

May 16, 1950

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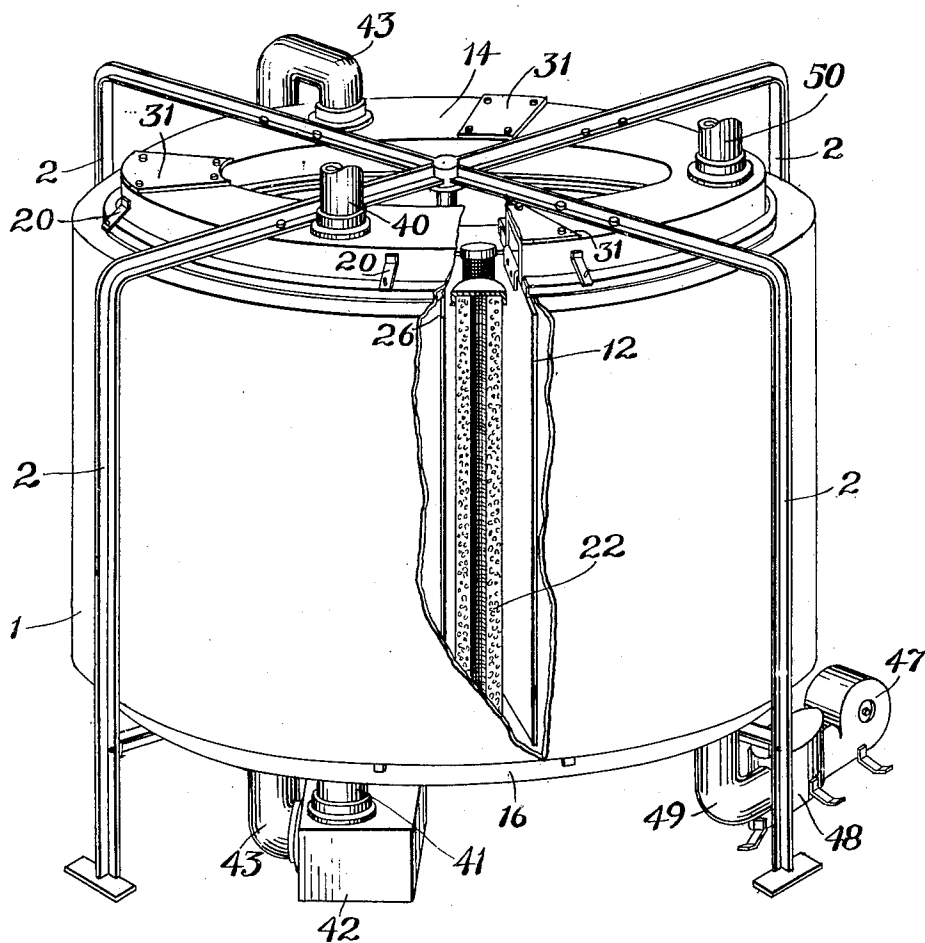
2,507,607

APPARATUS FOR CONDITIONING AIR

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6 Sheets-Sheet 1

Fig. 1.



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Fig. 2.

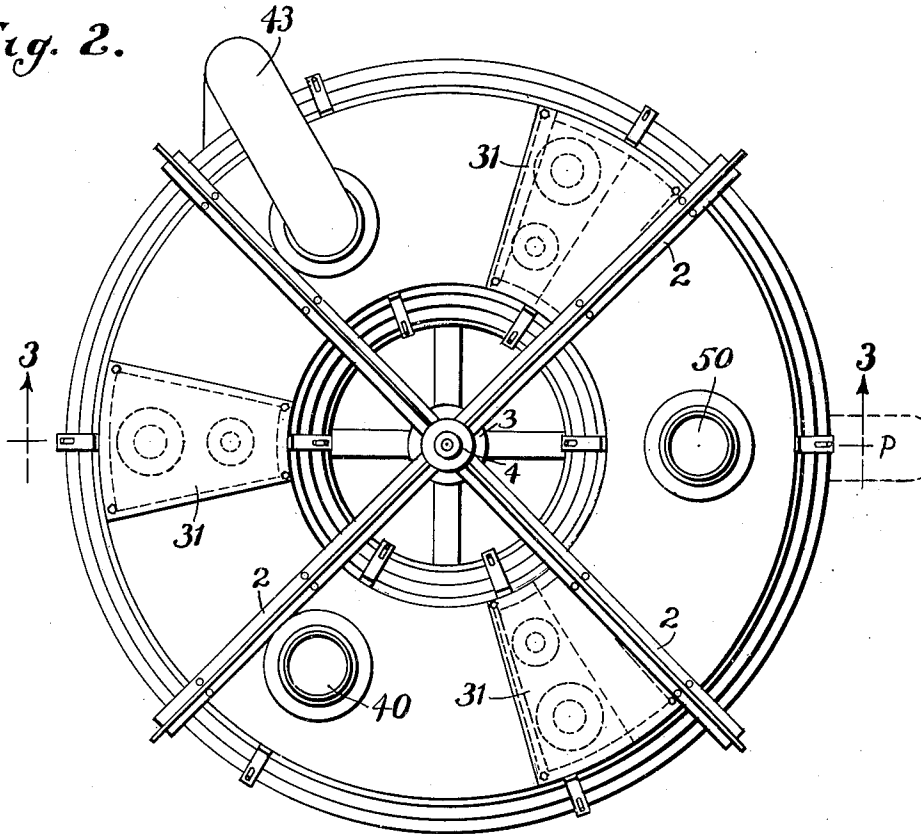
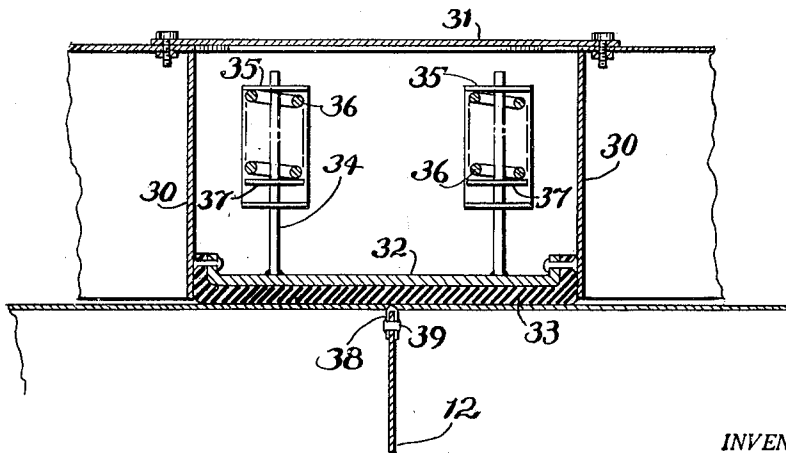


Fig. 7.



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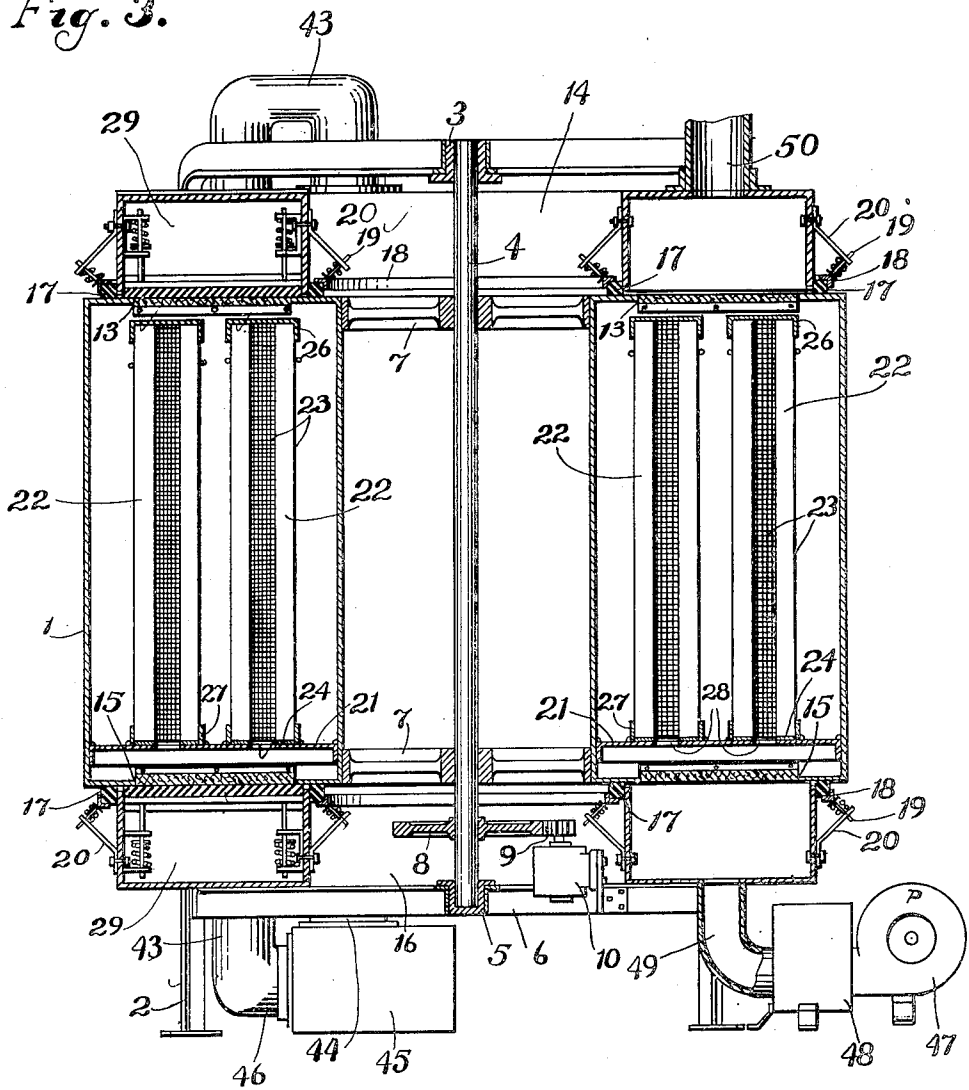
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Fig. 3.



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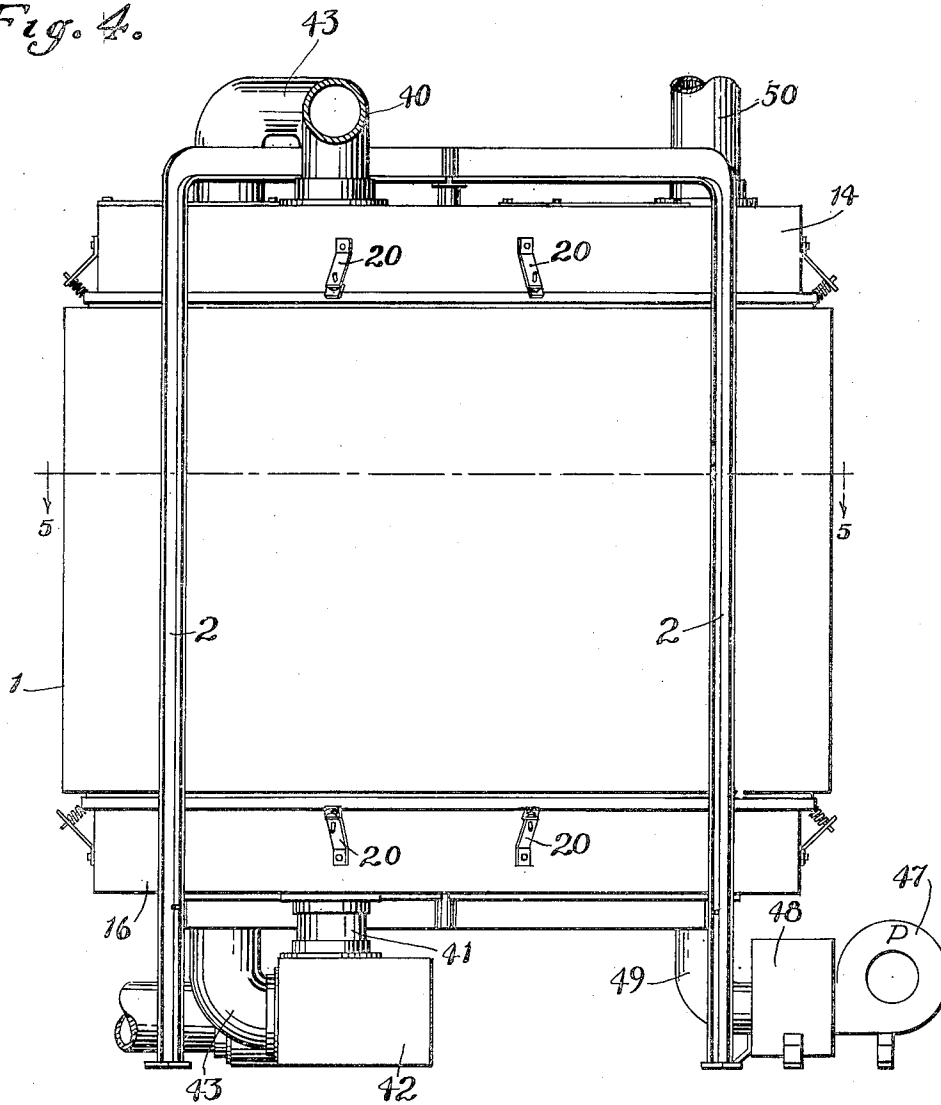
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Fig. 4.



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Fig. 5.

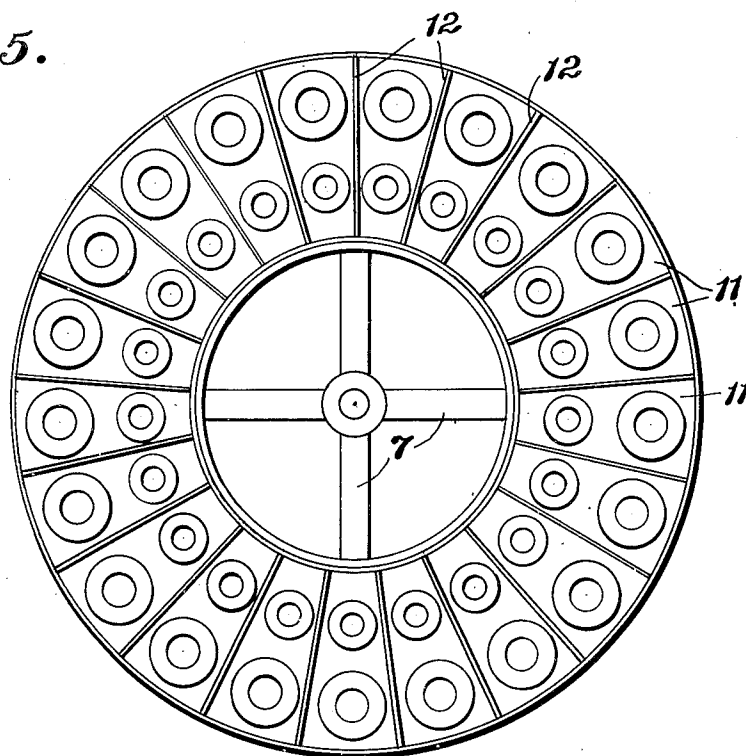
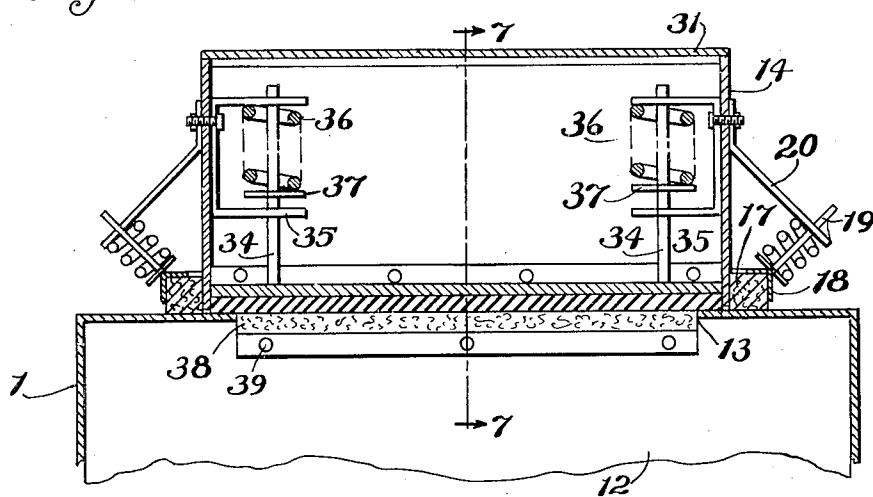


Fig. 6.



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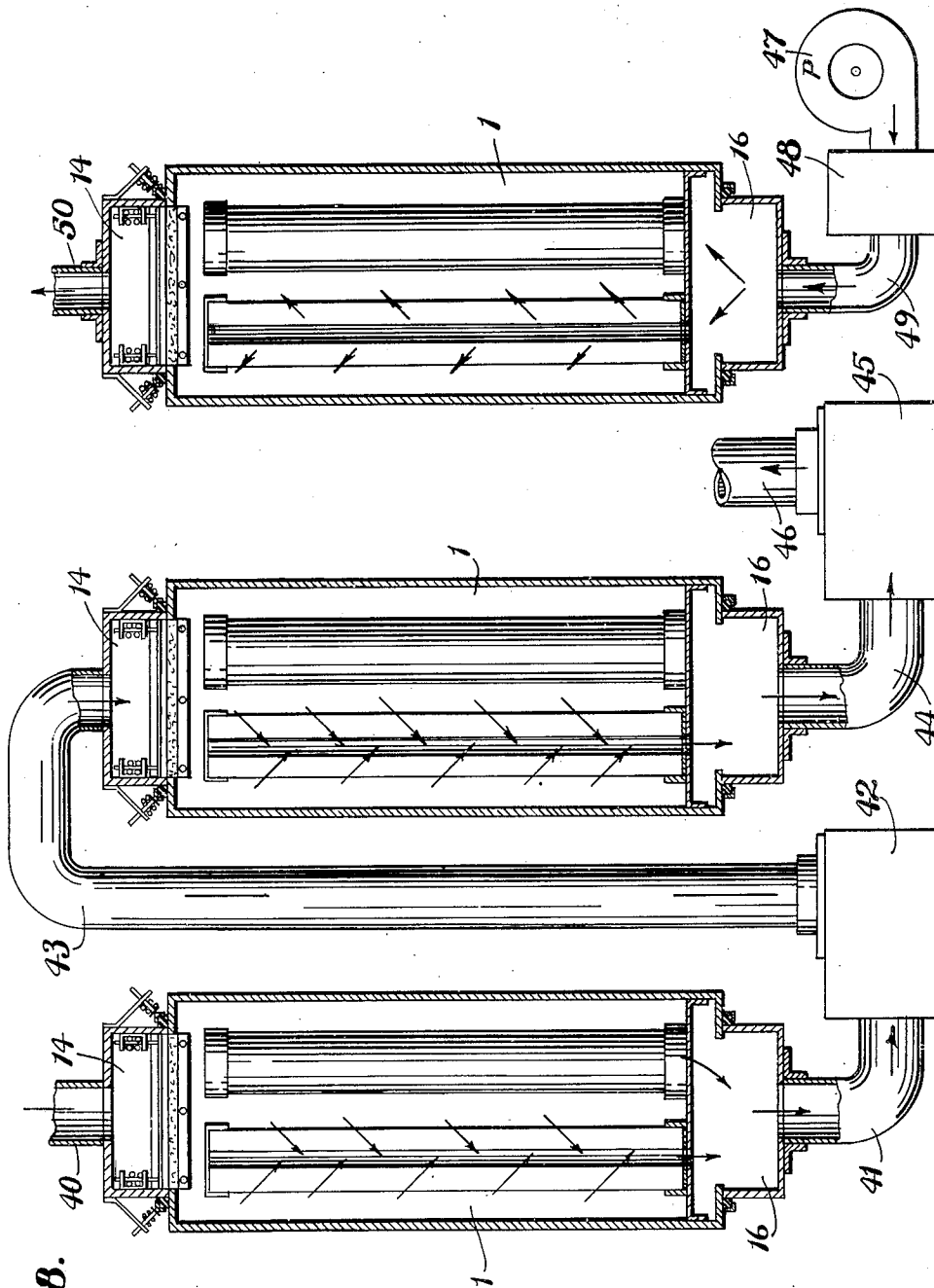


Fig. 8.

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UNITED STATES PATENT OFFICE

2,507,607

APPARATUS FOR CONDITIONING AIR

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Application March 18, 1946, Serial No. 655,213

6 Claims. (Cl. 183—4.6)

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This invention pertains to air conditioning and has more particular reference to air conditioning systems of the adsorption type.

It is usual in such systems to employ adsorbent material which, when it has adsorbed a certain amount of moisture, may be regenerated or activated by heat.

Such systems usually provide for the continuous dehydration of air in a single chamber by moving the adsorbent material on a conveyor belt or rotary drum through the dehydration chamber, then through a regeneration or activation chamber in a continuous process. Such a system is disclosed in my Patent No. 2,286,920.

One object of the present invention is to provide an improved apparatus for conditioning air designed to obtain a high efficiency of moisture removal and, at the same time, a satisfactory saturation of the adsorbent, by providing two-stage treatment of the air undergoing dehydration, and an intercooler between stages to remove heat from the system at a critical point.

Another object of the invention is to provide an air conditioning machine in which a large surface area of relatively thin adsorbent material offering a minimum of resistance to the flow of gases is condensed into a small cubic space.

Another object of the invention is to provide an air conditioning system in which a plurality of adsorber units are continuously and successively moved into and through two or more dehydrating chambers and then into and through an activating chamber in which it is prepared for a repetition of the cycle.

A further object of the invention is to provide an air conditioning system in which the adsorber units may be readily removed and replaced.

Other objects and advantages of the invention will appear in the specification when considered in connection with the accompanying drawings, in which:

Fig. 1 is a perspective view of the air conditioner, broken away at one point to show the elongated annular adsorber beds within the rotatable annular drum;

Fig. 2 is a plan view of the air conditioner;

Fig. 3 is a vertical sectional view taken on the line 3—3 of Fig. 2, in the direction of the arrows;

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Fig. 4 is a side elevation view of the air conditioner;

Fig. 5 is a horizontal sectional view of the rotatable annular drum, taken on the line 5—5 of Fig. 4, in the direction of the arrows;

Fig. 6 is an enlarged vertical sectional view of the seal shown in the upper manifold in Fig. 3;

Fig. 7 is a vertical sectional view, taken on the line 7—7 of Fig. 6, in the direction of the arrows; and

Fig. 8 is a schematic view to show the course of air through the first and second stages of the dehydration, and the flow of hot gases through the activation stage.

Referring to the several figures of the drawings, there is shown a rotatable annular drum 1 mounted within a suitable structural frame, shown as having four legs 2 bent over the top of the drum, each being connected to a plate carrying an upper vertical guide bearing 3 for a central vertical shaft 4 having a lower step bearing 5 mounted on cross beams 6 secured to the legs 2 of the supporting frame near the bottom thereof. Upper and lower radial arms or spokes 7 connect the shaft to the drum.

Rotation of the drum is effected by means of a gear 8 fixed to the shaft and meshing with a gear 9 driven by any prime mover, such as a motor 10 mounted on one of the cross beams 6 near the bottom of the frame.

The rotatable annular drum is divided into a plurality of compartments 11 by radial partitions or diaphragms 12. The top of the drum is provided with a continuous annular opening 13, which is closed by a stationary top manifold 14 fixedly attached to the frame. The bottom of the drum is also provided with a continuous annular opening 15, which is closed by a stationary bottom manifold 16 fixedly attached to the cross beams 6.

To prevent the escape of air between the rotating drum and the top and bottom manifolds, sealing ring gaskets 17 are placed at the junction of the manifolds and the drum. The sealing gaskets 17 are carried by angles 18, against which a plurality of circumferentially spaced spring plungers 19, mounted on brackets 20 attached to the manifolds, act to hold the gaskets in tight sealing engagement.

In each of the radial compartments 11, near the bottom thereof, there is provided a plate 21 attached to the walls of the compartment, as by welding, to form a gas-tight joint. The plate 21 forms a support for one or more elongated, annular, foraminous adsorbent containers 22. Each container comprises two concentric tubular wire screens 23 having the annular space between the screens closed at the bottom by an annular plate 24. The mesh of the screen is such as to retain a granular adsorbent 25 in the annular space between the screens. The adsorbent employed may be any adsorbent having characteristics substantially like silica gel or the gel of other activated hydrous oxides. Preferably, silica gel is used.

Each container is closed at its top, as by a cap member 26, and has its bottom end detachably mounted in a socket formed on the plate 21, as by means of a ring 27 welded thereon. The bottoms of the sockets have openings 28 therein corresponding in size and aligned with the open bottom ends of the annular adsorbent containers, as clearly shown in Fig. 3.

At three spaced aligned points on the top and bottom manifolds there are located seals 29 which, by reason of the sliding contact of the radial partitions 12 against the under face of the bottom of the seals, divides the manifolds and drum into three sectors, each sector gas-tight with respect to the adjacent sectors. The seals are identical in construction and the details thereof are best shown in Figs. 6 and 7.

The seal is shown as being mounted between partition walls 30 extending across the manifold. The top or cover plate 31 of the seal is detachably secured to the manifold as by bolts. The bottom of the seal rests on the top or bottom of the drum, as the case may be, and includes a bottom or sealing plate 32 having upturned flanges on its ends adapted to fit against the partition walls 30 and having its under surface, including the flanges, covered with a layer of sheet asbestos or rubber material 33 to engage the ends of the radial partitions. The arrangement is such that the seals can be easily removed so that the asbestos liners can be inspected and replaced. In addition, the top seals provide openings through which the annular adsorbent containers 22 can be readily removed for renewal and repair.

The bottom or sealing plate 32 of the seal is adjustably held in position against the drum, as by means of stems 34 fixed thereto and extending upwardly through U-shaped brackets 35 bolted to the side walls of the manifold. Coil springs 36, mounted on the stems between the arms of the bracket, press against discs 37 fixedly attachable to the stem to urge the stems and bottom plate downwardly.

Each radial partition or diaphragm 12 has that portion of its top and bottom edges extending between the edges of the openings in the top and bottom of the drum, covered by a strip 38 of reinforced asbestos cloth folded thereon and detachably secured thereto as by bolts 39. This strip engages the under side of the seal, as best shown in Fig. 7.

The width of the seal with respect to the compartments 11 containing the adsorbent units is such that at all times at least one of the partitions or diaphragms 12 is engaging the asbestos covered bottom or sealing plate of the seal in air-tight engagement. As is clearly seen from the foregoing, the air conditioner is divided into three

gas-tight sectors by the engagement of the radial partitions or diaphragms with the seals.

As the drum carrying the annular adsorbent containers rotates, they are continuously and successively moved through the three sectors, called, for convenience, the first stage, the second stage and the activation stage.

The flow of air through the first and second dehydration stages and the flow of the hot gases through the activation stage is schematically shown in Fig. 8. The outside air from which moisture is to be removed is supplied to the air conditioner at a sufficient pressure to force it through the system and enters the top manifold of the first stage by means of conduit 40. Then it moves from the manifold through the opening in the top of the drum into the various compartments of the drum, containing the adsorber units, as are at that time contained within the sector forming the first stage. The air passes through the pervious layer of adsorbent material, which removes part of the moisture content therefrom, into the interior of the adsorber units, thence downward through the openings in the plate 21 into the bottom of the drum and through the opening therein into the bottom manifold. From the bottom manifold, the now partially dried air passes through the conduit 41 into an intermediate cooler 42, where it is cooled. The cooler 42 may be of the water circulating type. From the intermediate cooler, the air moves, by means of conduit 43, which extends underneath the device and up one side to the top thereof, into the top manifold of the second stage. The air moves downwardly through the second stage, in a manner similar to its downward movement through the first stage, into the bottom manifold of the second stage, the remainder of the moisture content of the air being removed during its passage through the second stage.

From the bottom manifold of the second stage, the now dried air moves through conduit 41 into a second cooler 45, where it is cooled to the desired room use temperature. Cooler 45 may be of the water circulating type. From the second cooler 45, the now conditioned air moves, by means of the conduit 46, to the various points of use.

The removal of moisture from the adsorbent material carried by the annular adsorber units is effected in the activation stage. Atmospheric air is forced by a fan 47 through a heater 48, then through conduit 49 into the bottom manifold of the activation stage. From the bottom manifold the hot air passes through the opening in the drum into the bottom of the various compartments of the drum as are at that time contained within the sector forming the activation stage, thence upwardly through the openings in the plates and up into the hollow interior of the annular adsorber units, through the pervious solid layer of adsorbent material into the compartment of the drum. As the hot air passes through the adsorbent material it removes the moisture therefrom. The hot moisture-laden air then passes upwardly through the opening in the top of the drum into the top manifold and from the top manifold is exhausted into the atmosphere through conduit 50.

The operation of the device is as follows:

With the annular drum continuously and slowly revolving counterclockwise, the annular adsorbent container units are successively moved through the first stage, then through the activation stage, then through the second stage. The wet air to be conditioned is first passed through the first stage,

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then through the intermediate cooler into and through the second stage, where the remaining moisture is removed by the freshly dried adsorbent material. From the second stage, the now dried air is passed through a second cooler and then conducted to the points of use. The use of a second cooler may be omitted, if desired, and the air discharged directly to the points of use.

Obviously, the invention is not restricted to the particular embodiment thereof herein shown and described. Moreover, it is not indispensable that all of the features of the invention be used conjointly, since they may be employed advantageously in various combinations and sub-combinations.

While the invention has been described as having the annular drum rotating counterclockwise, obviously, the device would be operable with the annular drum rotating clockwise. Further, while only one activating stage is shown, obviously, a second activating stage could be used between the first and second dehydrating stages and, further, the various stages could be multiplied and combined in various manners. Moreover, the apparatus is capable of various uses, such as catalytic cracking and the treatment of fluids to remove constituents therefrom.

What is claimed is:

1. In an apparatus for conditioning air, the combination, comprising a frame; an annular drum having continuous annular openings in its top and bottom rotatably mounted therein; a plurality of vertical partitions mounted in said drum dividing it into a plurality of radial compartments; a transversely extending partition provided with a plurality of openings mounted in each compartment and forming a gas-tight joint with the walls thereof; a plurality of elongated, annular, foraminous adsorbent containers located in each of said compartments and removably mounted on said partition, each container being closed at its top and having its hollow interior at its bottom end in communication with one of said openings in said partition; an upper annular manifold fixedly mounted on said frame and communicating with the opening in the top of the drum; said upper one of said manifolds having an opening through which said annular containers are removable; a lower manifold fixedly mounted on the frame and communicating with the opening in the bottom of the drum; a plurality of sealing means located in each of said manifolds and cooperating with said partitions to divide the drum and the manifolds into a plurality of sectors, each sector being gas-tight with respect to its adjacent sectors; means for passing heated gases through one of said sectors; means for passing air to be dehumidified in succession through the other of said sectors; and means for rotating said drum whereby said compartments with the adsorbent containers are continuously and successively moved through each of said sectors.

2. In an apparatus for conditioning air, as set forth in claim 1, wherein each sealing means comprises a spaced pair of transversely extending walls mounted in the manifolds; a cover plate removably mounted on the upper manifold above said opening; a bottom sealing plate slidably and removably mounted within said side walls; and resilient means urging said sealing plate against said drum; and wherein the vertical partitions have their top and bottom ends provided with a gasket which forms a gas-tight fit with

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said sealing plates when they are brought into contact with each other.

3. In an apparatus for conditioning air, the combination comprising a rotatable annular drum having a spaced pair of continuous annular openings; a plurality of partitions mounted in said drum dividing it into a plurality of radial compartments; at least one elongated, annular, foraminous adsorbent container removably mounted in each compartment; a pair of fixed manifolds, one of which communicates with one of said openings, the other of which communicates with the other of said openings; the upper one of said manifolds having an opening through which said annular containers are removable; means carried by said manifolds and cooperating with said partitions to divide said manifolds and said drum into at least two sectors, each sector being gas-tight with respect to its adjacent sector; means for delivering air to be dehydrated into one of said sectors; means for delivering heated air into another of said sectors; and means for rotating said drum whereby said compartments containing adsorbent material are continuously and successively moved through each sector.

4. An apparatus of the character described, comprising a rotary member having a plurality of axially extending compartments, each of said compartments having a pair of vertically spaced openings formed therein; an elongated, annular, foraminous container adapted to hold granular adsorbent material removably mounted in each of said compartments; a pair of vertically spaced stationary annular manifolds having radial partitions therein dividing them into a plurality of separate corresponding fluid passage sectors, each of said sectors having a fluid conduit communicating therewith and having an opening therein for the passage of fluid; the upper one of said manifolds having an opening through which said annular containers are removable; said manifolds being mounted to slidably engage said rotary member as it rotates and being positioned so that the vertically spaced openings in said compartments will be successively brought into communication with the openings in the corresponding sectors of the vertically spaced manifolds respectively as the rotary member rotates, whereby successive axial flows of fluids will take place through the compartments of the rotary member as said rotary member rotates.

5. An apparatus as set forth in claim 4, wherein said foraminous containers and their hollow interiors are closed at their upper ends and are mounted in said compartments with the bottom ends of their hollow interiors in communication with the bottom openings in said compartments.

6. An apparatus of the character described, comprising a rotary member having a plurality of axially extending compartments, each of said compartments having a pair of vertically spaced openings formed therein; a container adapted to hold granular adsorbent material removably mounted in each of said compartments, said container comprising an elongated member having a hollow interior for the passage of fluids and having spaced foraminous, double side walls with the space therebetween adapted to hold said adsorbent material; a pair of vertically spaced stationary annular manifolds having radial partitions therein dividing them into a plurality of separate corresponding fluid passage sectors, each of said sectors having a fluid conduit communicating therewith and having an opening therein for the passage of fluid; the upper one of said

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manifolds having an opening through which said annular containers are removable; said manifolds being mounted to slidably engage said rotary member as it rotates and being positioned so that the vertically spaced openings in said compartments will be successively brought into communication with the openings in the corresponding sectors of the vertically spaced manifolds respectively as the rotary member rotates, whereby successive axial flows of fluids will take place through the compartments of the rotary member as said rotary member rotates.

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