

July 3, 1928.

G. BAYER

1,676,068

REFRIGERATING APPARATUS

Filed May 12, 1926

2 Sheets-Sheet 1

Fig. 1.

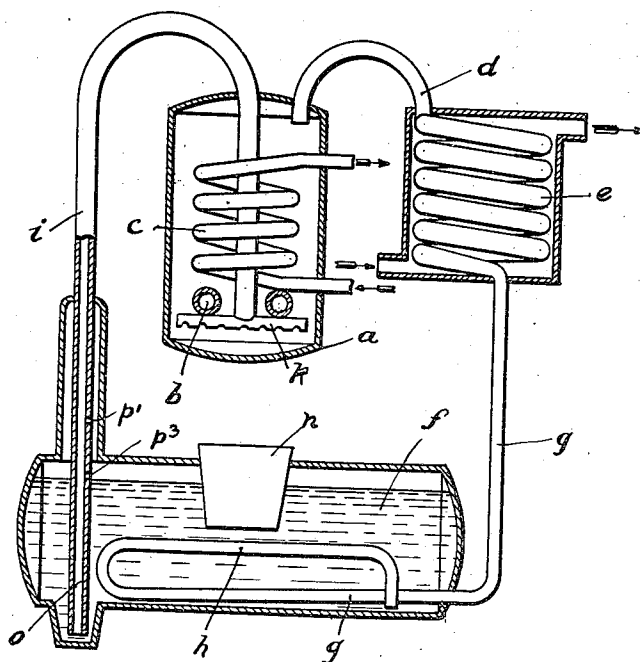
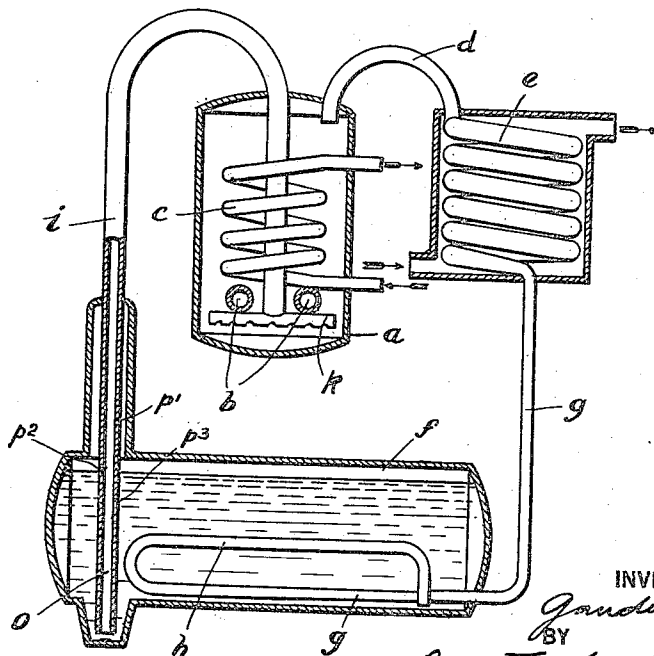


Fig. 2.



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2 Sheets-Sheet 2

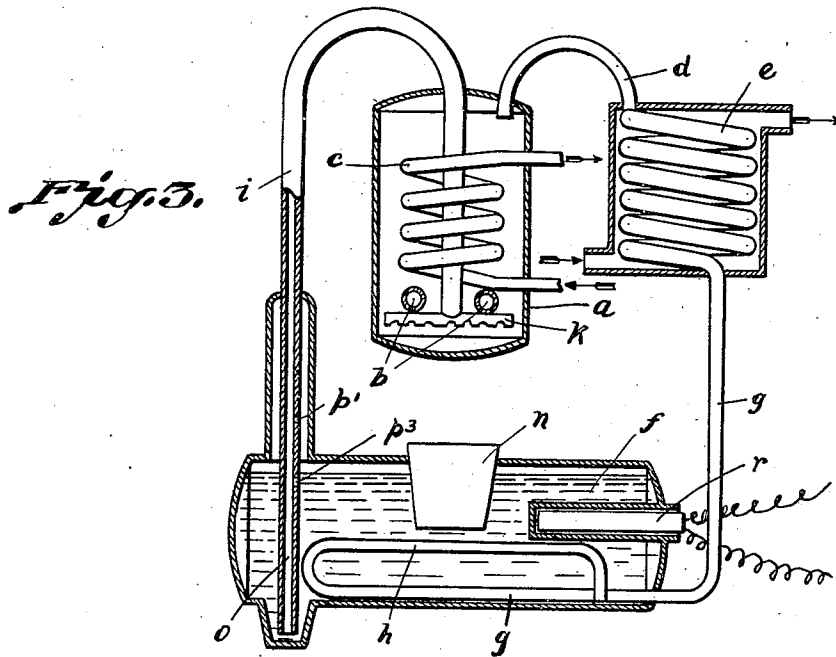
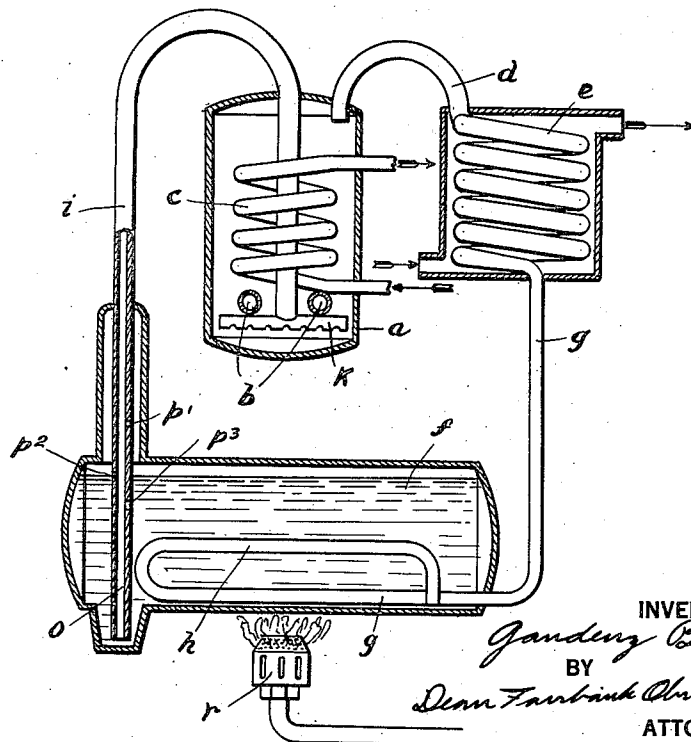


Fig. 4.



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REFRIGERATING APPARATUS.

Application filed May 12, 1926, Serial No. 108,560, and in Germany May 22, 1925.

This invention is an improvement in the apparatus shown in Patent 1,535,758, issued April 28th, 1925 to Gebruder Bayer. In said patent there is described and claimed an apparatus in which liquid which has passed over to the evaporator from the still-absorber during the heating period, may be returned to the still-absorber by the establishment of an abnormal pressure difference, and without the use of check valves, expansion valves, or other moving parts in the circuit. In said patent this is accomplished by connecting the evaporator and still-evaporator by conduits in which the cross-sectional areas of the ports are such in respect to each other that during the normal operation the pressure differences are such that only vapor of the refrigerant flows to the still-absorber from the evaporator, but by raising the pressure difference liquid from the lower part of the evaporator may be caused to flow to the still-absorber. The desired abnormal pressure difference for effecting this flow of liquid may be accomplished by an excessively rapid or low cooling of the still-absorber, or by a rapid or high heating of the evaporator. The patent proposes that the pressure increase be secured by the pouring of boiling water into a vessel contained in the evaporator. Thus, momentarily there is created an abnormally high pressure in the evaporator which cannot be immediately relieved through the gas outlet port, and which causes liquid to flow up the conduit from the bottom of the evaporator.

The object of the present invention is to provide means whereby the return of liquid from the evaporator is accomplished in an extremely simple manner and automatically following each heating period.

The four figures of the accompanying drawings illustrate, somewhat diagrammatically, four forms of an apparatus embodying the present invention.

The construction illustrated in Fig. 1 is similar in many respects to that shown in Fig. 4 of the patent above referred to. In this form there is provided a still-absorber *a* provided with a suitable heating device *b* and a cooling coil *c*. A pipe *d* serves to deliver the gaseous refrigerant from the still-absorber during the heating period to a condenser *e* in which the gas is cooled and changed to liquid form. The liquified refrigerant flows from the condenser to an

evaporator *f*, through a pipe *g* which terminates in a liquid seal *h*. During the cooling period the liquified refrigerant vaporizes in the evaporator, and the gas returns by a pipe *i* to the still-absorber. Preferably, this pipe terminates in a header *k* which is disposed below the liquid level in the still-absorber.

In accordance with the present invention the pipe *i* is provided with a plurality of ports in the wall thereof, and at different elevations in respect to the maximum liquid level in the evaporator.

In Fig. 1 there are illustrated two of these ports *p'* and *p³*. The port *p'* is so positioned that it is above the maximum liquid level in the evaporator, and the port *p³* is so positioned that it is slightly below this maximum level. The lower end part of the pipe *i* extends to the bottom of the evaporator, where it opens into a sump forming the lowest part of the evaporator chamber.

The conduits *g* and *i* are of the same relative cross-sectional areas as the corresponding pipes shown in said Patent 1,535,758, that is, the pipe *i* is materially larger than the pipe *g* so that return of the liquid may be accomplished without the use of valves.

In Fig. 1 there is shown a cell *n* into which boiling water may be poured if desired, for the purpose of producing a sudden and higher pressure difference between the evaporator and the still-absorber.

The construction shown in Fig. 2 is very similar to that shown in Fig. 1, except that the cell *n* is not illustrated and there are provided three of the ports or openings *p'*, *p²* and *p³*. The port *p²* is shown at approximately the normal liquid level which exists in the evaporator at the end of the heating period, but it will come below the liquid level if there has been an abnormal amount of water pass over with the gas during the preceding heating period.

The ports or openings *p'*, *p²* and *p³* are of considerably smaller area than is the single hole shown in Fig. 4 of the patent above referred to. As a result of the proper selection of the port areas, even with a low difference of pressure between the still-absorber and the evaporator, that is, upon a relatively slight cooling of the still-absorber or a relatively slight heating of the evaporator, the vapors which are produced in the evaporator cannot pass off by the very small uppermost

hole p' or even through the holes p' and p^2 if the latter be uncovered. As a result, liquid may pass up the pipe i even with comparatively small difference in pressure, until the liquid level in the evaporator has been lowered to the hole p^3 .

The uppermost hole p' is preferably arranged at such a height that it will never be covered by the liquid when the maximum quantity of condensate accumulates in the evaporator, which results at the lowest temperature of the condenser cooling water. The lowest hole p^3 is preferably arranged at such a height that it is below the level of the liquid when the amount of condensate accumulated at the end of a heating period is at the minimum, as for instance when the condenser cooling water is at the highest permissible temperature.

The holes p' and p^2 are fine bores, the total area of which is not sufficient to permit the necessary outflow of vapors produced during the beginning of the absorbing and cooling action. These holes p' and p^2 permit a sufficient drawing-off of the vapors that a normal cooling effect is produced during the beginning of the absorption or cooling period when the absorption is generally a rather rapid or violent one, and when the drop in temperature to be produced by the evaporation is at a maximum.

During the later phase of the cooling period the cooling effect in ordinary apparatus tends to become less effective, due to the reduction in the absorption capacity of the liquor in the still-absorber, and due to the lowering of the temperature around the evaporator to a point more nearly the same as that of the evaporator. In the present construction the effect is rendered more uniform and the cooling period is extended because the hole p^3 , that is, the lowest hole, is of such size that after it is uncovered by the liquid a considerably more intensive evaporation may take place, due to the larger total cross-sectional area of the uncovered gas outlet ports. The facility with which the liquid may be drawn back from the evaporator to the still-absorber, and automatically, is, however, the principal advantage of the apparatus.

In apparatus constructed in accordance with the patent above referred to, it was necessary to repeatedly pour boiling water into the heating vessel in the evaporator until the whole quantity of liquid had been passed from the evaporator to the still-absorber.

In the present construction considerably less heat need be employed in order to return all of the liquid. For instance, it is sufficient to heat the evaporator with an electric heating element, or by a gas flame in which the action of heat is more gradual than where boiling water is used. Instead of returning all of the liquid from the evaporator,

it is permissible with the present invention to return to the still-absorber only the lower layers of liquid in the evaporator. Most of the water in the evaporator will be in the lower portion thereof, due to the difference in specific gravity of the water and refrigerant. In case it is desired to return all of the liquid, it is evident that this may be done by establishing the desired high pressure difference between the evaporator and the absorber, as for instance, by repeatedly pouring boiling water into the cell n or by forcing very cold water through the pipe c of the still-absorber. It is only essential that the total areas of the holes p' and p^2 shall not exceed the area of the single hole employed in the construction shown in Patent 1,535,758.

The practical working of the new device may be effected by providing for five to ten minutes the flow through the cooling pipe c of the normal proportion of cooling water which was needed during the process of boiling, and after the apparatus has been switched over to cooling phase.

Thus, in the still absorber, there is produced a sufficiently low pressure which cannot be neutralized at once by vapor passing through the holes p' and p^2 , and as a consequence, liquid is returned from the evaporator until the hole p^3 is uncovered. In apparatus in which the switching over from boiling phase to cooling phase is performed automatically by suitable control mechanism, it is not necessary with the present invention to do anything other than to leave unaltered the rate of flow of cooling water for a short period, for instance, ten minutes after the boiling period has ended, the flow of water being merely switched over to the still.

Even if the automatic reduction of the quantity of cooling water for the cooling process is effected at the moment of shifting over from heating to cooling phase, still the areas of the holes p' and p^2 might be such that even the small quantity of cooling water which is used during the cooling period will produce the desired difference in pressure, whereby the outflow of gas cannot take place through the holes p' and p^2 , and a pressure difference will be effected which will cause the return of liquid to the still-absorber until the level of the hole p^3 is reached. Obviously, the dimensioning of the holes is not in any way dependent upon whether the shifting over from heating to cooling phase is effected automatically or manually. In the drawings there is shown only a single pipe i for the return of fluid from the evaporator to the still-absorber, but it will of course be evident that there may be employed an arrangement similar to that shown in Fig. 3 of Patent 1,535,758, in which a plurality of conduits are employed, one for each port in the evaporator.

In Figures 3 and 4 of the drawing I have shown the combination of the refrigerating apparatus with special heating means *r* for the evaporator Figure 3, showing heating by electric means, while Figure 4 shows heating by means of a burner *r*.

Having thus described my invention, what is claimed and desired to be secured by Letters Patent is:—

1. A refrigerating apparatus including a still-absorber, an evaporator, a condenser, and conduit means for delivering fluid from the evaporator to the still-absorber, said conduit means having a terminal portion at the lowest part of the evaporator and having a plurality of openings in the wall thereof, and at different elevations.

2. A refrigerating apparatus including a still-absorber, an evaporator, a condenser, and conduit means for delivering fluid from the evaporator to the still-absorber, said conduit means having a terminal portion at the lowest part of the evaporator and having a plurality of openings in the wall thereof, and at different elevations above said terminal portion, at least the lowest of said openings being disposed below the level of the liquid at the end of the heating period of the still-absorber.

3. A refrigerating apparatus including a still-absorber, an evaporator, a condenser, and conduit means for delivering fluid from the evaporator to the still-absorber, said conduit means having a terminal portion at the lowest portion of the evaporator and having a plurality of openings in the wall thereof, and at different elevations above said terminal portion, the lowest of said openings being disposed below the level of the liquid at the end of the heating period of the still-absorber, and the total cross-sectional area of the hole or holes above the liquid level in the evaporator at the end of the heating period being insufficient to permit the normal escape of gas from the evaporator during the beginning of the cooling period, whereby liquid from the lowest portion of said evaporator is forced from the latter through said conduit means.

4. A refrigerating apparatus including a still-absorber, an evaporator, a condenser, and conduit means for delivering fluid from the evaporator to the still-absorber, said conduit means having a terminal portion at the lowest portion of the evaporator and having a plurality of openings in the wall thereof, and at different elevations above said terminal portion, the lowest of said openings being disposed below the level of the liquid at the end of the heating period of the still-absorber, the total cross-sectional area of the hole or holes above liquid level at the end of the heating period being less than the total cross-sectional area of the hole or holes below said level.

5. A refrigerating apparatus including a still-absorber, an evaporator, a condenser, conduit means for delivering fluid from the evaporator to the still-absorber, said conduit means having a terminal portion at the lowest portion of the evaporator, and having a plurality of openings in the wall thereof, and at different elevations above said terminal portion, and means for producing a sudden rise of pressure within the evaporator.

6. A refrigerating apparatus including a still-absorber, an evaporator, a condenser, conduit means for delivering fluid from the evaporator to the still-absorber, said conduit means having a terminal portion at the lowest portion of the evaporator, and having a plurality of openings in the wall thereof, and at different elevations above said terminal portion, and a vessel in heat conducting relationship with the evaporator and adapted to receive a heating liquid for producing a sudden rise of pressure within the evaporator.

7. A refrigerating apparatus including a still-absorber, an evaporator, a condenser, conduit means for delivering fluid from the evaporator to the still-absorber, said conduit means having a terminal portion at the lowest portion of the evaporator and having a plurality of openings in the wall thereof, and at different elevations above said terminal portion, and heating means for the evaporator to thereby effect an abnormal rise in pressure in the evaporator and the return of liquid from the latter through said conduit means to the still-absorber.

8. The method of effecting the return of liquid from an evaporator to an absorber, which consists in varying the area of the gas outlet ports of the evaporator in accordance with the liquid level therein, whereby at high liquid level pressures are developed in the evaporator resulting in the forcing of liquid from the latter.

9. An evaporator for refrigerating apparatus of the intermittently operating absorption type, having an evaporation chamber, means for delivering liquefied refrigerant to the bottom thereof, and an open ended outlet conduit leading from the bottom of said chamber and having a plurality of openings in its wall within said chamber above the lower end of said conduit and of different areas, the lowest of said openings being of the largest area and one or more of said openings being disposed below the normal high liquid level in said still absorber.

10. An evaporator having a conduit for the delivery of gas from the top in the normal operation and liquid from the lower part under abnormal conditions, said conduit having a plurality of apertures in the wall thereof of different cross-sectional areas, and above the lower end of said conduit, one of said openings being disposed below the high liquid level in said still

absorber under normal operating conditions.

11. The method of operating a refrigerating apparatus of the intermittently acting absorption type, which method consists in providing the evaporator with a gas outlet of restricted area to permit gas escape under normal operating conditions, and a lower level liquid outlet, both outlets delivering to

the still absorber, and abnormally cooling the still absorber for a short period following the end of the heating period whereby an abnormal difference in pressure between the still absorber and the evaporator is effected and liquid is sucked from the evaporator.

In testimony whereof I affix my signature.

GAUDENZ BAYER.