Aug. 10, 1943.　　N. ERLAND AF KLEEN　　2,326,130

REFRIGERATOR

Filed July 22, 1939

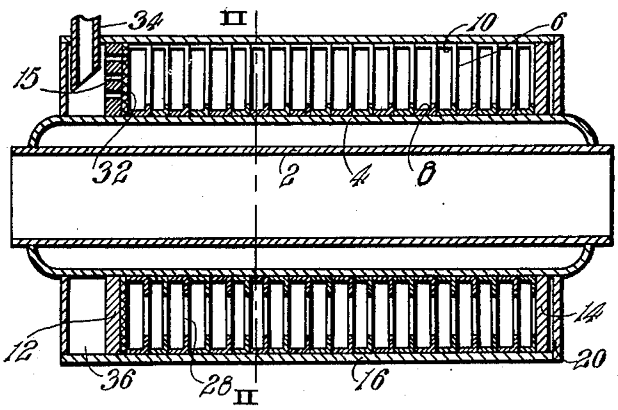


Fig.1.

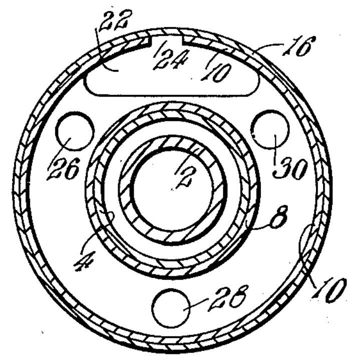


Fig.2.

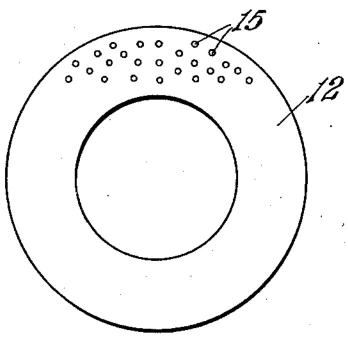


Fig.3.

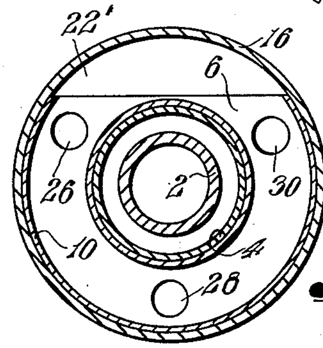
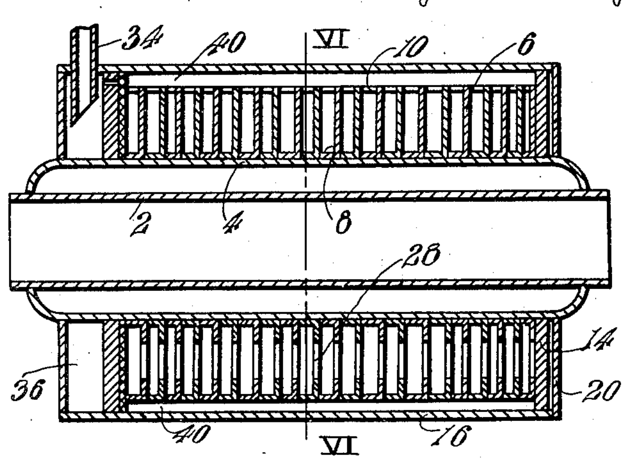
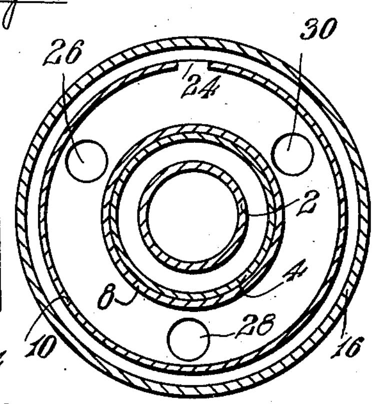


Fig.4.

Fig.5.　　Fig.6.





INVENTOR

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REFRIGERATOR

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23 Claims. (Cl. 62—179)

The present invention relates to boiler-absorbers or adsorbers intended for absorption or adsorption refrigerating apparatus and containing a dry salt or other solid substance capable of absorbing or adsorbing a gaseous cooling medium and of releasing the same when heated. The invention also comprises a method for filling such a boiler-absorber with salt. For the sake of simplicity, the expressions "absorption" and "absorber" are to be understood to include also "adsorption" and "adsorber," and "salt" is to be understood as a substance capable of absorbing a gaseous refrigerant and of releasing the same.

In the manufacture of boiler-absorbers of this type it is customary to fill the space reserved for the salt only about ⅓ full so that the salt is thus at liberty to swell up freely as it absorbs the refrigerating medium. Owing to this practise the boiler-absorbers are of large dimensions and the conduction of heat within the salt is very imperfect.

To remedy these drawbacks, it has been proposed to diminish the cubic volume of the boiler-absorber to such an extent that the salt, as it absorbs the refrigerating medium, is prevented from swelling to the full extent and so that, during the absorption period, it exerts a pressure on the walls of the boiler. At the same time, this pressure has been maintained comparatively low, because it was feared that too intense a compression would render it impossible for the gaseous refrigerating agent to penetrate into the salt. According to this earlier proposal, therefore, no compression at all is effected when the refrigerating medium has been expelled from the salt, which salt, in spite of its filling up the entire boiler, still retains a loose or porous texture, the result of which is that the heat is dissipated slowly as the boiler-absorber is cooled for the absorption of the refrigerating medium. The guiding principle of the selection of the dimensions of the boiler-absorber referred to has been that its cubic capacity should be equal to the combined volumes of the salt in its densest possible state, the refrigerating medium in its condensed form and such pores in the salt as are regarded as inevitable. The diminution of the boiler volume to such an extent as no longer to leave any space for pores has not been considered possible because the cooling medium would thereby be prevented from circulating.

The present invention goes a stage further in reducing the cubic capacity of the boiler-absorber whereby in addition to saving of material there is also gained the advantage of adequate heat conduction in all functioning phases and this implies a more rapidly and efficiently working boiler-absorber. I have found that it is possible, provided that the boiler-absorber is suitably constructed, to go beyond what was formerly considered to be the final and absolute limit for the boiler-absorber volume without impairing or lowering the absorption capacity of the boiler-absorber. The boiler-absorber of the present invention is, as a characteristic feature of same, filled with so much salt that, even after the refrigerating medium has been expelled, a pressure is still exerted on the salt whereby it is kept compressed within a volume smaller than that which it tends to occupy. The standpoint referred to above according to which the cubic contents of the boiler should be equal to the combined volumes of the salt, the cooling medium and the pores has proved to be fallacious, because, by my invention the volume of the boiler is reduced to less than the combined volumes of the salt deposited in its densest form and of the maximum quantity of absorbable refrigerating medium in either the solid or liquid form. Numerically, the filling charge can be estimated at 4–8 gram-molecules or more per litre of boiler-absorber volume. If the absorption medium consists of a halogen salt, the most advantageous filling charge is 5–6 gram-molecules per litre of boiler-absorber net volume.

The proportions of the boiler charge for various absorption media will now be explained in greater detail with the aid of several examples.

One kilogram molecule of strontium chloride ($SrCl_2$) weighs 159 kg. and in its densest form occupies a volume of 60 litres. According to the idea hitherto prevalent among technical experts a boiler-absorber volume of 436–486 litres is requisite for this quantity of salt. If we suppose that the operation is carried on with 5 kilogram molecules NH_3 in circulation, then it has been considered possible to reduce this volume to 336 litres. One kilogram molecule of $SrCl_2$ absorbs, for example, 8 kilogram molecules NH_3 which weigh 136 kg. and occupy in the liquid form a volume of 220 litres. The volume of the ammonia in the solid form is 176 litres. Thus the sum of the volumes of the salt and the ammonia is 280 litres when uncombined if the ammonia is in liquid form, or 236 litres if the ammonia is in solid form resulting in densities of the salt of 3.5 and 4.2 gram-molecules, respectively, per litre net volume of boiler-asborber. In accordance with the present invention, the cubic capacity of the boiler-absorber is made even less than the aforementioned volumes and may suitably be selected as 188 litres, thereby resulting in a density of 5.3 gram-molecules of salt per litre net volume of boiler-absorber. With a boiler-absorber having a net volume of 188 litres, of the 8 kilogram-molecules of ammonia weighing 136 kilograms and with 159 kilograms of $SrCl_2$, it is possible to maintain in circulation 7 kilograms of ammonia which weigh 119 kilograms without decomposing the ammonia.

On the other hand, in boiler-absorbers heretofore used, the net volume for one kilogram-molecule of $SrCl_2$ was 336 litres and, of the 8 kilogram-molecules of ammonia having a weight of 136 kilograms, it has not been possible to circuate more than five-sevenths of this amount, or 97.1 kilograms. Thus, for the same cooling effect, the volume of the boiler-absorber is, according to the present invention, reduced to

$$\frac{188.97.1}{336.119}$$

or 46% of what has heretofore been regarded as the minimum boiler-absorber net volume.

From the filling with $SrBr_2$ the same figures are obtained for the volumes. One kilogram molecule or 247.5 kg. has a volume of 60 litres and 8 kilogram molecules of NH_3 in solid form, have a volume of 176 litres. The boiler-absorber volume according to the invention is 236 litres at the utmost and may be appropriately 188 litres, whereas it was formerly assumed that over and above the volume of 236 litres it was necessary to allow space for pores in the salt, so that the net boiler-absorber volume had to be 300 litres.

One kilogram molecule $CaCl_2$ weighs 111 kg. and has a minimum volume of 52 litres. According to the ideas hitherto in vogue, the requisite boiler-volume should thus be 340 litres. One kilogram molecule of $CaCl_2$ can combine with 8 kilogram-molecules of NH_3 to form $CaCl_2.8\,NH_3$ and the total volume of the salt and of the refrigerant, when uncombined, is 272 litres if the refrigerant is in liquid form, and 228 litres if the refrigerant is in solid form. These two figures represent the greatest net volume of the boiler-absorber according to the invention. The most convenient boiler-absorber net volume is, however, 130 litres and thus the charge is more than 3.7 or 4.4 gram-molecules and preferably 7.7 gram-molecules of salt per litre net volume of boiler-absorber.

If lithium chloride $LiCl_2$ is selected as the absorption medium and methylamine CH_3NH_2 as the refrigerating agent, then the following values are arrived at. One kilogram molecule $LiCl_2$ weights 42.4 kg. and has a volume of 20.4 litres; it may combine with 3 kilogram-molecules of CH_3NH_2 weighing 93 kg. and occupying in liquid form a volume of 136 litres. According to the invention, the net volume of the boiler absorber is then selected at 156.4 litres as maximum whereas the volume of the boilers now in vogue is 203 litres.

With calcium chloride as the absorption medium and methylamine as the refrigerating agent, there is obtained, by similar reasoning, a boiler-absorber volume, according to the invention, of 322 litres per kilogram molecule of absorption medium at the utmost while with known boiler-absorbers the corresponding figure is 515 litres.

The values indicated in the foregoing examples as appropriate for the net boiler-absorber volumes are, in certain cases, not critical values but may be exceeded or lowered by 10–20% without any of the conditions being essentially modified.

The minimum volumes cited for the absorption media are those which they occupy in the entirely compact or fused condition. In practice, however, the boiler-absorber is conveniently filled with salt in a finely pulverized form free of water and then the salt occupies a volume substantially greater. Thus pulverized strontium chloride, for instance, has a specific gravity of approximately 1.0. For each litre of boiler volume it will be convenient to have a charge of 5.3 gram-molecules or 850 grams which, in powder form, thus takes up a volume of 850 cm^3, that is to say, the net volume of the boiler-absorber is filled 85% full with salt in powder form. This value may, of course, be exceeded or lowered and the boiler-absorber charges calculated according to the invention and reckoned as volume-percentages, range from 50 or 60% up to 95%, the most advantageous percentages being those between 80 and 90%. With the same degrees of distribution, fineness and of packing density in the absorption-media referred to, it is approximately true that a kilogram molecule occupies a volume of the same magnitude and the volume-percentages specified are therefore valid universally. More specifically, it must be emphasized that they are valid for strontium bromide and calcium chloride with ammonia as refrigerating agent.

In order to render a boiler-absorber of the high charging standard indicated above, practically possible and also utilizable, it is necessary to take special precautions to ensure a satisfactory conduction of heat between the salt and the walls of the boiler-absorber. To this end there must be fitted in the boiler-absorber a highly heat-conducting metallic skeleton. In the generally adopted type of boiler-absorber construction comprising a number of trays arranged axially behind one another to form a series of salt pockets, the depth or thickness of each salt pocket should not, according to the invention, exceed 5 mm. while the radial dimension of each of the trays should be 30–35 mm. at the utmost. In view of the high pressure steadily prevailing in the boiler-absorber, it is further advisable to fit special reinforcements within the interior of the boiler so as wholly or in part to free the outer encasing cover from stress.

One of the features of the invention is, further to provide construction for the boiler-absorber that will lend itself readily to mass production and into which it will be possible to introduce, in a single operation, the quantity of absorption medium specified above. This is, according to the invention, effected by dimensioning and forming the trays in such a manner that the boiler is filled to the extent desired when the trays are completely filled. An intermediate space is suitably left between the trays and the cover, this space being of such dimensions that the trays occupy only 60–95% and, preferably, 80–90% of the cross section area of the recess in the boiler-absorber that is intended for the salt. According to a further feature of the invention the trays are filled before the cover is fitted into its position, the filling being done from the side through excisions in the flanges of the trays, which flanges otherwise bear against each other along the periphery.

Additional characteristics of the invention will be disclosed by the following description of several constructional forms of the boiler-absorber represented in the accompanying drawing. Fig. 1 shows a first form of practical construction in a vertical section, Fig. 2 is a section taken on the line II—II of Fig. 1 while Fig. 3 shows a detail in plan view. Fig. 4 is a view similar to Fig. 2 of a slightly modified form of construction. Fig. 5 is a vertical section through another form of construction and Fig. 6 is a section taken on the line VI—VI of Fig. 5.

In Figs. 1 and 2, **2** denotes an inside pipe through which hot gases are intended to flow for the heating of the boiler-absorber, or in which it may be intended to fit an electric heater. **4** denotes a pipe coaxial with the former, which together with pipe **2** encloses an annular space suitable for containing a cooling agent during the absorbing periods. A plurality of trays **6**, in the form of annular discs provided with inner and outer flanges **8** and **10**, respectively, are arranged axially behind one another along the pipe **4** with the free end of the outer flange **10** on one tray engaging the body of the next tray to form a series of annular salt pockets. The inner flanges **8** bear tightly against the pipe **4** with a view to producing a satisfactory heat-conduction between trays **6** and the cooling agent in the space between the pipes **2** and **4** and also between the trays **6** and the hot gases in pipe **2**. The inner flanges **8** of the trays **6** may have internal screw threads engaging external threads on the pipe **4**. At the extremities of the boiler-absorber are provided two stay-plates **12** and **14**, rigidly secured to pipe **4** and serving to take up the axial pressure exerted by the salt, said stay plates holding the salt together with the trays in a package so that the volume of said package will remain fixed throughout the heating and cooling periods of the boiler-absorber. Although the stay plates have been shown in the form of discs, obviously other suitable means may be provided for the same purpose. As will be noted from plan view in Fig. 3, apertures are provided in the stay-plate **12** through which the refrigerating medium flows. The cylindrical mantle forming the cover of the boiler is denoted by **16**, and **20** denotes its two end plates which, owing to the presence of the stay-plates **12** and **14**, are not exposed to axial pressure. The outer flanges **10** of the trays **6** bear tightly against the mantle **16**. The depth or thickness of each salt pocket formed between adjacent trays is 5 mm. as maximum but should, preferably, not be less than 3 mm. while the radial distance between pipe **4** and mantle **16** should not exceed 30 to 35 mm., because, in this case, the boiler-absorber is heated and cooled internally, or from one side only. If the heating and cooling take place both internally and externally, the dimension last-named may be increased, though no more than twofold. The figures are to be regarded as valid irrespective of the absolute size of the boiler-absorber. Every one of the trays has an excision **22** the area of which represents, approximately 15% of the cross sectional area of the space in the boiler-absorber designed to contain the salt. These excisions which serve to facilitate the filling in of the salt are of similar form and are similarly positioned in all the trays. The outer flange **10** of each tray may be provided with an opening through which the salt may be introduced into each pocket prior to insertion of the entire package of trays into the cover **16**. In the trays there are, further three symmetrically distributed holes **26**, **28** and **30** which constitute channels extending longitudinally in the boiler, and are intended to facilitate the passage of the gaseous refrigerating medium to the different pockets of the salt package. In order to prevent the salt from falling out through apertures **15** in the stay-plate **12**, a metallic cloth **32** is inserted between it and the adjacent tray, as clearly shown in Figs. 1 and 5. The pipe **34** leading to the condenser of the refrigerating apparatus discharges at the one extremity of the boiler-absorber into a special chamber **36** within which any liquid refrigerating agent which may flow back towards the boiler-absorber is collected and prevented from coming into contact with the salt which would tend to lower its absorption capacity. This liquid then evaporates in the chamber **36** and the salt pockets are, in this way, protected.

In charging the boiler-absorber the procedure is, first, to fill the pockets formed by adjacent trays **6** completely with a dry salt such as, for instance, strontium chloride in pulverised and water-free form, before the cover has yet been put on. The portion of the salt in each pocket which may be considered as having the same cross-sectional shape as the excision **22** is then removed, by, for instance, ejecting it with a special tool inserted axially through the salt pocket. There is thus removed a quantity of salt which, reckoned as a percentage is approximately equal to the percentage that excision **22** forms of the cross sectional area of the space in the boiler-absorber designed to contain the salt, or, say, roughly 15%. When the cover is then put on, the space in the boiler-absorber provided for the salt package is thus about 85% full while the residual space is available for swelling. The salt is then saturated with the cooling-medium, such as ammonia, causing it to swell up and fill the aforementioned space in the boiler completely, so that the salt fills up the excisions **22** also. As a result of the limited space, the salt is thus so intensely compressed that, even when the ammonia is subsequently driven off and completely disappears, the space in the boiler provided for the salt remains completely fills and the salt package takes up a fixed position in the boiler from which it will not be shifted as a result of the diminution in volume occasioned by the expulsion of the cooling agent, as is the case with certain known types of boiler.

In the modified constructional form, of which a cross-section is shown in Fig. 4, the trays **6** have a portion linearly cut off along a straight line so that a longitudinal channel **22'** is formed between them and the cover **16** once the central pipe **4** and the package of trays secured thereto have been inserted in the cover **16**. The sections cut away are of such size that the channel **22'** forms 10–20% of the cross-sectional area of the boiler-absorber. By this construction, the package of trays may be charged in a specially simple and reliable manner while the amount of the charge is determined unequivocally by the construction of the boiler-absorber. In other words, all that is necessary is to lay the package of trays horizontally with the cut-off portion of each tray arranged on the top side of the package and to fill each tray up to a level flush with the straight edge of its cut-off portion, the filling of each tray being simplified by making use of a funnel-shaped chute placed over the package along its entire length. After the trays have been filled and the cover **16** has been applied, the boiler is filled with salt up to the 80–90 per cent desired.

The constructional forms for the boiler-absorber exemplified in Figs. 5 and 6 agree in the main with that described above and differ solely therefrom as regards the location of the space for swelling. In this case, the tray is here constructed with a diameter smaller than cover 16 so that a clear annular space 40 is left between it and the cover 16 coaxial therewith. The outer flanges 10 are cut away at 24 and by means of apertures so formed, the trays can be completely filled. After the cover has been put on and the boiler-absorber put in operation, the salt swells and deflects the flanges 10, so that space 40 is also filled.

With a view to obtaining a satisfactory conduction of heat within the salt, it may be expedient to add a small quantity of some substance of good heat-conducting capacity, such as, for example, lithium nitrate $LiNO_3$, lithium cyanide LiCN, lithium thiocyanide LiSCN, zinc cyanide $Zn(CN)_2$, zinc thiocyanide $Zn(SCN)_2$, potassium thiocyanide KSCN, cadmium nitrate $Cd(NO_3)_2$, ammonium nitrate NH_4NO_3, or ammonium thiocyanide NH_4SCN. Finely divided metals such as iron filings may also be employed for this purpose.

In charging the boiler-absorber according to the methods above indicated, the net volume of the space provided for the salt has not been completely filled as from 10 to 20% was left free. In certain instances it may be desirable to mix the salt with a substance or substances other than the refrigerant and to add enough of such substance or substances to the salt so that the mixture will completely fill up the net volume of the boiler-absorber. After the boiler-absorber is filled and closed, the addition substance or substances can be driven out, for example, by heating up the boiler-absorber. The substances used for this purpose must be of such composition that the chemical and physical properties of the salt are not affected thereby. Such addition substances can be water, alcohols or other liquids. Solid bodies can also be employed, and especially those that pass directly into the gaseous form, such for example, as camphor, salamoniac, ammonium carbonate, bicarbonate, etc. By the foregoing admixture, the salt may thus be made to occupy a volume greater than its volume in the pulverized, water-free condition, so that the quantity of salt remaining when the added substances are driven out will be in accordance with the previously mentioned figures.

If it is proposed to make use of this method of charging, it will prove serviceable to make use of a boiler construction conformable with Figs. 1–3 in which case the excisions 22 are not required.

With the boiler-absorber constructions described above and with the tight packing of the salt, experiments have shown it to be possible to saturate the salt with 8 kilogram molecules of ammonia per kilogram molecule of salt and also that with a generating period of two hours and an absorption period of the same duration, it is possible to expel or to reabsorb the quantity that theoretically can be circulated, that is, with a charge of strontium chloride, approximately 7 kilogram molecules of ammonia and, with a charge of calcium chloride, approximately 6 kilogram molecules of ammonia. Naturally other charging proportions (subject to the intervals indicated in the accompanying claims) than those specified in the manner of practical realization indicated above, may be utilized more particularly when different refrigerants and absorption media are employed.

From the foregoing, it is believed that the construction and advantages of the present invention may be readily understood by those skilled in the art without further description, it being borne in mind that numerous changes may be in the details disclosed without departing from the spirit of the invention as set out in the following claims.

I claim:

1. In an absorption refrigerating system operating with a dry absorbent capable of absorbing a gaseous refrigerating agent and expelling the same under heat, said absorbent having the characteristic of increasing in volume with the absorption of said refrigerating agent and decreasing in volume during the expelling of said refrigerating agent; a boiler absorber, and a charge of such absorbent in said boiler absorber, the net volume of said boiler absorber being less than the sum of the volumes of said charge and the refrigerating agent, both in their densest form.

2. In an absorption refrigerating system operating with a dry absorbent capable of absorbing a gaseous refrigerating agent and expelling the same under heat, said absorbent having the characteristic of increasing in volume with the absorption of said refrigerating agent and decreasing in volume during the expelling of said refrigerating agent; a boiler absorber, and a charge of such absorbent in said boiler absorber, said charge containing 4–8 gram molecules of said absorbent per liter net volume of boiler absorber.

3. In an absorption refrigerating system operating with a dry absorbent capable of absorbing a gaseous refrigerating agent and expelling the same under heat, said absorbent having the characteristic of increasing in volume with the absorption of said refrigerating agent and decreasing in volume during the expelling of said refrigerating agent; a boiler absorber, and a charge of a halogen salt absorbent in said boiler absorber, said charge containing 5–6 gram molecules of said halogen salt per liter net volume of boiler absorber.

4. The method of charging a boiler absorber of an absorption refrigerating system operating with dry absorbents having the characteristic of swelling upon taking up the refrigerating agent, which consists in placing in said boiler absorber 4–8 gram molecules of water-free absorbent pulverized so finely as to provide a mass of sufficient volume to occupy 60 to 95% of each liter of net volume of the boiler absorber, whereby from 40% to 5%, respectively of the net volume of said boiler absorber is left free to allow said salt to swell upon the first absorption of the refrigerating agent.

5. The method of charging a boiler absorber of an absorption refrigerating system operating with dry absorbents having the characteristic of swelling upon taking up the refrigerating agent, which consists in placing in said boiler absorber 5–6 gram molecules of water-free halogen salt absorbent pulverized so finely as to provide a mass of sufficient volume to occupy 80 to 90% of each liter of net volume of the boiler absorber, whereby from 20 to 10%, respectively of the net volume of said boiler absorber is left free to allow said salt to swell upon the first absorption of the refrigerating agent.

6. The method of charging a boiler absorber of an absorption refrigerating apparatus operating with solid absorbents having the characteristic of swelling upon taking up a refrigerating agent,

which consists in filling said boiler absorber with a charge containing a mixture of a solid absorbent and a substance other than the refrigerating agent, vaporizable at a temperature below the melting point of the absorbent, said charge containing 4–8 gram molecules of such salt absorbent per liter net volume of the boiler absorber, and heating the boiler absorber to vaporize and expel said vaporizable substance from said boiler absorber, prior to the feeding thereto of the refrigerating agent.

7. In the method of charging a boiler absorber of an absorption refrigerating apparatus operating with solid absorbents having the characteristic of swelling upon taking up a refrigerating agent, the improvement which consists in admixing to a body of a dry solid absorbent containing 4–8 gram molecules of said absorbent per liter net volume of the boiler absorber, a predetermined quantity of a substance other than the refrigerating agent, and vaporizable at a temperature below the melting point of the absorbent, whereby said solid absorbent is made to occupy a volume greater by 5 to 50% than it normally occupies in its pulverized and water free condition, filling said boiler absorber with said mixture, and heating the same to vaporize and expel said substance from said boiler absorber.

8. The method of charging a boiler absorber of an absorption refrigerating apparatus operating with solid absorbents having the characteristic of swelling upon taking up a refrigerating agent, which consists in filling said boiler absorber with 4–8 gram molecules of a solid absorbent per liter net volume of the boiler absorber, said solid absorbent containing its water of crystallization, and heating the same to vaporize and expel said water from said boiler absorber.

9. In the method of charging a boiler absorber of an absorption refrigerating apparatus operating with solid absorbents having the characteristic of swelling upon taking up a refrigerating agent, the improvement which consists in admixing to a body of a solid absorbent, a liquid other than the refrigerating agent and vaporizable at a temperature below the melting point of the absorbent, said body containing 4–8 gram molecules of said absorbent per liter net volume of the boiler absorber, filling said boiler absorber with said mixture, and then heating the same to vaporize and expel said liquid from said boiler absorber.

10. In the method of charging a boiler absorber of an absorption refrigerating apparatus operating with solid absorbents having the characteristic of swelling upon taking up a refrigerating agent, the improvement which consists in admixing to a body of a solid absorbent, a predetermined quantity of a solid substance other than the refrigerating agent and vaporizable at a temperature below the melting point of the absorbent, said body containing 4–8 gram molecules of said absorbent per liter net volume of the boiler absorber, filling said boiler absorber with said mixture, and then heating the same to vaporize and expel said solid substance from said boiler absorber.

11. In the method of charging a boiler absorber of an absorption refrigerating apparatus operating with solid absorbents having the characteristic of swelling upon taking up a refrigerating agent, the improvement which consists in admixing to a body of a halogen salt absorbent, a predetermined quantity of a solid substance other than the refrigerating agent and vaporizable at a temperature below the melting point of said absorbent, said body containing 5–6 gram moleclues of said halogen salt absorbent per liter net volume of the boiler absorber, filling said boiler absorber with said mixture, and then heating the same to vaporize and expel said solid substance from said boiler absorber.

12. In an absorption refrigerating system operating with a dry absorbent capable of absorbing a gaseous refrigerating agent and expelling the same under the influence of heat, said absorbent having the characteristic of increasing in volume with the absorption of the refrigerating agent and decreasing in volume during the expelling of said refrigerating agent; a boiler absorber, a charge of such absorbent in said boiler absorber, the volume of said boiler absorber being less than the sum of the volumes of said charge and the refrigerating agent, both in their densest form, and means in said boiler absorber for preventing the refrigerating agent in liquid form from contacting said absorbent.

13. In an absorption refrigerating apparatus, the improvement which consists in a boiler absorber containing a charge of 4–8 gram-molecules of salt absorbent per liter net volume of boiler absorber, said absorbent having the characteristic of increasing in volume upon absorbing the refrigerant, said boiler absorber comprising a casing, a pair of cover plates closing the ends of said casing, and means in said casing interposed between said charge of absorbent and said cover plates to take up axial pressure stresses from said absorbent.

14. A boiler absorber for absorption refrigerating apparatus comprising a casing, a central pipe co-axial with said casing and spaced inwardly from the latter to form therewith an annular chamber, a series of annular trays disposed transversely in said chamber and adapted to be filled with a salt absorbent, the edges of said trays being turned outwardly, said trays being arranged axially in said chamber with their outwardly turned edges disposed in the same longitudinal direction, a portion of said outwardly turned edges being removed to provide openings for filling said trays with the salt absorbent, a pair of cover plates closing the ends of said chamber, and a pair of stay-plates fixed to said central pipe and interposed between said cover plates and the respective end trays of said series for taking up axial pressure stresses from the salt absorbent, one of said stay-plates being spaced inwardly from the adjacent cover plate to form therewith a condensate collecting chamber for preventing liquid from contacting the salt absorbent in said trays.

15. A boiler absorber for absorption refrigerating apparatus comprising a casing, a central pipe co-axial with said casing and spaced inwardly from the latter to form therewith an annular absorbent chamber, a series of annular trays disposed transversely in said chamber and adapted to contain a salt absorbent, said trays being arranged axially in said chamber along said central pipe and spaced inwardly from the walls of the casing to form an absorbent expansion chamber, a pair of cover plates closing the ends of said annular absorbent chamber, and a pair of stay-plates interposed between said cover plates and the respective end trays of said series for taking up axial pressure stresses from the salt absorbent.

16. A boiler absorber for absorption refrigerating apparatus comprising a casing, a central

pipe co-axial with said casing and spaced inwardly from the latter to form therewith an annular salt absorbent chamber, a series of annular trays transversely disposed in said absorbent chamber and adapted to contain a salt absorbent, said trays being arranged axially in said chamber along said central pipe, said trays being linearly cut off in a straight line at one side to form a longitudinal channel with the inner wall of said casing, a pair of stay-plates fixed to said central pipe adjacent the respective end trays of said series for taking up axial pressure stresses in said absorbent chamber, and cover plates closing the ends of said casing adjacent said stay-plates, one of said cover plates being spaced longitudinally from the adjacent stay-plate to form therewith an annular condensate collecting chamber in said casing for preventing liquid from entering said absorbent chamber.

17. In a boiler-absorber for use in connection with refrigerating apparatus of the intermittent absorption type, a casing, a central pipe coaxial with said casing and spaced inwardly from the latter to form therewith an annular absorbent chamber, a series of annular heat conducting members arranged axially one behind the other along said central pipe and extending transversely across said chamber to form a series of annular pockets each containing solid absorbent material having the characteristic of increasing in volume upon absorbing the refrigerant, the depth or thickness of each pocket calculated along the axis of said absorbent chamber being not more than 5 mm., and a pair of stay-plates in said chamber fixed to said central pipe adjacent the respective end pockets of said series to hold said series of pockets in a package and to take up axial pressure stresses arising from the increase in volume of the absorbent material in absorbing the refrigerant.

18. In a boiler-absorber having an absorbent chamber, heat conducting means in said chamber dividing the latter transversely into a series of pockets axially spaced from one another, each pocket containing 4–8 gram-molecules of solid absorbent material per litre net volume thereof, the depth or thickness of each pocket being not more than 5 mm.

19. In a boiler-absorber having an absorbent chamber formed with a substantially cylindrical casing, a plurality of trays in said chamber coaxial with said casing and arranged in end-to-end relation axially of said chamber with the turned edges of said trays disposed in the same longitudinal direction to form a series of closed pockets adapted to contain solid absorbent material, the outer turned edges of said trays forming a continuous heat-conducting surface along said casing.

20. In a boiler-absorber having an absorbent chamber formed within a substantially cylindrical casing, a plurality of trays in said chamber co-axial with said casing and arranged in end-to-end relation axially of said chamber with the turned edges of said trays disposed in the same longitudinal direction to form a series of closed pockets adapted to contain solid absorbent material, the outer turned edges of said trays forming a continuous heat-conducting surface along said casing, and means in said absorbent chamber adjacent the respective end trays of said series for holding said series of trays in a package and prevent displacement of said package axially of said chamber.

21. The method of charging a boiler-absorber of an absorption refrigerating system operating with solid absorbents having the characteristic of swelling upon taking up a refrigerating agent, which consists in filling said boiler-absorber with 4–8 gram-molecules of a solid absorbent per litre net volume of boiler-absorber, said solid absorbent containing water as absorbed vapor, and heating the same to vaporize and expel said water from the boiler-absorber.

22. In a boiler-absorber for refrigerating apparatus of the intermittent absorption type, a substantially cylindrical casing closed at its opposite ends to provide a chamber, heat conducting means in said chamber dividing the latter into a series of pockets each containing solid absorbent material having the characteristic of increasing in volume upon absorbing the refrigerant, and separate means held in axially spaced relation from one another in said chamber and at the ends of said series of pockets and each of said means having sufficient rigidity to prevent enlargement of said series longitudinally of said chamber.

23. In a boiler-absorber for use in connection with absorption refrigerating apparatus operating with solid absorbent material and a refrigerant, a substantially cylindrical casing closed at its opposite ends to provide a chamber, and heat conducting means in said chamber dividing the latter into a series of pockets each containing 4–8 gram-molecules of absorbent material per liter net volume thereof, the thickness of each pocket being not more than 5 mm. and the radial dimension of each pocket being not more than 35 mm.

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