C. CORTESI, E. PRASSONE, E. ERANI & A. CONTIN.

REFRIGERATING APPARATUS.

APPLICATION FILED FEB. 2, 1915.

1,237,303.

Patented Aug. 21, 1917.

2 SHEETS—SHEET 1.

Fig. 1.

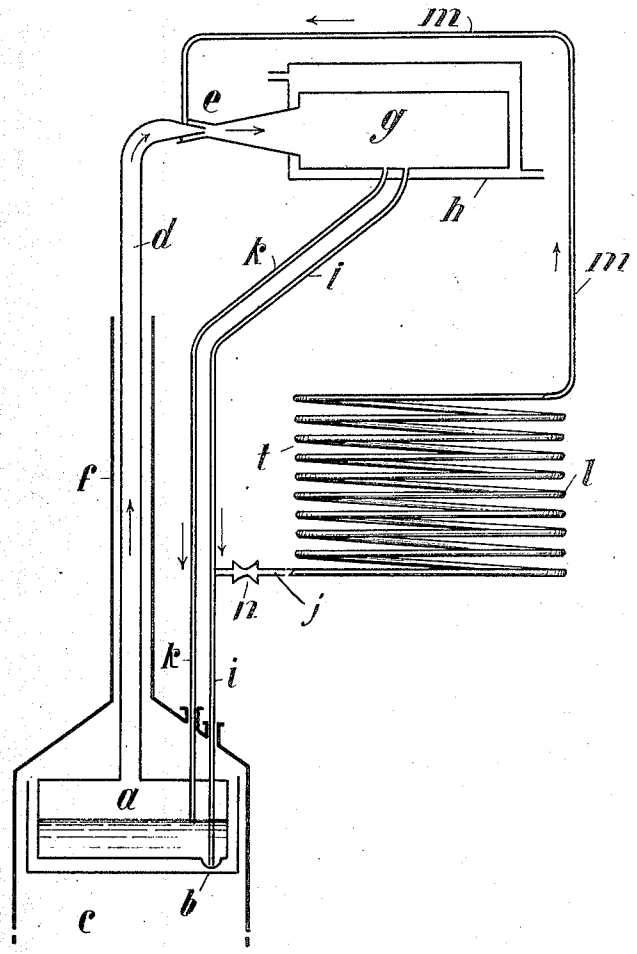

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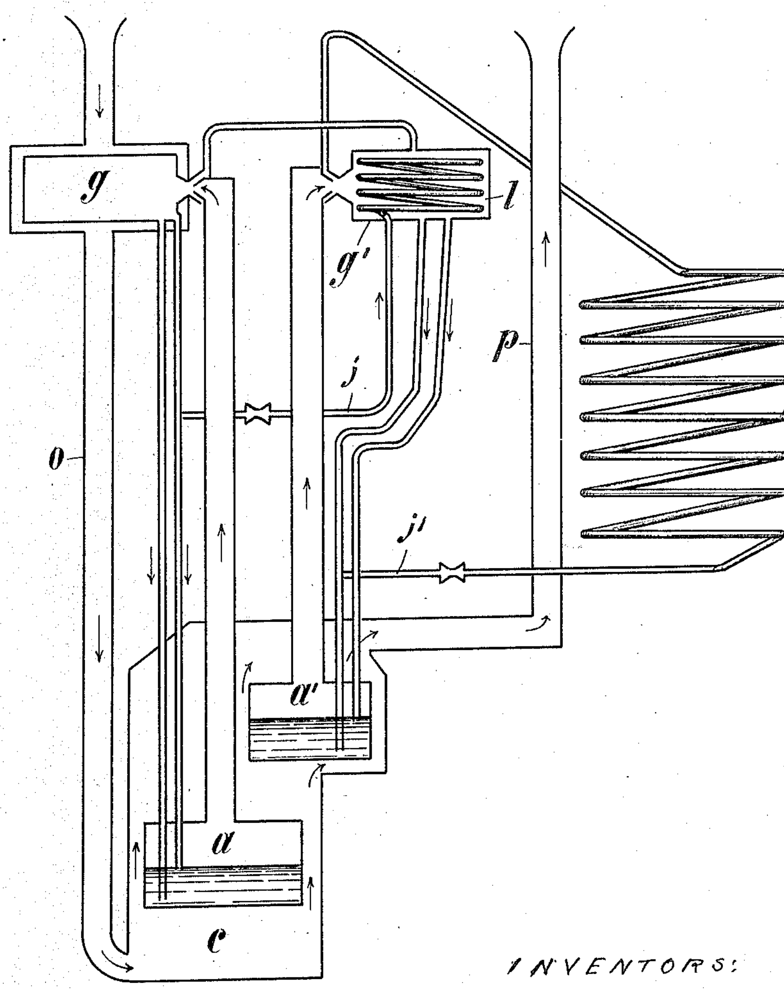
Fig. 2.



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REFRIGERATING APPARATUS.

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To all whom it may concern:

Be it known that we, CESARE CORTESI, EUGENIO PRASSONE, ERNESTO ERANI, and ANGELO CONTIN, all subjects of the King of Italy, and residing at Rome, in the Kingdom of Italy, have invented certain new and useful Improvements in Refrigerating Apparatus, of which the following is a specification.

The present invention refers to improvements in refrigerating processes and apparatus for the production of low temperatures, of the kind in which a certain quantity of fluid circulates continuously and changes its state by being evaporated in a boiler and in a cooler or refrigerator without communicating with the exterior, and by being liquefied in the condenser. The continuity of the process is secured by means of a heating apparatus and a current of cooling medium respectively supplying and carrying away heat from the circulating fluid.

The characteristic feature of the present invention is that the general circulation of the fluid comprises two distinct stream loops which have a portion of their course in common. Starting from the point where the two currents branch off, and proceeding in one direction, the first loop is formed by a current of liquid which by gravity is fed into the boiler and from this rises in the form of vapor up to an injector, where the common portion of the two stream loops begins. The vapor coming from the boiler forms a jet which draws into the condenser the exhaust of the cooler. Both vapors become liquefied in the condenser and by gravity reach the branching point where the two currents separate again. The second stream loop comprises the current of liquid which starts from the branching point, reaches the expansion coil where it evaporates under the action of the ejector, which produces a vacuum, and thus the temperature of the fluid is lowered. The exhaust vapor from the expansion coil reaches the injector and is forced again into the condenser as already mentioned. Thus it will be seen that the two loops begin both in the form of a current of liquid moving by gravity, a portion of which reaches the boiler where it evaporates and its vapor acts as driving medium in an ejector, while the residual current evaporates in an expansion coil and its vapor is by the said injector forced into the condenser where both vapors get mixed and liquefied and the cycle begins again. Then it will be understood of course that the injector and the condenser are placed at such a height as to enable the return of the liquid into the boiler by gravity alone, thereby overcoming the pressure of the vapor produced in same.

The combination of two or more apparatus of this kind, in such a manner that the cooler of one of them keeps low the temperature in the condenser of the following one, permits of obtaining in practice a temperature as low as it may be required.

It will be understood that the arrangement of the apparatus according to the present invention obviates the necessity of providing the subsidiary apparatus usually needed for controlling the travel of the liquid, such as valves, or other devices, with movable parts, requiring continuous attendance.

In the annexed drawing are diagrammatically shown in Figure 1 a refrigerating apparatus with a cycle of the kind above mentioned, and in Fig. 2 a refrigerating apparatus comprising two cycles connected in series.

The refrigerating apparatus for the application of the simple cycle according to the present invention substantially comprises three parts, namely the boiler, the condenser and the cooler, all of which communicate permanently with each other and constitute a hermetically closed unit, within which, by heating the boiler and by keeping the condenser at a constant low temperature, takes place a continuous circulation of the medium the state of which during the circulation successively undergoes variations from liquid to vapor and conversely in such a manner, however, that a constant evaporation at low temperature takes place in the cooler.

In Fig. 1 *a* is the boiler, which may also be heated in a water or oil bath, or the like. The said boiler is heated by the furnace —*c*—, in which may be burnt a solid, liquid or gaseous fuel, or recourse may be had to electrical heating. From the boiler there runs upward a pipe —*d*— having a large diameter and designed to convey the vapor to the ejector, —*e*—. This pipe may be protected against heat losses by a layer of heat-insulating material, or surrounded by

a current of hot gases (combustion gases) &c., which rise along a concentric pipe —*f*— which in turn may be also protected against heat losses. The vapor passing through the ejector reaches the condenser —*g*— inclosed in a vessel —*h*—, within which circulates the cooling medium. Owing to the low temperature maintained in the condenser the vapor is converted into liquid and collected on the bottom of the condenser, and by gravity it again descends in the boiler along two pipes —*k*—*i*—. These two pipes end inside the boiler, the first of them a little below the free surface of the liquid in the normal conditions of circulation, while the other extends down to the bottom of the boiler for the reasons explained hereinafter.

The pipe —*k*— leads from the condenser directly to the boiler without any other communication. From the pipe —*i*— starts a branch —*j*— which leads to the coil —*l*— of the cooler or refrigerator —*t*—. From the other end of the coil starts a pipe —*m*— which terminates at the ejector —*e*—.

The sucking action of the ejector causes a permanent rarefaction in the coil *l* of the cooler —*t*—, in which flows a portion of the liquid descending from the condenser through the pipe —*i*—. The portion of said liquid which must be diverted to the coil is regulated by an opening —*n*—, the size of which is fixed by the builder of the apparatus, so that the user need not change same. Owing to the action of the injector the liquid evaporates and produces a low temperature.

The vapors developed from said liquid, after having been sucked by the ejector, mix up with the vapor reaching it from the boiler and liquefy in the condenser, whereupon they again start circulating.

It is understood that any liquid, from the least to the most volatile, such as water, ethers, alcohols, chloroform, carbon sulfid, tetrachlorid of carbon &c., may be used, it being only necessary to regulate the sucking capacity of the ejector —*e*— in relation to the pressure required in the cooler in order to obtain the temperature desired. This pressure for a given temperature of the cooler depends of course upon the nature of the liquid employed.

For instance if when using chloroform it is desired to have in the cooler the temperature of — 20°, by keeping the condenser at +10°, it will be easy to determine the pressure required in the boiler according to the efficiency of the ejector, and, consequently, the height of the liquid columns —*k*— and —*i*—, which are sufficient to overcome the said pressure. If for any reason the pressure should increase in the boiler so as to surpass the value corresponding to the height of the liquid column in the pipes —*k*—*i*—, the liquid could not descend any more from the condenser into the boiler, but, on the contrary, it would be blown back from the latter into the condenser. However, in this case it will easily be understood that, as soon as the lower opening of the pipe —*k*— becomes uncovered, the vapors of the boiler will flow into the condenser and thus reëstablish the equilibrium. Since the apparatus consists of a completely hermetically closed system, the best result will be obtained by exhausting the air contained therein. By doing so not only is the pressure diminished, but also the boiling temperature of the liquid, and consequently the height of the columns —*k*— and —*i*— is shortened.

In the case of chloroform being employed, the said height amounts to about 2.50 m. and the temperature in the boiler to about 50°.

With a less volatile liquid said height is still further reduced; the contrary takes place with more volatile liquids. It is also possible to use mixtures of liquids, such as water and alcohol, &c. The liquids selected to suit the particular purposes aimed at, and the construction of the apparatus may be modified for the different uses of the machine, as will be explained hereinafter.

One of the difficulties that sometimes are met with in refrigerating machines is the scarcity or lack of water or the fact that the available water is of too high a temperature.

In Fig. 2 is illustrated a machine in which two cycles identical with those already described are coupled in series in such a manner as to enable the machine to work with a high temperature in the condenser. In this case as the cooling fluid, water may be used either in a small quantity, if it has a low temperature, or in greater quantities if at a high temperature, or air may be used in place of water.

The first cycle is performed in the boiler —*a*— (Fig. 2), in the condenser —*g*— and in the cooler —*l*—; and is practically identical with the cycle of Fig. 1. The second cycle is carried out in the boiler —a^1— and in the cooler —l^1—. The condenser —g^1— surrounds the cooler —*l*— of the first cycle and is influenced by the low temperature of same.

By establishing, for instance, for the first cycle a temperature of +10° in the cooler and of +50° in the condenser, the second cycle will work with the temperature of +10° around the condenser. It ensues that the cooling action is to be carried out in the condenser —*g*— the temperature of which being as high as 50° C. will allow of carrying away large quantities of heat even when the water available has a temperature higher than 10° C.

It is obvious that in plants of this kind the steam leaving the still may be caused

to condense around the boilers feeding the second cooling cycle which require a low temperature,—that is, may be employed as heating medium for the boiler a^1 of Fig. 2 instead of the hot air, as shown on the drawing thus utilizing the heat of condensation. When using air, the same, since it is already heated, may be drawn into the furnace, thus utilizing a heat which is generally wasted. In Fig. 2 is shown the condenser on the path of a descending cold air column which, passing through the pipe —*o*—, feeds the furnace. Moreover since in the second cycle the liquid in the boiler —a^1— is boiling at a temperature that is lower than that of the liquid contained in the boiler —*a*—, instead of employing a separate furnace for heating the boiler —a^1—, for this purpose there may be used the heating gases escaping from the furnace —*c*— which exhaust through the pipe —*p*—.

This machine is an improvement upon refrigerating machines existing hitherto in every respect without any exception. Furthermore the low temperature of the boiler permits of by-products of combustion, or exhaust vapors of other machines being used for the heating. In this way with a minimum of expense it will be possible to cool railway cars conveying foodstuffs, or to cool trains, making use to that end of the exhaust steam of the locomotive. Since there are no essential movable parts, any supervision is unnecessary, and this permits of the system being employed directly and in a great number of cases for small cooling cells designed for scientific or domestic use, and for small industries; it may also be employed for cooling dwelling-places having recourse to the radiators already generally in use for hot water heating. It will be understood that in this latter case all that is to be done is to provide a cooler in the upper part of the building and to cause a cooling fluid to circulate in the radiators.

By the combination of several cycles in such a way that the cooler of the one forms the condenser of the successive one, the lowest temperatures are obtained, these machines being of the greatest simplicity and capable of producing the same effects as the most complicated plants (such as are used for the production of liquid air, separation of oxygen, preparation of hydrogen and the like).

An example of the combination of two cycles to this end is that represented in Fig. 2, when it is supposed that the temperature be already low in the first condenser —*g*—.

Having thus described our said invention what we claim is:

1. In a refrigerating apparatus utilizing a circulating fluid, the combination comprising a boiler, means for supplying heat to said boiler, an expansion coil, a condenser, a conduit adapted to convey vapor from said boiler to said condenser, an injector in said conduit, a return connection between said condenser and said boiler, a connection between the boiler and the expansion coil, and a connection between the expansion coil and the injector whereby vapor passing from the boiler through said injector induces the flow of fluid from said expansion coil into said condenser.

2. In a refrigerating apparatus utilizing a circulating fluid, the combination comprising a boiler, an expansion coil, a condenser located at a higher level than the boiler, a conduit adapted to convey vapor from said boiler to said condenser, an injector in said conduit, a return connection to permit the fluid to flow by gravity from said condenser to said boiler, a connection between the boiler and the expansion coil, and a connection between the expansion coil and the injector whereby the vapor passing from the boiler through said injector induces the flow of fluid from said expansion coil into said condenser.

3. In a refrigerating apparatus utilizing a circulating fluid, the combination comprising a boiler, means for supplying heat to said boiler, an expansion coil, a condenser, a conduit adapted to convey vapor from said boiler to said condenser, an injector in said conduit, a return connection between said condenser and said boiler opening a little below the level of the liquid in said boiler, a second connection between said condenser and said boiler extending substantially to the bottom of the boiler, a connection between said second connection and the expansion coil, and a connection between the expansion coil and the injector whereby vapor passing from the boiler through said injector induces the flow of fluid from said expansion coil into said condenser.

4. In a refrigerating apparatus utilizing a circulating fluid, the combination comprising a plurality of apparatus each comprising a boiler, means for supplying heat to said boiler, an expansion coil, a condenser, a conduit adapted to convey vapor from said boiler to said condenser, an injector in said conduit, a return connection between said condenser and said boiler, a connection between the boiler and the expansion coil, and a connection between the expansion coil and the injector whereby the vapor passing from the boiler through said injector induces the flow of fluid from said expansion coil into said condenser, the expansion coil of each of said apparatus except the last being located in the condenser of the succeeding apparatus.

5. In a refrigerating apparatus utilizing a circulating fluid, the combination comprising a boiler, an expansion coil, a condenser, a conduit adapted to convey vapor

from said boiler to said condenser, an injector in said conduit, a return connection between said condenser and said boiler, a connection between the boiler and the expansion coil, and a connection between the expansion coil and the injector whereby the vapor passing from the boiler through said injector induces the flow of fluid from said expansion coil into said condenser, the expansion coil of each of said apparatus except the last being located in the condenser of the succeeding apparatus, and a single heating means arranged to act on all the boilers of the series.

6. In a refrigerating apparatus utilizing a circulating fluid, the combination comprising a boiler, means for supplying heat to said boiler, an expansion coil, a condenser, a conduit adapted to convey vapor from said boiler to said condenser, an injector in said conduit, a return connection between said condenser and said boiler, a connection between the boiler and the expansion coil, a connection between the expansion coil and the injector whereby the vapor passing from the boiler through said injector induces the flow of fluid from said expansion coil into said condenser, and a conduit arranged to lead air around said condenser and into the boiler heating means.

In testimony whereof we affix our signatures in presence of two witnesses.

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Witnesses:
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