

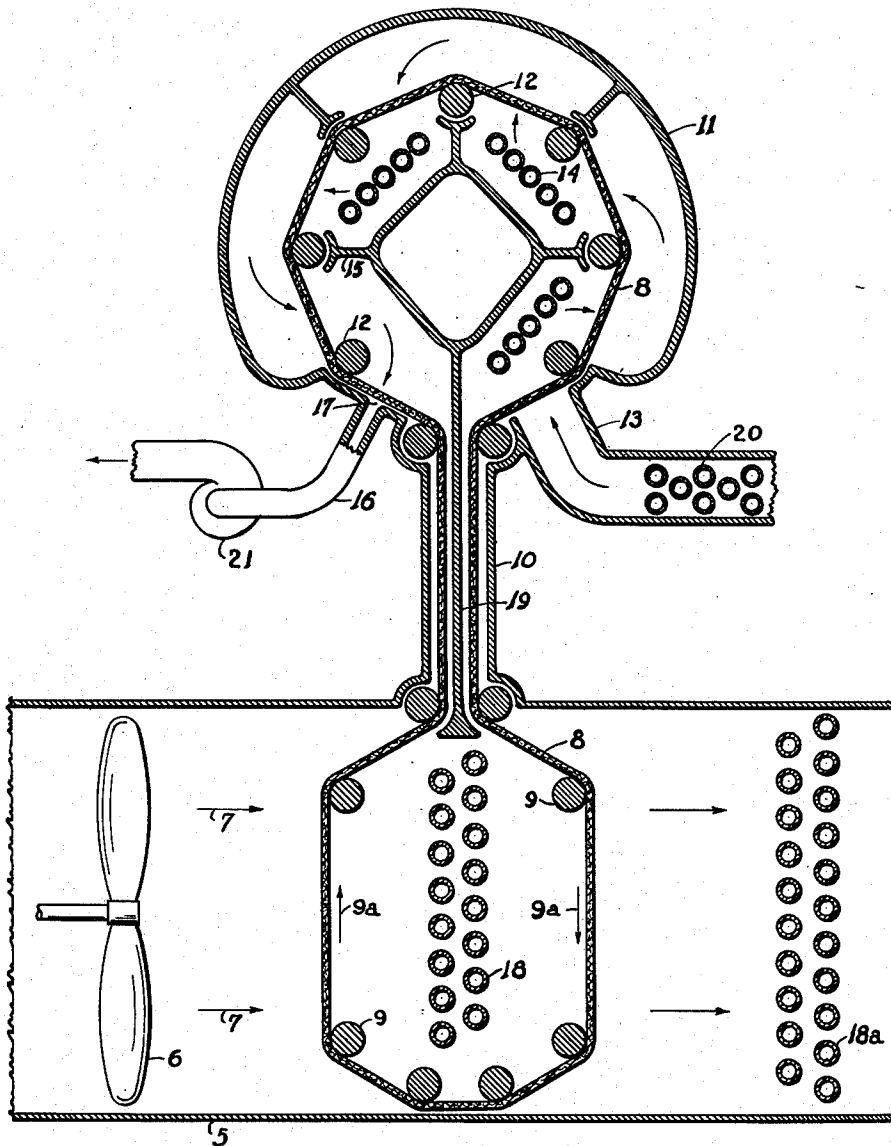
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ADSORPTION AIR CONDITIONING SYSTEM

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ADSORPTION AIR CONDITIONING SYSTEM

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This invention relates to air conditioning, and more particularly air conditioning systems of the adsorption type.

5 The general object of the invention is to provide an improved method of and apparatus for conditioning air in which the moisture content of the conditioned air is reduced by adsorption.

It is well known that dehydrating agents or adsorbers, after they have taken up a certain amount of moisture, must be regenerated in order that they may become once again useful for the purpose of removing moisture from air or other gas contacting therewith. Regeneration of adsorbers is accomplished by subjecting 10 them to heat so that the adsorbed moisture is driven off. Obviously, during the period of regeneration adsorbers must be relieved from immediate air conditioning service. Thus, in prior practice, it has often been necessary periodically to interrupt the conditioning of air in order that adsorbers used to condition the air might be regenerated. Where continuous conditioning has been required, it has been necessary to provide two or more dehydrating chambers through 15 which the air to be conditioned is routed at different times.

An object of the invention is to provide an improved air conditioning system utilizing a dry or solid adsorber in which the dehydration of air 20 may be carried on continuously in a single conditioning chamber.

It is another object of the invention to provide an improved air conditioning system in which a continuous belt formed of and/or carrying a hygroscopic material is passed through an air conditioning chamber and then through a regenerat- 25 ing chamber, in which it is prepared for a repetition of the adsorption cycle.

It is another object of the invention to provide a continuous system for dehydrating air in which 30 the air is cleaned as well as dehydrated by an adsorber.

It is another object of the invention to provide an improved method of and apparatus for conditioning air in which air to be conditioned is 35 contacted with an adsorber, whereby the adsorber takes up both moisture and dirt from the air, and in which other air is utilized to effect both the regeneration and the cleaning of the adsorber.

It is another object of the invention to provide an air conditioning system which is continuous, highly efficient and reliable in operation, and which is adapted to condition air relatively in- 40 expensively.

A feature of the invention resides in contacting air to be conditioned with a continuous belt made of and/or carrying hygroscopic material, removing the belt from contact with the air to be conditioned and preparing it for a repetition of its 45 dehydrating function.

Another feature of the invention resides in circulating air to be conditioned in contact with a moving belt made of and/or carrying hygroscopic material, whereby moisture and dirt are removed 50 from the air to be conditioned, removing such moisture and dirt from the belt at a point outside the chamber in which the air to be conditioned is contacted with the belt, and returning the belt for a repetition of its dehydrating and 55 cleaning function.

Another feature of the invention resides in passing air in contact with a continuous belt made of and/or carrying hygroscopic material, passing the belt from the chamber in which it 60 contacts with the air to be conditioned to a regenerating chamber and then back to the air conditioning chamber, and regenerating the belt by circulating through and in contact therewith 65 in the regenerating chamber a heated gas, such as air.

Another feature of the invention resides in passing air in contact with a continuous belt made of and/or carrying hygroscopic material, passing the belt from the chamber in which it 70 contacts with the air to be conditioned to a regenerating chamber and then back to the air conditioning chamber, regenerating the belt by circulating through and in contact therewith 75 in the regenerating chamber a heated gas, such as air, the regenerating gas being withdrawn from the regenerating chamber through a relatively narrow slot positioned proximate the surface of the belt, whereby the gas withdrawn from 80 the regenerating chamber passes therefrom at relatively high velocity, entraining and carrying off dirt particles from the belt.

Another feature of the invention resides in passing air in contact with a continuous belt made of and/or carrying a hygroscopic material, 85 passing the belt from the chamber in which it contacts with the air to be conditioned to a regenerating chamber and then back to the air conditioning chamber, the belt passing to the regenerating chamber and the belt passing there- 90 from being in heat exchange relation but being separated from each other by a partition adapted to prevent moisture interchange therebetween.

Other objects, features and advantages of the invention will be more apparent from the follow- 95

ing description, to be read in connection with the accompanying drawing, which diagrammatically represents an air conditioning system in accordance with the invention.

- 5 Referring to the drawing the numeral 5 designates an air conditioning chamber through which air to be conditioned is circulated by a fan 6 in the direction indicated by arrows 7. Within chamber 5 the air circulated by fan 6 contacts with continuous belt 8, which is suitably carried within the conditioning chamber by means such as rollers 9. One or more of the rollers 9 will be rotated by any suitable driving means to cause travel of the belt 8, preferably in the direction indicated by the arrows 9a, while the remainder of rollers 9 may idle while properly supporting and guiding the belt 8. The belt 8 preferably extends across the entire cross-sectional area of chamber 5 so that substantially all of the air passing through the conditioning chamber contacts with and/or passes through the belt.

- Belt 8 may be formed of an adsorber, such as cotton, or other fibrous material, or it may be formed of material which is non-hygroscopic. When the belt is formed of hygroscopic material it is preferably arranged to serve as a carrier for other hygroscopic material, such as calcium chloride, lithium chloride, silica gel or the like, with which it is preferably impregnated or coated. When the belt 8 is formed of non-hygroscopic material, it is coated with or otherwise carries such a material as effects the adsorption of moisture from the air. While the belt 8 is preferably sufficiently sieve-like so that air may pass there-through without encountering excessive resistance, the mesh or openings in the belt formation are preferably sufficiently fine to entrap dirt particles and the like from the air to be conditioned, so that the belt serves not only to dehydrate the air but to clean it as well. It is advantageous to construct the belt of fibrous textile material, not only because it is itself hygroscopic, but also because such material provides effective cleaning action while not offering excessive resistance to air flow therethrough.

- After the belt 8 has been passed through the chamber 5, it is withdrawn therefrom through a duct 10 and supplied to regenerating chamber 11 of any desired shape or design, through which it is carried on suitable rollers 12. As explained in connection with rollers 9, one or more of the rollers 12 may be driven to effect desired motion of the belt while the remainder of the rollers 12 may idle. Air or other gas is supplied to the chamber 11 through connection 13. Preferably, the air so supplied is preheated as by heating coils 20, but such preheating is not essential to the intended operation, since within the chamber 11 and preferably positioned close to the belt 8 are heating coils 14. Coils 14 serve to heat not only the belt 8 but also the air intaken within the chamber 11 from connection 13. Thus the moisture removed from the air in conditioning chamber 5 is driven off from the belt and/or the hygroscopic material it carries, in preparation for a repetition of the cycle. If desired, of course, coils 14 may be eliminated, the air in such case being sufficiently preheated to effect the desired regeneration.

- Preferably, baffles 15 are provided within chamber 11 to route the introduced air through the belt 8 and between the coils 14 in a serpentine course, thus assuring intimate and highly effective contact between the reactivating air and the belt. Preferably, as illustrated, the air is circulated through the chamber 11 in a direction counter to

that in which the belt 8 is passed therethrough. At the end of the chamber 11 opposite air inlet connection 13, is provided an outlet connection 16, which is connected to a fan 21, preferably of the high pressure type. Outlet connection 16 is so formed that its inlet end 17 is a comparatively small orifice or slotted opening extending substantially completely across the full width of belt 8, and this orifice is located relatively close to the surface of the belt entering the regenerating chamber 11. This arrangement insures the withdrawal of air and water vapor from the regenerating chamber at relatively high velocity, and this in turn causes the entrainment and carrying off of dirt particles from the belt entering the regenerating chamber. Thus, it will be noted that the air or other gas which is used for regenerating the belt also serves to clean the same in a continuous process.

Since the adsorption of moisture from air causes a substantial increase in its dry bulb temperature, due to the release of the heat of vaporization, cooling coils 18 are provided in the conditioning chamber 5 to reduce the dry bulb temperature of the dehydrated air. As illustrated, the cooling coils 18 are positioned within the path described by the belt 8; thus the air is cooled between the two dehydrating stages provided by its passage twice through the belt. This intercooling tends to make the second dehydrating step more effective than if no provision were made for intercooling but, if desired, the coils 18 may be positioned beyond the belt 8. Further to reduce the dry bulb temperature of the dehydrated air, cooling coils 18a are preferably provided within the casing 5 and beyond the belt 8.

The belt passing from the conditioning chamber 5 to the regenerating chamber 11 is relatively warm due to the liberation of the heat of vaporization from the conditioned air as above described. However, the belt passing from the regenerating chamber 11 to conditioner chamber 5 is considerably hotter than the belt passing through duct 10 in a reverse direction, due to the high temperature of the reactivating air. It is desirable that the temperature within regenerating chamber 11 be maintained at a high value to facilitate regeneration of the adsorber, whereas it is desirable that the temperature within the conditioning chamber 5 be maintained as low as possible to reduce the cooling load on coils 18 and to provide more efficient adsorption. Accordingly, applicant provides for heat exchange between the belt leaving the regenerating chamber and the belt passing thereto by passing these portions of the belt in close proximity to each other within the relatively narrow duct 10. However, to prevent moisture interchange between the belt portions, a partition 19, of metal or other material impervious to moisture, is provided within the duct 10 to separate the belt portions therein. As will be understood, the partition 19 is preferably formed of material having a high heat conductivity to facilitate heat interchange within the duct 10.

The duct 10 connecting the conditioning chamber and the regenerating chamber is relatively flat. The space between each side of the duct 10 and the partition 19 is made as small as possible, consistently with the provision of enough space for the passage of the belt 8 and some clearance on either side thereof, in order to prevent the circulation of air between the conditioning chamber and the regenerating chamber.

Since many modifications may be made in the

invention without departing from its scope, it is to be understood that the above description and accompanying drawing are intended as illustrative only and not in a limiting sense, applicant limiting himself only as indicated in the appended claims.

I claim:

1. In an apparatus of the character described, a regenerating chamber, means for supplying to and passing through said chamber hygroscopic material which is to be regenerated and relieved of dirt particles, means for passing through said chamber in contact with said material gas having a relatively high temperature, and means for withdrawing said gas from said material at a velocity which is considerably higher than the velocity at which said gas is passed in contact with said material, whereby to remove particles of foreign matter from said material.
2. In an apparatus of the character described, a regenerating chamber, means for supplying to and passing through said chamber hygroscopic material which is to be regenerated and relieved of dirt particles, means for passing through said chamber in contact with said material gas having a relatively high temperature, and means for withdrawing from said material at relatively high velocity gas which has contacted therewith, said last mentioned means including a slot positioned relatively close to the surface of said material, the cross-sectional area of said slot being considerably smaller than the smallest free area provided for the passage of said gas through said regenerating chamber
3. In an apparatus of the character described, a regenerating chamber, means for supplying to and passing through the chamber hygroscopic material to be regenerated, means for passing through said chamber in contact with said material and in a direction counter to that of said material gas having a relatively high temperature, and means for withdrawing said gas from said chamber at a point proximate the point at which said material is supplied to said chamber at a velocity which is considerably higher than the velocity at which said gas is passed in contact with said material.
4. In an apparatus of the character described, a regenerating chamber, means for supplying to and passing through the chamber hygroscopic material to be regenerated, means for passing through said chamber in contact with said material and in a direction counter to that of said material gas having a relatively high temperature, and means for withdrawing said gas from said chamber at a point proximate the point at which said material is supplied to said chamber and at a velocity considerably higher than the velocity at which said gas is passed in contact

with said material, said last-mentioned means including orifice means positioned relatively close to said material and having a cross-sectional area which is relatively small as compared with that of the path through which said gas is passed in contact with said material.

5. In combination with an apparatus including a regenerating chamber, an air conditioning chamber, and an endless hygroscopic belt passing to and from each of said chambers; conduit means connecting said conditioning chamber and said regenerating chamber through which said belt passes to and from each chamber, and water-impervious partition means within said conduit means for separating belt portions passing through said conduit means in opposite directions.

6. In combination with an apparatus including a regenerating chamber, an air conditioning chamber, and an endless hygroscopic belt passing to and from each of said chambers; conduit means connecting said conditioning chamber and said regenerating chamber through which said belt passes to and from each chamber, and water-impervious partition means having relatively high heat conductivity for separating belt portions passing through said conduit means in opposite directions.

7. In combination with an apparatus including a regenerating chamber, an air conditioning chamber, and an endless hygroscopic belt passing to and from each of said chambers; relatively narrow conduit means connecting said conditioning chamber and said regenerating chamber through which said belt passes to and from each chamber, and water-impervious partition means within said conduit means for separating belt portions passing through said conduit means in opposite directions, said conduit means being sufficiently narrow to prevent appreciable gas flow between said regenerating chamber and said conditioning chamber.

8. In combination with an apparatus including a regenerating chamber, an air conditioning chamber, and an endless hygroscopic belt passing to and from each of said chambers; conduit means connecting said conditioning chamber and said regenerating chamber through which said belt passes to and from each chamber, and a metal partition within said conduit means for separating and segregating belt portions passing through said conduit means in opposite directions, whereby heat interchange is permitted between belt portions moving in opposite directions through said conduit means and whereby moisture interchange between said belt portions moving in opposite directions is prevented.

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