March 21, 1961 H. W. WESTEREN 2,975,860

ATMOSPHERE DRYING APPARATUS

Original Filed May 3, 1957 2 Sheets-Sheet 1

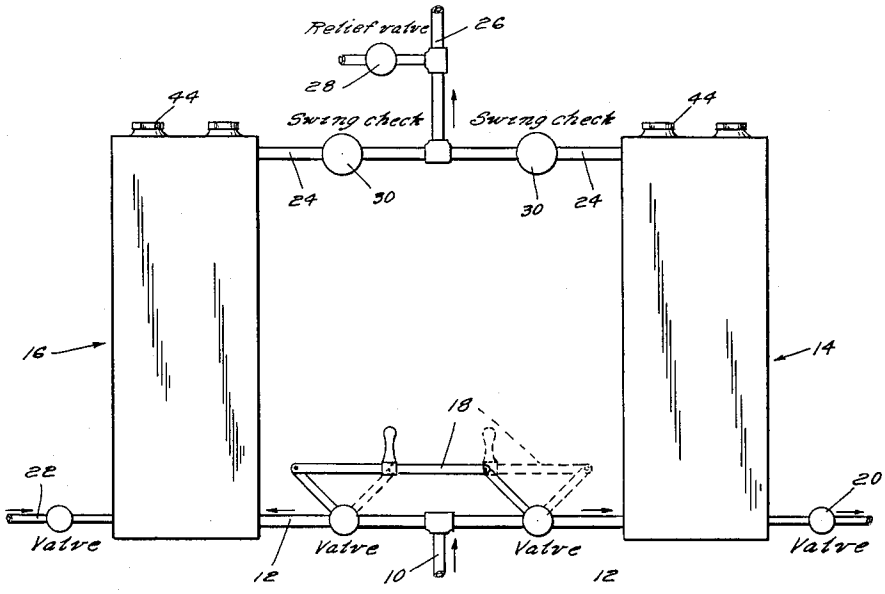



Fig. 1

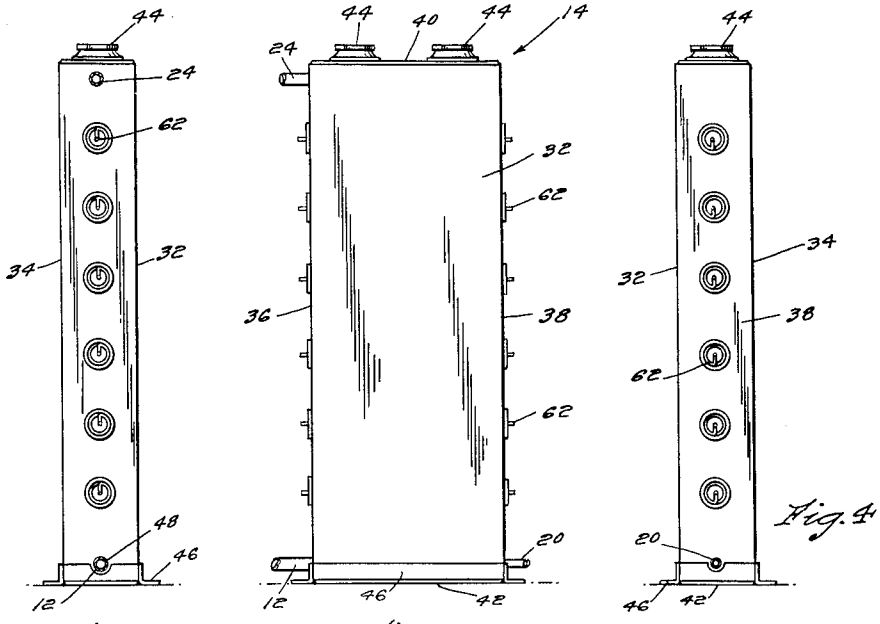



Fig. 3

Fig. 2

Fig. 4

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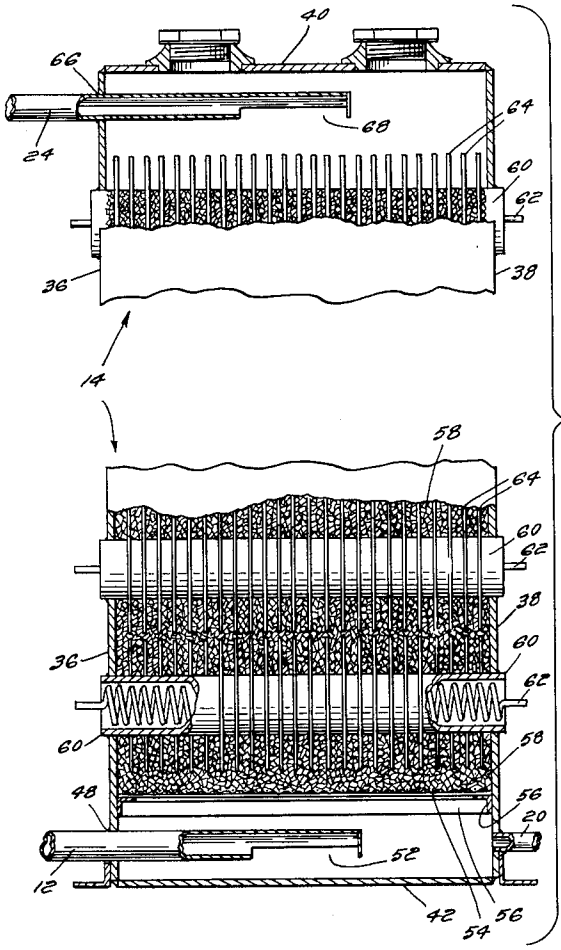



Fig. 5

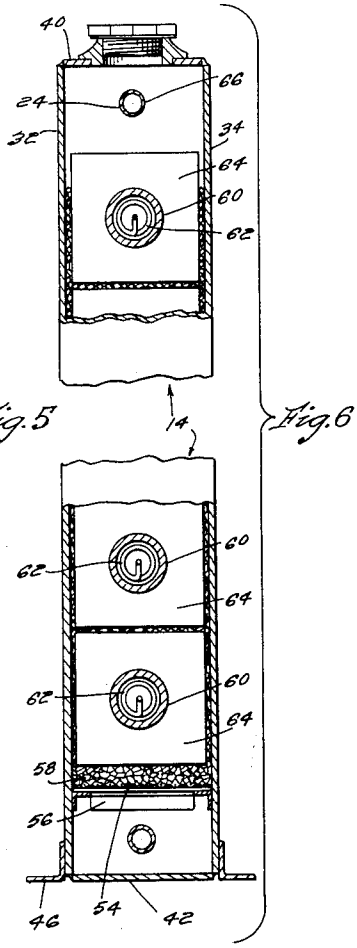



Fig. 6

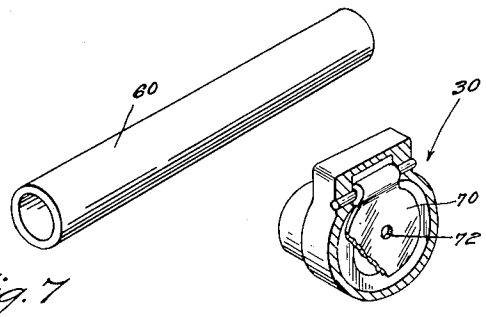



Fig. 7




Fig. 9

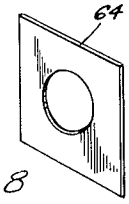



Fig. 8

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2,975,860

# ATMOSPHERE DRYING APPARATUS

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Original application May 3, 1957, Ser. No. 656,840. Divided and this application Dec. 15, 1958, Ser. No. 789,220

1 Claim. (Cl. 183—4.7)

This application is a division of applicant's co-pending application, Serial No. 656,840, filed May 3, 1957.

The present invention pertains generally to the provision of novel and improved apparatus for properly conditioning heat treatment atmospheres and the like, and more particularly, is concerned with problem of removing moisture therefrom.

A primary object of the instant invention is the provision of atmosphere drying apparatus specifically constructed so as to enable reactivation to take place in a reasonable length of time and without the use of expensive and complicated equipment, such as blowers, heat exchangers, and the like.

Another important object of my invention is the provision of an atmosphere drier having novel and improved means for rapidly and uniformly heating the desiccant utilized in order to aid in efficient reactivation of the latter.

Another object of this invention is the provision of atmosphere drying appartus wherein the desiccant chamber is so constructed as to enable it to be more readily cooled after it has been heated during the reactivation cycle.

A further object of the instant invention is the provision of atmosphere drying apparatus having novel and improved means for controlling the flow of purge gas through the desiccant chamber during reactivation of the latter.

Still another object of my invention is the provision of apparatus of the character described which is simple and economically feasible to manufacture, easy to operate, and highly efficient in operation.

Other objects, features and advantages of the invention will become apparent as the description thereof proceeds when considered in connection with the accompanying illustrative drawings.

In the drawings which illustrate the best mode presently contemplated by me for carrying out my invention:

Fig. 1 is a diagrammatic view showing the general layout of my novel and improved atmosphere drying apparatus;

Fig. 2 is a front elevation of one of the desiccant or drying chambers per se;

Fig. 3 is a side elevation thereof;

Fig. 4 is an elevational view taken from the other side thereof;

Fig. 5 is a longitudinal, vertical section, on an enlarged scale, of one of the desiccant chambers;

Fig. 6 is a transverse, vertical section thereof;

Fig. 7 is a perspective detail, on an enlarged scale, of one of the conducting pipes which forms a part of my construction;

Fig. 8 is a perspective detail, on an enlarged scale, of one of the radiation fins which forms a part of my construction; and

Fig. 9 is a perspective view, on an enlarged scale, partly in section and partly broken away, showing the swing check valve which forms a part of my invention.



This invention is concerned with the treatment of atmospheres and gases where specialized uses require that they be either completely dry or free from certain reacting chemicals. For example, where hydrogen bearing atmospheres are to be used in connection with the heat treatment of high-speed steels and the like, it is absolutely essential that the atmosphere be rid of any appreciable moisture since otherwise vaporization would take place at the high heat treatment temperatures, and oxygen content of the vapors would result in contamination of the work load being heat treated.

Generally speaking, it is standard practice to dehumidify atmospheres and gases of this type by passing them through a drying chamber comprising a desiccant therein, the desiccant functioning the absorb the moisture from the gas stream, whereupon the latter is substantially dried before passing to its point of use, such as a heat treatment furnace. Depending on certain factors, such as the rate of flow of the atmosphere, the moisture content thereof, and the size and temperature of the desiccant chamber, the desiccant will eventually become saturated, at which point it becomes necessary to reactivate same by removing the moisture therefrom. Quite obviously, if this is not done, the desiccant will be incapable of drawing off further moisture from the gases passing therethrough and hence will become completely inefficient for its intended purpose.

Since it is a well-known fact that desiccants will not absorb or retain moisture at relatively high temperatures, reactivation may be accomplished by heating the desiccant chamber in order to release the absorbed moisture and then purging the moisture therefrom by a regulated gas flow. Once this has been done and the chamber has again been cooled, the desiccant may resume its absorbing function.

The problem which presents itself in connection with the above described reactivation operation resides in the fact that desiccants are notoriously poor conductors of heat, and hence, it has proven extremely difficult to effectively and uniformly heat the desiccant in a reasonable period of time. Furthermore, once the desiccant has become uniformly heated and purged of its moisture, it must be cooled before being used again, and here again, its poor conductive qualities are a deterrent to rapid and efficient cooling. The instant invention has overcome this problem by the provision of novel and improved heat exchange means in the desiccant chamber, which mean, while extremely effective in use and operation, nevertheless do not require any expensive or complicated apparatus, such as blowers, heat exchangers, and the like. Furthermore, my construction enables the desiccant chamber to be heated, purged, and cooled in a relatively short period of time.

It should be pointed out that even though my invention is primarily concerned with the removal of moisture from hydrogen bearing heat treatment atmospheres, the construction now to be described is equally applicable where moisture removal is not the primary concern. For example, desiccant-type driers can be utilized in connection with dissociated ammonia and will function to absorb any residual ammonia in the dissociated stream. Also, $CO_2$ and $H_2O$ can be removed from nitrogen in order to provide so-called dry nitrogen, and in each of these instances, the drying apparatus and the reactivation process are substantially the same. In addition, it should be understood that this invention may be of value in connection with a wide variety of uses having no connection at all with heat treatment atmospheres, as such, the above disclosed examples being purely for purposes of illustration.

Referring now to the drawings, and more particularly to Fig. 1 thereof, the atmosphere or gas to be dried flows

inwardly through conduit 10 to line 12, which in turn connects at its opposite ends to drying or desiccant chambers 14 and 16, hereinafter to be described in detail. It will be understood that the chambers 14 and 16 are of identical construction, and a double acting valve 18 is associated with line 12 to insure that the flow of atmosphere will always be directed to one or the other of the chambers 14 and 16. In other words, when the valve 18 is in its full-line position, the flow will be to chamber 14, and the line to chamber 16 will be blocked. Conversely, when the valve is in its dotted-line position, the flow will be solely to chamber 16. Vent means 20 and 22 are provided adjacent the lower extremities of chambers 14 and 16, respectively, for reasons hereinafter to be made apparent.

After passing through chamber 14 or 16, the atmosphere flow egresses through line 24 and then outwardly through conduit 26, the latter being provided with a relief valve 28. Specially designed swing check valves 30 are provided in line 24 adjacent each of the chambers. The construction and function of the valves 30 will hereinafter be made apparent.

Referring now to Figs. 2 through 6, the construction of chamber 14 will be described; and since, as afore stated, the chambers 14 and 16 are of identical construction, it will be understood that the ensuing description is equally applicable to chamber 16. As will be seen most clearly in Figs. 2 through 4, the chamber 14 basically comprises a rectangular housing having front and rear walls 32, 34, side walls 36, 38, and top and bottom walls 40, 42, respectively. In order that the chamber may be readily filled with and emptied of the desiccant utilized in connection therewith, top wall 40 is provided with a pair of necked, openable closures 44. Any desirable means, such as brackets 46, may be utilized for insuring that the chamber will remain in its proper, upright position during use.

Referring now to Figs. 5 and 6, it will be noted that the chamber 14 is provided with an inlet opening 48, through which the line or conduit 12 extends. When the chamber is set up as a part of the system shown in Fig. 1, inlet opening 48 is preferably disposed on inner side wall 36, while outer side wall 38 is provided with the venting valve 20 in substantial alignment with line 12, said venting valve being operable to aid in the purging of the chamber, as will hereinafter become apparent. Preferably, the line or conduit 12 is closed at its inner end and has a downwardly disposed flow opening 52 so that the flow of atmosphere to be dried will be directed downwardly against bottom wall 42, and upon making contact therewith, it will be deflected upwardly through the desiccant. This aids in accomplishing better diffusion of the atmosphere or gas.

Spaced slightly above line or conduit 12 and in substantially parallel relation to bottom wall 42 is a screen-like partition 54 mounted by any suitable means, such as brackets 56. As will be apparent, the partition 54 functions to maintain the desiccant 58, with which the chamber is filled, spaced from the bottom of the chamber while at the same time enabling the atmosphere to pass upwardly therethrough. As hereinbefore indicated, desiccant 58 is a material having the ability to absorb certain constituents, such as moisture, from a gas or atmosphere stream passing therethrough. Some examples of desiccants in common use are activated alumina, silica gel, and molecular sieve, although I prefer to utilize the latter since it has a greater absorbent capacity and also is capable of performing its absorbing function at higher temperatures. Molecular sieve as utilized in this invention is characterized by a mass of small, chalk-like pellets consisting of crystalline sodium and calcium alumino-silicates. It might be pointed out that while use of molecular sieve is desirable due to its greater absorbent capacity and its capability of absorbing effectively at higher temperatures, these very factors prove disadvantageous during the reactivation cycle. In fact, the extreme difficulty in reactivating molecular sieve has made this otherwise desirable absorbent impractical for use in apparatus of the general type under consideration, but this difficulty has now been overcome by the instant construction.

Extending transversely of chamber 14, from side wall 36 to side wall 38, are a plurality of vertically spaced and aligned open-ended pipes 60, said pipes having extending therethrough heating coils 62, which may be energized by any suitable means (not shown). Mounted on each of the pipes 60, by any desirable means, are a plurality of radiation fins 64, said fins being mounted in closely spaced relation and being of a width so as to substantially span the chamber 14 as shown most clearly in Fig. 6. As will be apparent, this particular arrangement enables the entire desiccant mass to be rapidly, uniformly, and efficiently heated, and since the pipes 60 are open ended, circulation of air therethrough will enable the mass to be more readily cooled after the heating operation is completed. Thus, while the open-ended pipes 60 in themselves provide a relatively inefficient heating arrangement, it has been found that by supplying sufficient energy to the coil 62, enough heat may be generated to reactivate the desiccant mass 58, particularly in view of the efficient dissemination of the heat which is accomplished by the fins 64 and their particular arrangement. At the same time, the inefficiency of the heating system becomes a decided advantage during the cooling of the chamber, and this is an important point since, as afore indicated, the desiccant is not capable of performing its drying function after reactivation until it has once again become cool, a time interval normally of considerable length due to the poor heat conductive qualities of the desiccant. By speeding up this cooling operation, a more efficient and economically feasible unit is provided.

As will be noted in Fig. 5, the upper level of desiccant 58 is somewhat lower than the upper edges of the top series of radiation fins 64. The reason for this is to insure that purge gas flowing downwardly through the chamber will be somewhat preheated before actually contacting the desiccant.

Adjacent the upper extremity of chamber 14, and preferably at inner side wall 36, there is provided an outlet opening 66 for receiving line 24. As will be noted, line 24 is provided with a downwardly disposed opening 68 at its inner end for receiving the now dried atmosphere and passing it outwardly through swing check valve 30 and conduit 26. Swing check 30 is shown in detail in Fig. 9 and comprises a swingable element 70 which will swing open to allow free flow in one direction but which will restrict the flow in the opposite direction, all in a well-known and conventional manner. In the instant construction, however, the swingable plate 70 is provided with a small aperture or orifice 72 for enabling a regulated flow to take place in said opposite direction. Thus, the swing check valves 30 are positioned in line 24 so as to enable free and unhindered flow of dried atmosphere from the chambers 14 and 16, and at the same time, so as to enable a small regulated flow of atmosphere into said chambers through line 24 during the reactivation cycle.

Assuming that the chambers 14 and 16 are both reactivated, the cycle of operation is as follows. With the venting valves 20 both closed, valve 18 is moved to its full-line position (Fig. 1) whereupon the flow of atmosphere to be dried will be completely directed into chamber 14 through line 12 and opening 52. The atmosphere will then be deflected upwardly through the screen-like partition 54 and then through the desiccant mass 58. As the atmosphere passes upwardly, its moisture content will be absorbed therefrom by the desiccant whereupon, by the time the atmosphere reaches outlet 68 and conduit 24, it will be substantially moisture free. The atmosphere then flows outwardly through line 24, swing check valve

30, and conduit 26, and then to its point of use. It will be understood that during this phase of the operation the chamber 14 is cooled, or at least at substantially room temperature.

When the desiccant 58 in chamber 14 has become saturated, valve 18 is moved to its dotted-line position, whereupon the flow of incoming atmosphere will be directed solely to chamber 16. At the same time, venting valve 20 in chamber 14 is opened, and heating coils 62 in said latter chamber are energized. As will be obvious, energization of the coils 62 will heat the pipes 60 and their respective radiation fins 64, which in turn rapidly and uniformly heat the desiccant mass 58. In the meantime, the opening of vent 20 in chamber 14 results in a pressure reduction, which causes a certain amount of the dried atmosphere flow passing from chamber 16 to circulate back through the chamber 14 in order to purge same of the moisture which has been released from its desiccant by the afore mentioned heating operation. Since this flow of purge gas into chamber 14 is made possible by the fact that the latter's swing check valve 30 has orifice 72 therein, it follows that the rate of this back flow may be readily regulated by varying the size of said orifice. Thus, use of my particular modified swing check valve provides a simple and effective way of controlling the back flow of purge gas and eliminates the necessity of using complicated throttling valves and the like which would otherwise be necessitated.

After the chamber 14 has been completely reactivated, or in other words, removed of its moisture content, the heating circuit is turned off, and venting valve 20 is closed. If desired, the heating circuit and venting valves could be tied in with each other so that said valves will automatically open when their respective coils 62 are energized and, conversely, closed when the latter are de-energized. This could very simply be done by effecting the opening and closing of these valves by means of solenoids controlled by the heating circuit, but it will be understood that it is immaterial to the successful operation of the instant invention whether such be the case or whether said venting valves be manually operated.

As soon as the chamber 14 has been reactivated in the manner above set forth and its vent valve 20 closed, the flow of dried atmosphere passing from chamber 16 through line 24 will exit completely through conduit 26. Then, when the desiccant in chamber 16 has become saturated, the valve 18 is swung back to its full-line position, whereupon the flow of atmosphere to be dried will once again be through the now reactivated chamber 14, while at the same time, reactivation of chamber 16 takes place in the manner described supra. Thus, a complete cycle of operation is provided wherein a constant and continuous flow of dried atmosphere is emitted, since the reactivation process is substantially shorter in point of time than that required for one of the chambers to become saturated, under normal operating conditions at least.

As will be noted, the flow of purge gas passing through a given chamber during its reactivation is always in a direction opposite to that of the flow of atmosphere being dried. This is important since it insures that the upper portion of the desiccant bed will be better purged and dried, whereupon atmosphere passing upwardly through said chamber is less liable to contain any moisture as it passes from the desiccant bed. It will also be noted that the back purging operation of the instant invention utilizes gas or atmosphere which has already been dried thereby resulting in better purging and more effective reactivation. As hereinbefore indicated, the fact that the purge gas is preheated by the uppermost fin 64 before contacting the desiccant bed also aids in the accomplishment of more effective reactivation. These factors, when taken in account with my improved heating and cooling means, have resulted in the provision of highly efficient and yet economical drying apparatus.

While there is shown and described herein certain specific structure embodying the invention, it will be manifest to those skilled in the art that various modifications and rearrangements of the parts may be made without departing from the spirit and scope of the underlying inventive concept and that the same is not limited to the particular forms herein shown and described except in so far as indicated by the scope of the appended claim.

I claim:

Atmosphere drying apparatus comprising a pair of chambers each substantially filled with a desiccant, inlet and outlet openings adjacent opposite extremities thereof, vent means adjacent said inlet openings, first valve means for diverting the flow of atmosphere to be dried to one or the other of said inlet openings, second valve means adjacent each of said outlet openings for enabling a regulated flow of dried atmosphere to pass into and through the other chamber when the vent means of the latter is operated, said second valve means comprising swing check valves having a relatively small aperture extending through the swinging element of each check valve, and means for heating said chambers.

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