Dec. 3, 1929. F. O. CONILL 1,738,233

REFRIGERATION

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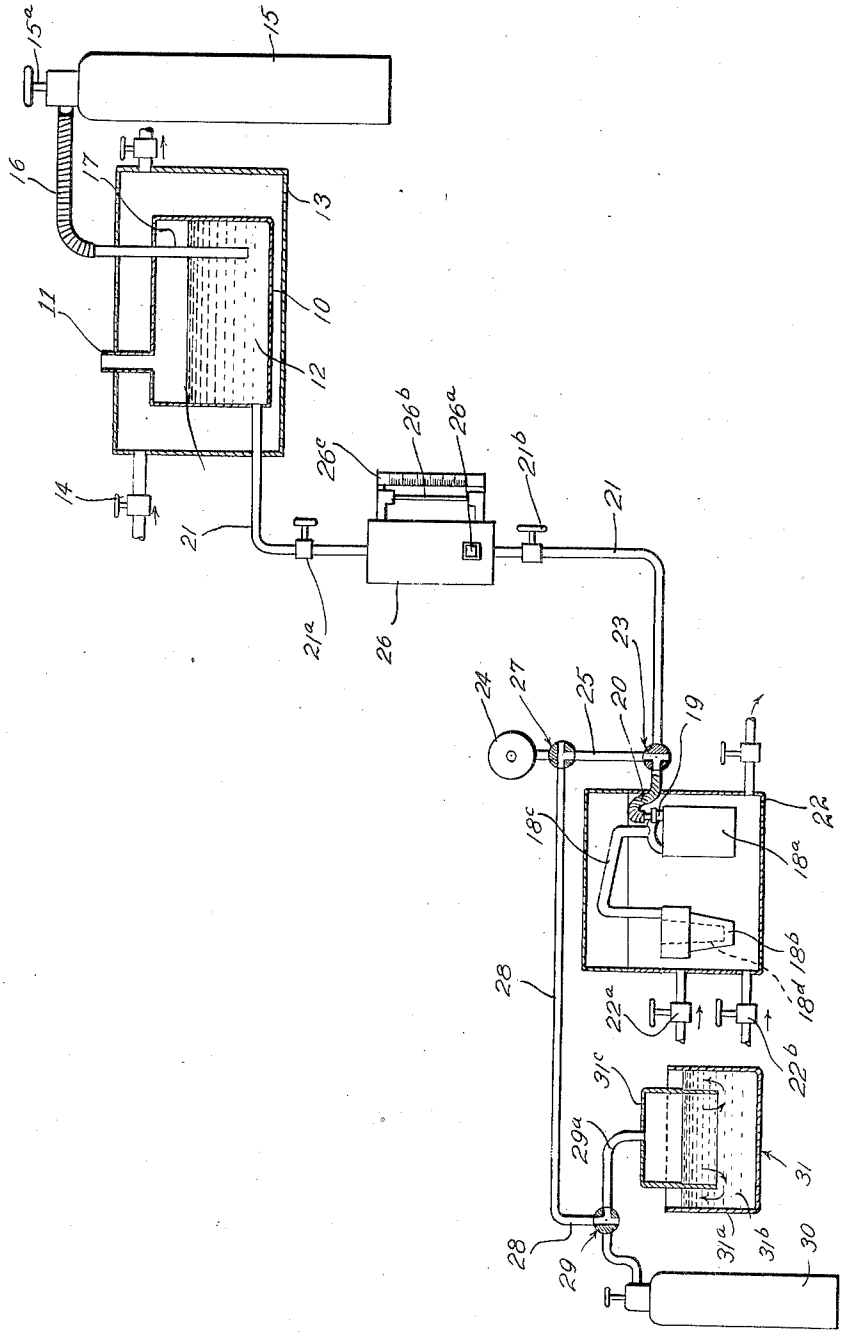

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REFRIGERATION

Application filed January 16, 1923. Serial No. 612,886.

This invention relates to refrigeration and more particularly to an art and apparatus for preparing refrigerating apparatus for practical use.

One of the objects of this invention is to provide a simple and practical refrigerating apparatus of highly efficient and effective action. Another object of this invention is to provide a practical art and apparatus for preparing the refrigerating apparatus for efficient practical use and action and more particularly for preparing, and filling the apparatus with, the active solution. Another object is to provide an art of the above character which may be readily carried out in practice, and more particularly one which is well adapted for carrying on commercially on a large scale. Other objects will be in part obvious or in part pointed out hereinafter.

The invention accordingly consists in the features of construction, combinations of elements, arrangements of parts, and in the several steps and relation and order of each of the same to one or more of the others, all as will be illustratively described herein, and the scope of the application of which will be indicated in the following claims.

In the accompanying drawing there is shown diagrammatically one of various possible embodiments of the mechanical features of this invention.

As conducive to a clearer understanding of this invention, it might be noted at this point that this invention deals more particularly with refrigerating apparatus in general of the character such as that disclosed in my co-pending application Serial No. 612,888 filed January 16, 1923, and which includes principally two receptacles in communication with one another, one of which is adapted to receive therein a suitable liquid having dissolved therein a liquefiable gas. This liquid or solution in the one receptacle is, in the practical operation of the apparatus, heated to drive the gas out of solution and into the other receptacle where the gas is liquefied. This latter receptacle has associated with it a suitable refrigerating chamber in thermal contact with the liquefied gas, which, upon the cessation of the heating of the liquid in the other receptacle, begins to evaporate and in so doing obtains its heat of evaporation from the refrigerating chamber and producing therein the cooling or refrigerating action. One of the dominant aims of this invention is to provide an art and apparatus for preparing refrigerating apparatus of this character for practical operation, and with the above understanding it might be noted further that various liquids or solvents and various gases acting therewith may be employed. In the ensuing description, however, it will be assumed that the liquid solvent employed is water and that the gas dissolved therein and acting therewith is ammonia; but it will be understood that water and ammonia are hereinafter employed illustratively and that many of the features of this invention are applicable to other solvents and gases. It may further be noted, however, that the preferred embodiment of my invention includes water as the solvent and ammonia as the soluble gas.

Referring now to the drawing, there is shown at 10 a container or tank which may be supplied as by the vent 11 with the liquid solvent indicated at 12. The container 10 is preferably jacketed as at 13, the jacket 13 being connected as by the conduit 14 with any suitable source of cooling or refrigerating brine. A gas container 15 provided with a valve 15^a is connected to the container 10 as by the conduit 16, a pipe 17 in connection with the conduit 16 extending into the container or tank 10 with its discharge end well below the upper level of the liquid solvent 12. As hereinabove set forth, the liquid solvent 12 is preferably water.

The water 12 employed is preferably distilled water in order to free it from impurities, and may be distilled in any suitable manner. A quantity of potassium bichromate is added to the water, and there is also dissolved in the water a quantity of calcium chloride for purposes hereinafter set forth. At this point it may be noted, however, that the potassium bichromate is

preferably added in the proportion of two grams for each liter of water. The calcium chloride is added to materially raise the boiling point of the resultant solution and preferably in sufficient quantity to raise the boiling point to approximately 180° C. After such an addition has been made, the solution may be agitated to hasten the dissolving of the salt in the water, after which the resultant solution is filtered in any suitable manner and introduced into the container 10. Through the conduit 14 there is then introduced cooling brine to maintain the solution 12 at a relatively low temperature, preferably in the neighborhood of −15° C., the calcium chloride in the solution 12 acting to lower the freezing point sufficiently to prevent freezing from taking place.

The valve 15ª is thereupon turned on to permit the ammonia gas from the container 15 to flow through the conduit 16 and the pipe 17 into the solution 12, by which it is dissolved. The water as treated above is found to have a much greater capacity for absorbing the ammonia gas than pure water alone and the flow of ammonia is maintained until the solution 12 is saturated therewith. The solution 12 thus prepared and thus saturated with ammonia is thereupon ready for introduction into the refrigerating apparatus and may thereupon be distributed to the refrigerating apparatus to be charged therewith.

Before such distribution, however, takes place, the temperature of the solution 12 is raised in order that there may be effective at the free surface of the solution a slight pressure due to the ammonia gas tending to come out of solution not only thereby to prevent the occlusion of air by the solution but also for another purpose to be more clearly described hereinafter. The temperature may be raised in any suitable manner as by cutting off the flow of brine through the jacket 13, and preferably the temperature is raised to about 0° C.

One of the refrigerating apparatuses hereinbefore briefly described is indicated generally at 18, and it will be noted that it includes a receptacle 18ª which is adapted to receive and contain the liquid with the liquefiable gas dissolved therein, and another receptacle 18ᵇ connected with the first receptacle as by the conduit 18ᶜ. The two receptacles are in practice sealed and the receptacle 18ᵇ is provided with a refrigerating chamber 18ᵈ, preferably wholly enclosed within the receptacle 18ᵇ and adapted to be surrounded by the gas which is liquefied in the receptacle 18ᵇ upon the heating of the solution in the receptacle 18ª to drive the gas out of solution and into the receptacle 18ᵇ to be liquefied therein. As to the details of construction of this refrigerating apparatus, which, it is to be understood, is merely diagrammatically illustrated in the drawing, reference may be had to my above-mentioned co-pending application, and it is, moreover, to be understood that the apparatus shown in the drawing is representative of one of the refrigerating apparatuses of this general type and which it is intended to charge for preparing it for practical use.

The receptacle 18ª of the refrigerating apparatus 18 is provided with a filling valve or vent 19, preferably taking the form of that shown in my above-mentioned co-pending application, and to this filling vent 19 is connected as by the flexible tube or conduit 20 a main conduit 21 leading to the container 10 hereinbefore described. The refrigerating apparatus is immersed in a tank or container 22 adapted to be connected as by the conduit 22ª to a suitable source of heat, such as, for example, to a steam supply, by means of which the apparatus 18 may be heated in order to drive off air that may adhere to the interior walls thereof or that may be occluded by the substance of the walls themselves. In the conduit 21 is inserted a two-way valve 23 adapted in one position to close the conduit 21 against the flow of solution therein and to the receptacle 18ª and to connect to the flexible conduit 20 and hence to the apparatus 18 an air-pump 24, as by means of the conduit 25. The air-pump 24 thus acts to remove the air from the interior of the apparatus 18 and after exhausting the air from the apparatus to a sufficient degree to reduce the pressure therein to about from 0.5 to 5 mm. of mercury, the steam supply to the jacket 22 is cut off and the jacket thereupon supplied with cooling brine as by the conduit 22ᵇ. The temperature of the apparatus is in this manner reduced to about −20° C. and it may at this point be noted that this temperature is below that at which the prepared solution 12 in the container 10 hereinbefore described is maintained. The two-way valve 23 is thereupon positioned to cut off the air-exhausting pump 24 and to connect to the flexible conduit 20, and hence to the receptacle 18ª of the refrigerating apparatus, the conduit 21 which, as above noted, leads to the container 10. The apparatus 18 is thereupon ready to be charged with the required amount of prepared solution.

In the conduit 21 is inserted a measuring device for predetermining the quantity of prepared solution with which the particular apparatus 18 is to be charged. This measuring device may take the form of a container 26 connected at its upper end with that portion of the conduit 21 leading to the tank or container 10, a valve 21ª being inserted to control the admission of the prepared solution to the measuring device 26. The lower end of the container 26 is connected to that portion of the conduit 21 leading to the ap-

paratus being charged, and a valve 21b is adapted to control the flow of the solution to the apparatus being charged. At a convenient point in the side wall of the measuring apparatus 26, which may conveniently be of cylindrical form, I prefer to insert a glass window 26a in order that the action within the container 26 may be readily observed. A glass gauge 26b is connected to the container 26 in order that the level of the solution therein may be at all times indicated, and associated with this glass gauge 26b is preferably a scale 26c suitably graduated in order directly to indicate the volume or quantity of solution within the measuring container 26.

The solution 12 having been prepared in the container 10 as hereinbefore described, the valve 21b is closed and the valve 21a opened to permit the flow of a quantity of the solution 12 into the container 26. The flow is allowed to continue until the height indicated by the glass gauge 26b and by the associated scale 26c corresponds to the volume or quantity of solution intended to be passed into the particular refrigerating apparatus 18. For this purpose the scale 26c may conveniently be graduated to read directly in liters, for example, since the quantity of solution with which the apparatus 18 is to be charged may vary, as will be readily understood, in accordance with the size or intended refrigerating capacity of the apparatus 18 itself.

The required amount of solution having been passed into the measuring device 26, the valve 21a is closed to cut off the flow of the solution from the main tank, and the valve 21b is thereupon opened, it being understood, of course, as hereinbefore described, that the two-way valve 23 is first positioned to cut off the air-exhausting pump 24 and to connect the apparatus 18 directly to the conduit 21. The pressure within the apparatus 18 having been materially reduced by the pump 24, as above described, the flow of the measured quantity of solution at once takes place from the measuring device 26 and into the receptacle 18a of the refrigerating apparatus 18, after which the valve 21b may be closed to place the apparatus in condition for subsequent operation.

At this point it should be noted that during the charging of the apparatus 18 with a predetermined quantity of solution the temperature of the apparatus 18 is maintained in proximity to −20° C., and that the temperature of the solution 12, after its preparation as hereinbefore described, has been brought to about 0° C. This difference in pressure insures the maintenance of a gas pressure at the free surface of the solution with which the apparatus 18 is being charged, which pressure is greater than that inside the apparatus 18, thus insuring the space within the apparatus 18 not occupied by the quantity of solution with which it is supplied being charged with gas coming out of solution and thus minimizing the danger of including within this space undesired residual quantities of air.

In the conduit 25 leading to the air-pump 24 is inserted a two-way valve 27 through which the conduit 25 is connected to a conduit 28 in the end of which is a two-way valve 29 adapted to connect the conduit 28 either to an ammonia gas container 30 or to a testing apparatus, generally indicated at 31, and to be more clearly hereinafter described. The two-way valve 27 is thereupon positioned to cut off the air-pump 24 and to connect the conduit 28 to the conduit 25, and the two-way valve 23 is then positioned to connect the conduit 25 to the apparatus 18 through the flexible conduit 20. The valve 29 is then positioned to connect the gas container 30 to the conduit 28, whereupon an excess amount of ammonia gas is permitted to flow into the apparatus 18. The flow is allowed to continue until a substantial pressure is set up within the apparatus 18, the ammonia gas thus introduced being in part absorbed by the solution already introduced into the receptacle 18a thus to compensate for whatever losses may have been incurred, and also to mingle with whatever residual air may have remained within the apparatus 18.

The valve 29 is thereupon positioned to disconnect the gas holder 30 and to connect the conduit 28 to the testing apparatus 31. The latter comprises a receptacle 31a containing water, indicated at 31b, and in any suitable manner there is supported in inverted position a vessel 31c having its open end submerged in the water 31b and having a connection with the conduit 29a leading to the valve 29.

The excess ammonia thus introduced into the apparatus 18 and placed therein under a substantial pressure is allowed to escape into the inverted vessel 31c and carries with it as it escapes the residual air from the apparatus 18. The ammonia is absorbed in the water 31b, whereas the residual air carried with it escapes to the atmosphere in the path indicated by the arrows *a*, and in so doing produces visible bubbles. The escaping mixture of gas and residual air is allowed to continue until the cessation of bubbles takes place, which indicates that the residual air has been removed and that only ammonia gas is passing out of the apparatus 18, the ammonia producing no bubbles since it is dissolved in the water 31b.

At this point the valve 29a is then positioned to cut off both the testing apparatus and the gas holder 30; and the valve 23 is then positioned to cut off the conduit 20. The filling vent 19 is thereupon closed and sealed, preferably in the manner described

in my above-mentioned co-pending application. The refrigerating apparatus 18 thus charged is thereupon ready for practical operation.

It will be understood that the devices and apparatus hereinabove described as connected to the tank or reservoir 10 may represent only one of several of such devices and apparatuses similarly connected to this reservoir or tank in order to make possible the charging of a plurality of refrigerating apparatus at the same time. For the sake of simplicity of illustration, however, only one set of such devices and apparatuses is illustrated in the drawings.

The refrigerating apparatus thus charged is found in practice to operate at high efficiency, and it may be noted that a contributing factor to this high efficiency of operation is the provision hereinabove described for insuring the exclusion or the entire removal of residual air from the interior of the apparatus. Also, in charging the solution with potassium bichromate and with calcium chloride, the solvent is found to dissolve or absorb greater quantities of the gas, thus insuring an efficient initial charging of the apparatus. Moreover, the potassium bichromate prevents the formation during the practical operation of the refrigerating apparatus, as briefly hereinbefore described, of insoluble gases whose effect would be as detrimental to the efficiency as the presence of an appreciable quantity of air. Another factor contributing to the high efficiency of operation resides in the fact that the calcium chloride raises the boiling point of the solution beyond that necessary to drive off the gas and to cause the latter to be liquefied in the refrigerating chamber of the apparatus. Thus, for example, the calcium chloride may be present in sufficient quantity to raise the boiling point of the solution to 180° C., whereas the temperature necessary to drive off the gas and cause its liquefaction may be in the neighborhood of 130° C. The vapor tension of the solution is thus decreased to such an extent that substantially no water vapor is present in the refrigerating apparatus during its operation and thus the deleterious effects on the efficiency of operation, similar to the undesirable effects of the presence of air, are effectively avoided.

It will thus be seen that there has been provided in this invention an art and apparatus in which the several objects hereinbefore set forth, as well as many advantages, are achieved. It will be seen that the art and apparatus provided for preparing, and charging the apparatus with, the solution adapt themselves readily for practical operation and particularly for such operation on a large or commercial scale; and it may further be noted that the invention makes possible a highly efficient refrigerating action.

As many possible embodiments may be made of the mechanical features of the above invention and as the art herein described might be varied in various parts, all without departing from the scope of the invention, it is to be understood that all matter herein set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

I claim as my invention:

1. The herein described art of filling refrigerating apparatus with a solution having dissolved therein a liquefiable gas, which consists in evacuating the apparatus to remove air therefrom, reducing the temperature of the apparatus below that of the prepared solution, and thereupon introducing into the apparatus a predetermined quantity of said solution.

2. The herein described art of charging refrigerating apparatus which consists in introducing a soluble gas into a liquid solvent to be dissolved thereby, reducing the temperature of the resultant solution, reducing the temperature of the refrigerating apparatus below that of the resultant solution, and introducing a predetermined quantity of said solution into the apparatus.

3. The herein described art of charging refrigerating apparatus which consists in introducing a soluble gas into a liquid solvent to be dissolved thereby, reducing the temperature of the resultant solution, heating said apparatus to drive off the air adhering to the walls thereof, evacuating the apparatus to remove the air therefrom, reducing the temperature of said apparatus, and thereupon introducing into the apparatus a predetermined quantity of said solution.

4. The herein described art of filling refrigerating apparatus with a solution having dissolved therein a liquefiable gas, which consists in introducing a predetermined quantity of said solution into the refrigerating apparatus, passing into said solution within said apparatus an additional amount of said gas, and permitting the excess gas with residual air to escape from said apparatus through an unsaturated liquid in which said gas is soluble.

5. In apparatus for filling refrigerating apparatus, in combination, a container adapted to receive a liquid having dissolved therein a liquefiable gas, means for heating the refrigerating apparatus to drive off air adhering to the walls thereof, air-exhausting means adapted to be connected to said refrigerating apparatus to remove air therefrom, and means for thereupon connecting said container to said refrigerating apparatus to permit the introduction of said solution from said container into said apparatus.

6. In apparatus for filling refrigerating apparatus, in combination, a container adapted to receive a liquid having dissolved therein a liquefiable gas, air-evacuating means adapted to be connected to the refrigerating apparatus to remove the air therefrom, means for reducing the temperature of the refrigerating apparatus, and means for connecting said container to said refrigerating apparatus to permit the introduction of said solution from said container into said apparatus.

7. In apparatus for filling refrigerating apparatus, in combination, a container for receiving a liquid having dissolved therein a liquefiable gas, air-exhausting means adapted to be connected to the refrigerating apparatus to remove air therefrom, means for reducing the temperature of the apparatus below that of the solution in said container, and means for connecting said container to said apparatus to permit the introduction of solution into the apparatus.

8. In apparatus for filling refrigerating apparatus, in combination, a container for receiving a liquid having dissolved therein a liquefiable gas, means for heating the refrigerating apparatus to drive off air adhering to the walls thereof, air-evacuating means adapted to be connected to the apparatus to remove air therefrom, means for reducing the temperature of said apparatus below that of the liquid solution in said container, and means for connecting said container to said apparatus to permit the introduction of solution into said apparatus.

In testimony whereof, I have signed my name to this specification this 5th day of January, 1923.

FERNAN O. CONILL.