed at its other end in the connection leading from the dehydrator to the trap, and means to prevent drainage through said conduit during the generating cycle comprising a conduit communicating with the drain conduit at a point intermediate its ends, at one end, and with a chamber in heat exchange with hot gases flowing from the still-absorber, at its other end.

10. In a refrigerator of the intermittent absorption type including a still-absorber, an evaporator and means to connect the same in operative cycle including a trap, a dehydrator and a gas and liquid separating chamber connected to the dehydrator and trap, means to remove absorbent accumulating in the evaporator comprising a drain conduit connected to the evaporator by a plurality of conduits terminating at different levels, and liquid sealed at its other end in the connection leading from the separating chamber to the trap, said drain conduit having an enlarged section intermediate its ends.

11. In a refrigerator of the intermittent absorption type including a still-absorber, an evaporator and means to connect the same in operative cycle, means to remove absorbent accumulating in the evaporator, said means terminating at its upper end in the evaporator and communicating at its other end with the still-absorber, and means to equalize the pressure in said second mentioned means shortly after the beginning of the generating cycle, said last mentioned means having one end in heat exchange relation with the hot gases evolved from the still-absorber during the generating cycle and the other end communicating with the second mentioned means at a point intermediate its ends.

12. In a refrigerator of the intermittent absorption type including a still-absorber, an evaporator and means to connect the same in operative cycle including a trap, means to remove absorbent accumulating in the evaporator, said means terminating at one end in the evaporator and connected at the other end to the still-absorber and including an enlarged section intermediate its ends, and means to equalize the pressure in said second mentioned means shortly after the beginning of the generating cycle, said last mentioned means communicating with the upper portion of the enlarged section and with the aforementioned trap and being effective to supply volatilized refrigerant from the trap to the enlarged section to prevent further drainage.

13. In a refrigerator of the intermittent absorption type including a still-absorber, an evaporator and means to connect the same in operative cycle including a trap, means to remove absorbent accumulating in the evaporator, said means terminating at one end in the evaporator and communicating at the other end with the still-absorber and including an enlarged section intermediate its ends and means to equalize the pressure in said second mentioned means shortly after the beginning of the generating cycle, said last mentioned means comprising an auxiliary chamber communicating with the trap below the normal liquid level therein and at a point adjacent its top with the aforementioned enlarged section so as to supply volatilized refrigerant from the trap to the enlarged section.

14. In a refrigerator of the intermittent absorption type including a still-absorber, an evaporator and means to connect the same in operative cycle including a trap, means to remove absorbent accumulating in the evaporator said means terminating at one end in the evaporator and connected at the other end to the still-absorber and including an enlarged section intermediate its ends and means to equalize the pressure in said second mentioned means shortly after the beginning of the generating cycle, said last mentioned means comprising an auxiliary chamber communicating with the trap below the normal liquid level therein and positioned at least partially within the trap and communicating at a point adjacent its top with the aforementioned enlarged section so as to supply volatilized refrigerant from the trap to the enlarged section.

15. In a refrigerator of the intermittent ab-

sorption type including a still-absorber, an evaporator and means to connect the same in operative cycle including a trap connected to the still-absorber by a steam tube, means to remove absorbent accumulating in the evaporator, said means terminating at one end in the evaporator and communicating at the other end with the still-absorber, and means to equalize the pressure in said second means shortly after the beginning of the generating cycle, said last mentioned means comprising an auxiliary chamber connected to the trap and surrounding the aforementioned steam tube in heat exchange relationship and communicating adjacent its upper portion with the first mentioned means at a point intermediate its ends so as to supply volatilized refrigerant to said second mentioned means to equalize the pressure therein.

16. In a refrigerating system of the intermittent absorption type including a still-absorber, an evaporator and means to connect the same in operative relation including a trap, a gas and liquid separating chamber connected to the trap at its lower end and to the evaporator at a point above the normal liquid level in the separating chamber, and a dehydrator including a plurality of connected conduits communicating with said trap at its inlet portion and with said gas and liquid separating chamber at its outlet portion.

17. In a dehydrator for an absorption refrigeration system, a trap, an inlet for gas to be dehydrated communicating with the lower portion of the trap, an outlet for the gas to be dehydrated communicating with the upper portion of the trap, a plurality of spaced conduits communicating with each other and with said outlet, means connecting the conduits to the trap at their lower portions, an outlet for dehydrated gas communicating with the conduit remote from the trap and an outlet for liquid communicating with an intermediate portion of said trap.

18. In a refrigerator of the intermittent absorption type including a still-absorber and an evaporator, means to connect the same in operative relation, including a dehydrator comprising a plurality of connected heat exchange conduits sloped from the horizontal, a trap interposed in circuit between the still-absorber and the evaporator, a gas and liquid separating chamber connected to said trap, means to connect the gas and liquid separating chamber with the lower portion of the dehydrator coil, and means above the normal liquid level therein to connect the gas and liquid separating chamber with the evaporator.

19. In a refrigerator of the intermittent absorption type including a still-absorber, an evaporator and means to connect the same in operative cycle, means to remove absorbent accumulating in the evaporator at the beginning of the generating cycle, said means terminating at one end in the evaporator and communicating at the other end with the still-absorber, means providing a liquid seal for the still-absorber end of said last mentioned means, and means to equalize the pressure in said absorbent removing means shortly after the beginning of the generating cycle, said last mentioned means communicating with the absorbent removing means at a point intermediate its ends.

20. In a refrigerator of the intermittent absorption type including a cabinet provided with a refrigeration space in the forward upper portion thereof, an evaporator in the refrigeration space, a still-absorber, an air cooled dehydrator, and an air cooled condenser operatively connected to said evaporator, a flue in said cabinet extending substantially from top to bottom thereof, said flue being open at the top and bottom for a circulation of air therethrough and having a widened portion positioned at least in part below said refrigeration space, and a relatively long narrow portion positioned to the rear of said space, said widened portion housing said condenser, said dehydrator having a relatively narrow cross section and being housed in the narrow portion of said flue and substantially conforming in width to the width of said flue so that air passing through the condenser and warmed thereby will flow through the dehydrator and the flow of said air will be induced by the heat given off by the dehydrator, and a second independent flue having an inlet and outlet housing said still-absorber.

21. In a refrigerator of the intermittent absorption type including a cabinet provided with a refrigeration space in the forward upper portion thereof, an evaporator in the refrigeration space, a still-absorber, an air cooled dehydrator including a plurality of heat exchange conduits, and an air cooled condenser operatively connected to said evaporator, a flue in said cabinet extending substantially from top to bottom thereof, said flue being open at the top and bottom for a circulation of air therethrough and having a widened portion positioned at least in part below said refrigeration space, and a relatively long narrow portion positioned to the rear of said space, said widened portion housing said condenser, said dehydrator having a relatively narrow cross section and being housed in the narrow portion of said flue and substantially conforming in width to the width of said flue so that air passing through the condenser and warmed thereby will flow through the dehydrator and the flow of said air will be induced by the heat given off by the dehydrator, and a second independent flue having an inlet and outlet housing said still-absorber.

22. Intermittent absorption refrigeration apparatus comprising a cooling chamber, an evaporator disposed in said cooling chamber, a still-absorber, a condenser, an absorber coil, and a dehydrator connected in operative relation to said evaporator, said condenser including a receiver and a coil constructed and arranged to receive heat from said absorber coil, said condenser coil being connected to said evaporator through a liquid seal at one of its ends and having its other end connected to said condenser receiver whereby when refrigerant within said condenser coil is heated by said absorber coil, the pressure in said condenser coil and condenser receiver will be increased to expedite the discharge of refrigerant from said condenser receiver.

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2,313,707

CERTIFICATE OF CORRECTION.

Patent No. 2,313,707. March 9, 1943.

JOHN LITHGOW, ET AL.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 4, first column, line 36, for "storabe" read --storage--; and second column, line 35, for "a conduit" read --conduit 55--; line 66, for "tray 30" read --trap 30--; page 8, first column, line 1, claim 5, for "mends" read --means--; line 25-26, claim 7, for "absorp" read --absorption--; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 11th day of May, A. D. 1943.

Henry Van Arsdale,
(Seal) Acting Commissioner of Patents.