DEHYDRATION UNIT

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Fig. 1.

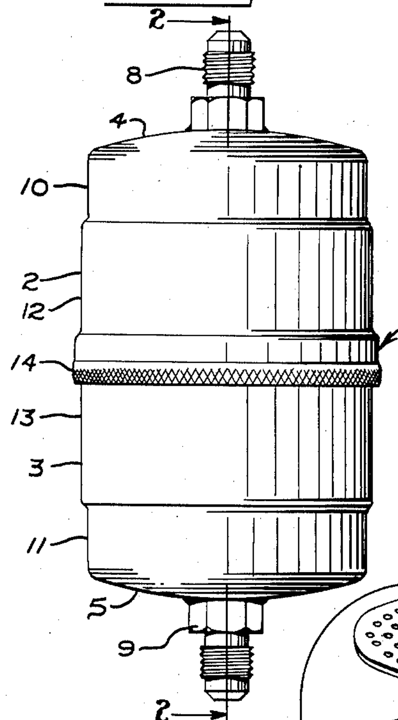


Fig. 2.

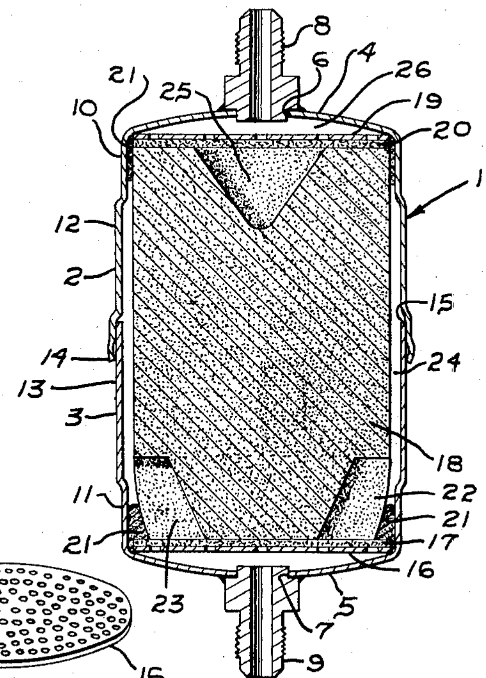
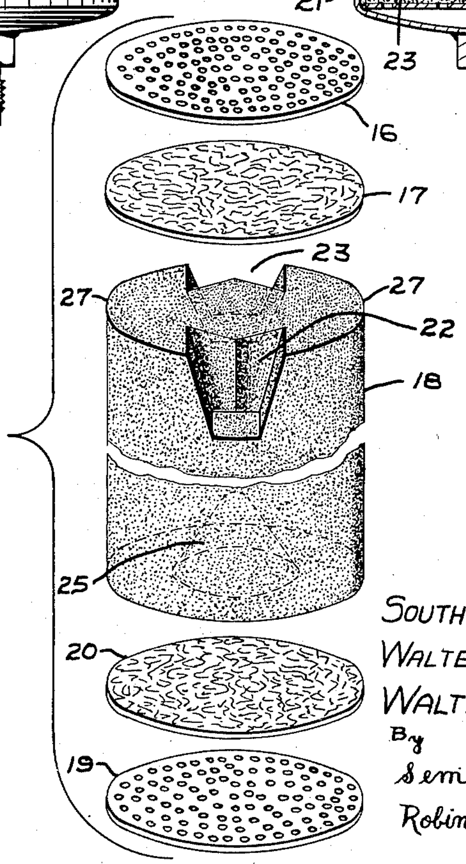


Fig. 3.



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DEHYDRATION UNIT

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This invention relates to dehydrating apparatus and more particularly to a dehydrator for removing moisture from refrigerants.

In the usual refrigerating apparatus the refrigerant, a fluid having suitable volatility characteristics, is compressed while in the gaseous state and then passed through a condenser or cooler. The condenser removes heat absorbed by the refrigerant while in the apparatus to be cooled and the compressor, and, in most cases, condenses the refrigerant to the liquid state. The cooled refrigerant is throttled through an expansion valve which results in sudden cooling of the refrigerant to a temperature below the temperature of the apparatus to be cooled. The refrigerant is then passed to the refrigerated unit and absorbs heat from that unit before again passing to the compressor to repeat the cycle.

One of the most common difficulties encountered with refrigerating machinery is freezing of moisture as it passes through the expansion valve. When subjected to the low temperature on the discharge side of the expansion valve the moisture forms ice which interferes with the operation of the valve. The valve may then be frozen in the open position which permits excessive refrigerant to pass into the heat absorbing apparatus. In such a case the refrigerant is not completely vaporized in the heat absorbing apparatus, and either passes to the compressor as a liquid or lowers the pressure of the vapor sufficiently to impair the flow of gaseous refrigerant to the compressor.

It is only necessary for the usual refrigerant to be contaminated with traces of moisture to cause the formation of sufficient ice to interfere with the operation of the expansion valve. The moisture may enter the refrigerant at the compressor through moisture-contaminated oil used to lubricate the compressor. In most cases, however, the moisture is introduced through leaks in the refrigerating system at points in the apparatus where the refrigerant is under less than atmospheric pressure. Many of the most common refrigerants now used will be at pressures considerably below atmospheric during certain periods of the refrigerating cycle.

Heretofore dehydrators have been employed in which the moisture absorbing material is in a finely divided form. The finely divided desiccants, however, possess the very serious disadvantage of tending to leave the body of the absorbent material and enter the stream of the refrigerant. The desiccating material then may cause serious damage to the finely machined

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parts of the refrigerating apparatus. This difficulty is aggravated by attrition of the particles of desiccant when it is in a loose condition. The movement of the particles as the refrigerant flows past them diminishes the size of the particles which, of course, facilitates their leaving the body of absorbent material. Furthermore, there is a tendency for the refrigerant to channel through the loose absorbent material, thereby reducing the effectiveness of the absorbent.

An object of this invention is to provide a monolithic moisture absorbent body for the removal of moisture from refrigerants.

A further object of this invention is to provide an effective, compact dehydrator having a large capacity for removing water from the refrigerants and which may be manufactured at a low cost.

Another object of this invention is to provide a dehydrator for refrigerants in which a large block of bonded adsorbent is supported in a casing and notches are provided in the block to allow the refrigerant to bypass a portion of the block.

It is also an object of this invention to provide a rugged compact dehydrator for refrigerants in which the dehydrating material is bonded activated alumina.

With these and other objects in mind this invention resides in a dehydrator for refrigerants in which a large mass of bonded adsorbent material is supported directly by the walls of a casing and notches in the bonded adsorbent allow the refrigerant to bypass a portion of the adsorbent.

In the drawings:

Figure 1 is an elevation view of the dehydrator constructed according to this invention;

Figure 2 is a longitudinal sectional view along the line 2—2 of Figure 1 of the dehydrator; and

Figure 3 is an exploded perspective view showing the arrangement of the various parts within the casing of the dehydrator in an inverted position.

In most cases the dehydrator herein described will be used to remove moisture from the refrigerant when the refrigerant is in the liquid phase; the dehydrator will, therefore, ordinarily be installed between the condenser and the expansion valve in the refrigeration apparatus. In some instances, however, it may be desirable to remove the moisture from a gaseous refrigerant. The dehydrator herein described can be used equally as well to remove moisture from gases as from liquids.

Referring to Figure 2 the dehydrator consists of a casing indicated generally by 1 consisting of an upper section 2 and a lower section 3. Sections 2 and 3 of the casing are generally cup-shaped members preferably drawn from sheet metal. The bases 4 and 5 of cup-shaped sections 2 and 3 are apertured at 6 and 7, respectively, for the reception of nipples 8 and 9. Nipples 8 and 9 are threaded for connection with the conduit conveying the refrigerant through the refrigeration apparatus and provide an inlet and outlet to the dehydrator.

Immediately adjacent the bases 4 and 5 of the sections 2 and 3 of the casing are relatively restricted lateral portions 10 and 11 forming part of the lateral wall of the casing. These relatively restricted sections extend for a short length along the depth of the cup-shaped members and join with expanded wall portions 12 and 13 comprising the remainder of the lateral wall of the dehydrator. The cup-shaped sections 2 and 3 are joined along their rims 14 and 15 to form a hollow vessel closed at the ends by the bases 4 and 5 and having openings in the ends for the introduction and discharge of the refrigerant.

In the preferred form of the invention shown in the drawings, the rim 14 of one of the sections of the casing is flared outward to overlap the rim 15 of the other section. Rim 15 fits snugly against the inner wall of the flared rim and is secured thereto by a sweated joint. After the formation of the sweated joint, the extreme tip of rim 14 is rolled against the outer wall of the other section. This method of joining the two sections of the casing provides an inexpensive means of forming a fluid tight joint. Of course, other methods, such as the use of flanges to join the two sections, may be employed if desired.

Fitting within the casing and resting on the base 5 of section 3 of the casing at its juncture with the restricted tubular section 11 is a perforated plate 16. This plate is usually constructed of metal, preferably aluminum, and serves as a support for a disc of glass wool 17 resting on its upper surface, and the moisture absorbent material 18. A similar perforated plate 19 fits at the juncture of the restricted portion of the walls of section 2 and the base of that section and retains a second disc 20 of glass wool resting on the upper surface of absorbent material 18. The absorbent material 18 is of sufficient length to subject the perforated plates 16 and 19 to a slight stress when the sections of the casing are joined which aids in holding the absorbent material firmly in place.

The glass wool disc is ordinarily prepared from felted glass fibers of extremely small diameter. The disc has the appearance and feel of soft felt and is not brash as are the ordinary glass wools. Furthermore, the wool prepared from these extremely fine fibers does not break off in splinters as is common with most glass wools. By the use of this exceedingly fine glass fiber, the filtering properties of the disc 17 are enhanced and the danger of glass particles breaking free from the disc is minimized.

The disc 17 is primarily to make sure that no solid particles will leave the dehydrator. It has also been found satisfactory to use a disc prepared from glass cloth. The weave of the cloth should be sufficiently close to prevent any particles of the absorbent from passing therethrough. A disc prepared from glass cloth has some advantages in strength over the felted glass wool previously described.

The term "absorbent material" is herein used in its generic sense and includes material relying

on adsorptive as well as absorptive properties for removing moisture from the refrigerant. It is essential, however, that the absorbent material be of a self-contained nature and not a loose porous bed of desiccant. The loose porous beds of desiccating material have the inherent disadvantage of tending to leave the enclosure retaining the material and entering the stream of refrigerant. Since many of the desiccating materials having the best moisture absorbing properties are of a hard granular nature, they might cause serious scoring of the refrigerating equipment if allowed to pass from the dehydrator.

It is preferred that the absorbent material be a single block or monolith of activated alumina. Such a block may be prepared by binding ground hydrated alumina with a binder, and heating the block to the temperature sufficient to activate the alumina. The binder should be of a material capable of withstanding the temperature required for activation of the alumina. For example, hydrated alumina may be mixed with an aluminum phosphate binder of the type described in U. S. Patent No. 2,405,884 to form a plastic mass which may be molded into any desired shape. On air drying the aluminum phosphate binder sets to give the cast or molded block sufficient strength for ordinary handling. When the block is then heated to the temperature necessary to activate the aluminum phosphate, the binder forms a hard, water-resistant binder which is excellent for use in a dehydrator. By control of the proportions of hydrated alumina, aluminum phosphate binder and water, a porous block is formed having absorbent properties equally as good as unbonded alumina. The bonded block, therefore, has all of the advantages inherent in a monolith of absorbent materials such as resistance to attrition of the absorbent, channeling through the absorbent, and classification of the absorbent material without any loss of dehydrating properties.

For example, bauxite varying from 60 to 100 mesh in particle size may be mixed with an aluminum phosphate of the type described in Patent No. 2,405,884. The aluminum phosphate will comprise approximately 5–10% of the mixture. Sufficient water is added to the mixture to give it the desired workability and a block of the proper shape is molded. After air drying, the block is heated to a temperature of 450° F. to 1200° F. to activate the bauxite. The time and temperature of activation will be determined by the degree of activation desired. This example is described only to illustrate a method of preparing the absorbent block, and limits the invention in no manner.

Binders other than those having an aluminum phosphate base have been used. Binding materials prepared from sodium silicates may be used, but they, in general, are not as water-resistant as the aluminum phosphate materials. Organic adhesive materials are not as satisfactory as the aluminum phosphate binders because they char on heating to activating temperatures.

It is, of course, within the scope of this invention to use other absorbent materials. Silica gel, for example, has been widely used as a desiccant because of its excellent water adsorptive properties. Silica gel, however, has a serious disadvantage of breaking up into fine particles when exposed to water in the liquid, rather than the gaseous, phase. In view of the hardness of the particles of silica gel, serious damage to the refrigerating apparatus might be incurred if the glass disc did not stop all such fragments of the gel. Furthermore, over an extended period of use the shape of the absorbent block would be varied because of the fragments of the silica particles, and the absorbent block might become loose in the casing.

The block of absorbent material fits snugly against the restricted portions 10 and 11 of the casing sections 2 and 3 to prevent flow of the refrigerant around the absorbent material and thereby by-passing the dehydrator. By accurately fixing the outer dimensions of the absorbent block, a sufficiently snug fit of the block within the casing to prevent serious by-passing can be obtained. It is generally advisable to use an impervious binder 21 which not only insures a close fit between the wall of the casing and the absorbent block, but aids in holding the block firmly in place within the dehydrator. A sodium silicate binder has been found suitable for this purpose. Similarly an organic adhesive which is resistant to water and the particular refrigerant employed will be satisfactory, since it will not be subjected to high temperatures.

The amount of water which finds its way into the refrigerant in the ordinary refrigerating mechanism is usually small. It is desirable, however, to provide a dehydrator having sufficient water absorbing capacity to eliminate the necessity of ever removing the dehydrator from the refrigerating system for replacement. It is, therefore, necessary that the block of absorbent be sufficiently large to absorb all water likely to enter the refrigerant during the life of the refrigerating machinery. There should, of course, be a safety factor allowing absorption capacity over and above that normally required for the absorption of water. In providing this large dehydrating capacity it must be borne in mind that the space available for the dehydrator is often somewhat limited. It is not, therefore, desirable to provide a dehydrator of relatively short length and very large cross-sectional area to permit the installation of the necessary absorption capacity. Furthermore, channeling is especially serious in such a structure. On the other hand, if the dehydrator does not have a large diameter but is of considerable length, the pressure drop in the fluid flowing through the dehydrator will be excessive, and accurate control of the refrigerating operation is low.

In order to overcome the above difficulties, block 18 is notched at 22 and 23 at its inlet end to allow some of the fluid to flow into the space 24 between the expanded portions 12 and 13 of the casing and the outer surface of the block. The fluid may then flow through this space towards the outlet of the dehydrator, but complete by-passing of the absorbent material is prevented by the close fit between the restricted portion 10 of the casing and the block of absorbent. The refrigerant then flows from the upper end of the space 24 through the absorbent block to the outlet nipple 8. The discharge end of the absorbent block has been drilled to form a channel 25 providing direct communication between the interior of the absorbent material and the outlet of the dehydrator. Channel 23 encourages radial flow from the space 24 substantially radially to the channel. The tendency of the refrigerant to flow to the upper end of space 24 before entering the absorbent is reduced thereby and more effective use is made of the total mass of the absorbent material.

A block of the shape described and illustrated in the drawings allows the use of an absorbent member having a large volume and consequent large moisture absorbent capacity. The notches 22 and 23 communicating with chamber 24 allow the use of a relatively long block without increasing the pressure drop of the refrigerant as it flows through the absorbent material. It is possible, therefore, to provide a compact structure having a large moisture absorbing capacity without increasing the resistance to flow of the refrigerant as it passes through the refrigerating apparatus.

By use of an absorbent block of sufficient length to extend into both restricted sections 10 and 11, the block is supported longitudinally by the two perforated plates 16 and 19 and laterally at both ends of the block by the restricted sections of the casing. Except in the region of the notches 23 and 24, the outer edge 27 of the inlet end of the absorbent material fits snugly against the restricted section 11 of the casing to provide lateral support for the block. The absorbent is, therefore, held firmly in place within the casing, and the danger of cracking the block is obviated.

A dehydrating unit for refrigerating apparatus having a large moisture absorbing capacity has been described herein. The high moisture absorbing capacity has been provided without appreciably increasing the space required for the refrigerating apparatus and without causing an appreciable pressure drop in the fluid as it flows to the expansion valve.

The dehydrator comprising the present invention may be manufactured at a very low cost without any loss in effectiveness of the apparatus. A bonded moisture absorbent material is provided which effectively removes moisture and other impurities from the refrigerant. Furthermore, contamination of the refrigerant with particles of the moisture absorbing material is minimized.

The present invention has been illustrated and described in detail to clarify the disclosure of the invention. It is to be understood that the concept of the invention is not limited to the specific details herein set forth but falls within the scope of the appended claims.

We claim:

1. A dehydrator for the removal of moisture from fluids comprising a casing having an inlet at one end and an outlet at the other end, said casing having tubular sidewalls with a tubular section of large internal diameter at the center separating a tubular section of reduced internal diameter at each end of the sidewalls, a monolithic block of moisture absorbent material within the casing having its sides fitting snugly against the sidewalls of the casing at the area of reduced internal diameter and spaced from the sidewalls at the center whereby the block is supported in the casing by the sidewalls, a binder between the block and casing at the area of reduced internal diameter near the outlet end of the casing, joining the sidewalls of the casing and block and sealing openings between the block and casing to prevent by-passing of the block by the fluid, and notches in the block at its inlet end extending therefrom to the side of the block adjacent the section of large internal diameter thereby providing conduits allowing direct flow from the inlet to the space between the sidewalls of the casing and the block.

2. A dehydrator for the removal of moisture from fluids comprising a casing having an inlet

at one end and an outlet at the other end, said casing having tubular sidewalls with a section of large internal diameter at the center separating a section of reduced internal diameter at each end of the sidewalls, a monolithic block of bonded activated alumina within the casing having its sides fitting snugly against the sidewalls of the casing at the section of reduced internal diameter and spaced from the sidewalls at the center whereby the block is supported in the casing by the sidewalls, a binder between the block and casing at the section of reduced internal diameter near the outlet end of the casing joining the sidewalls of the casing and block and sealing openings between the block and casing to prevent by-passing of the block by the fluid, and notches in the block at its inlet end extending therefrom to the sides of the block adjacent the section of large internal diameter thereby providing conduits allowing direct flow from the inlet to the space between the sidewalls of the casing and the block.

3. A dehydrator for removing moisture from fluids comprising a cylindrical casing having an inlet at one end and an outlet at the other end, a monolithic block of moisture absorbent material mounted within the casing, the side walls of said block engaging the side walls of the casing over an area adjacent the ends thereof and spaced from the side walls of the casing intermediate the ends, and notches in the block at the inlet end thereof extending to the sides in the region spaced from the side walls of the casing to provide conduits allowing direct flow from the inlet to the space between the side walls of the casing and the block.

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