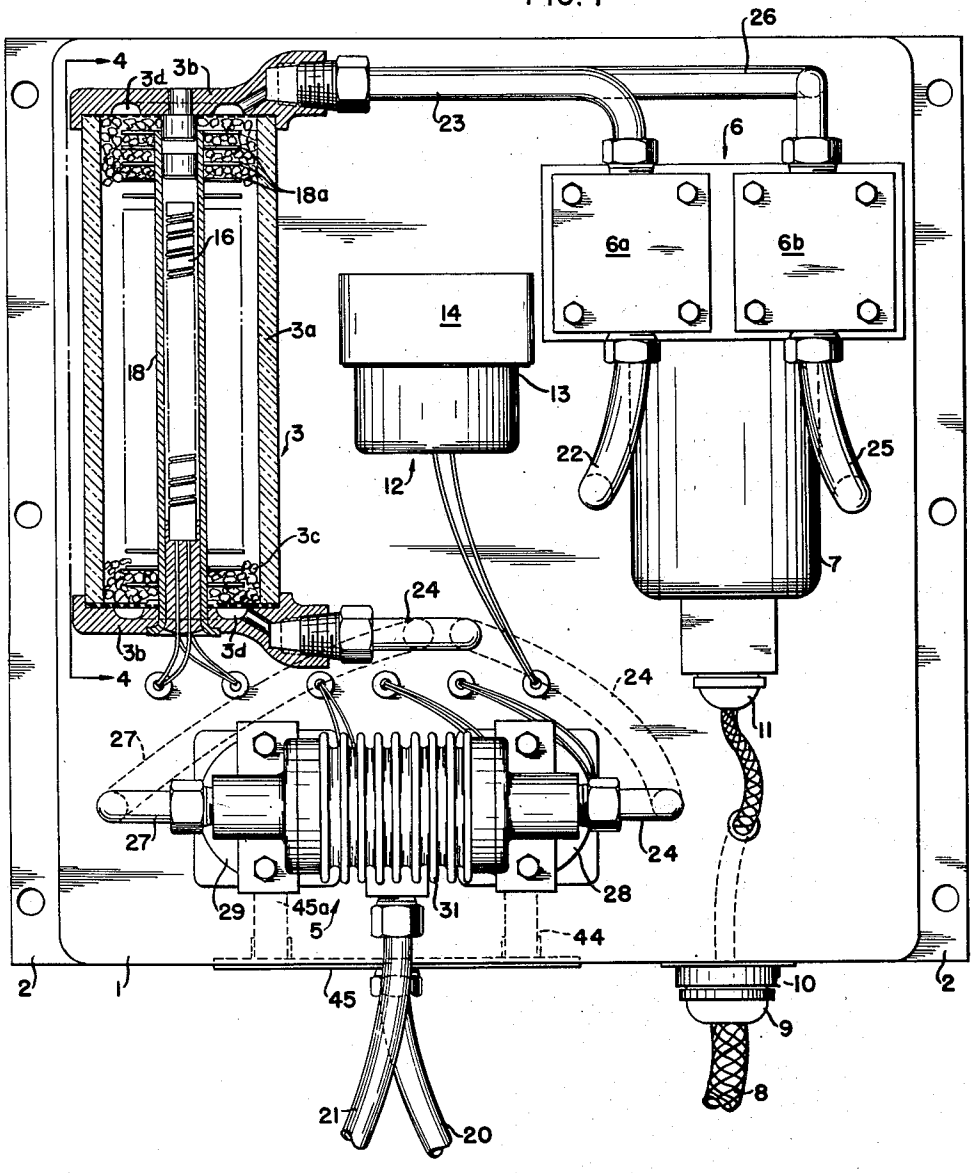
March 5, 1957 J. J. BIEGER ET AL 2,783,547

DESICCATING APPARATUS

Filed April 9, 1954 3 Sheets-Sheet 1

FIG. 1



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DESICCATING APPARATUS

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FIG. 2

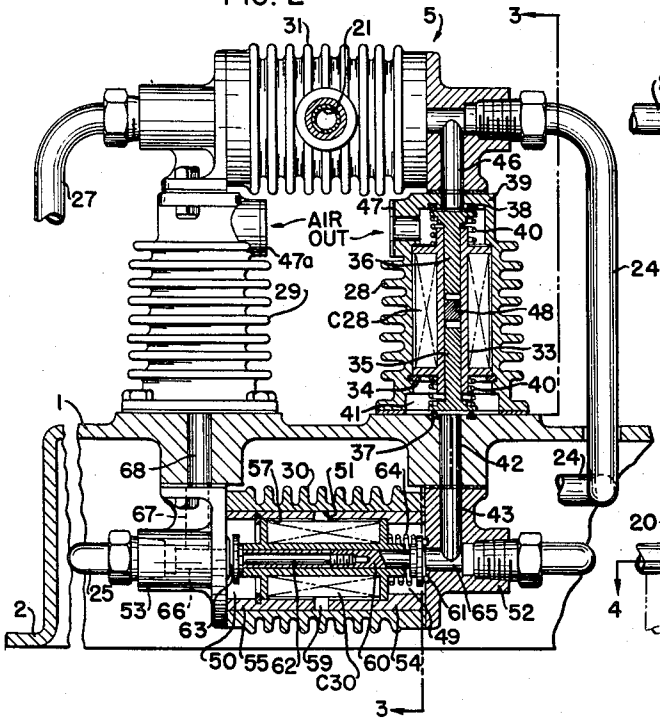


FIG. 3

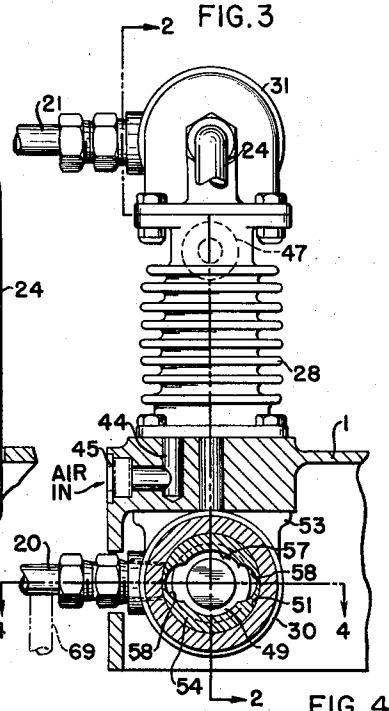


FIG. 4

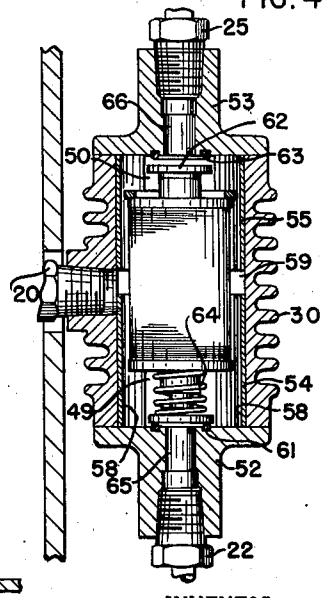
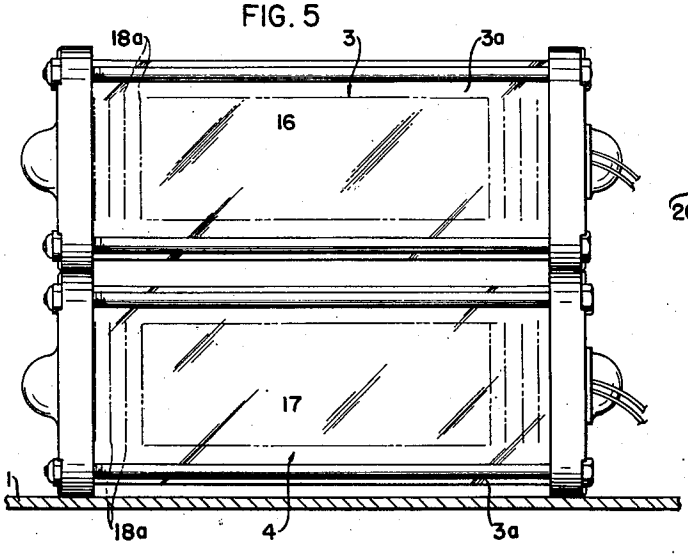


FIG. 5



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DESICCATING APPARATUS

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FIG. 6

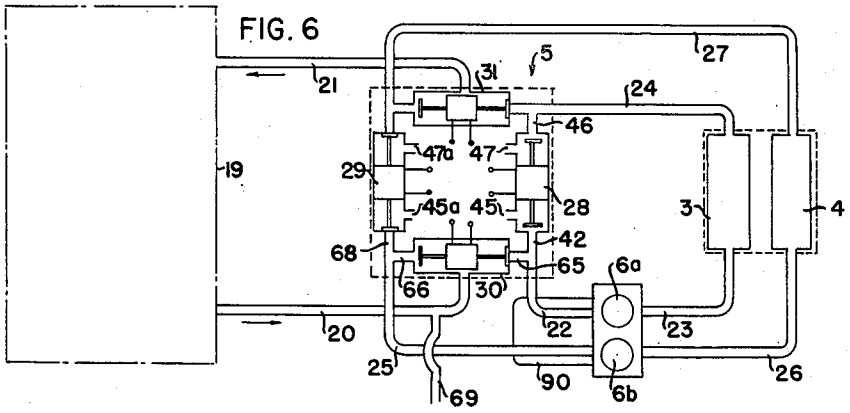
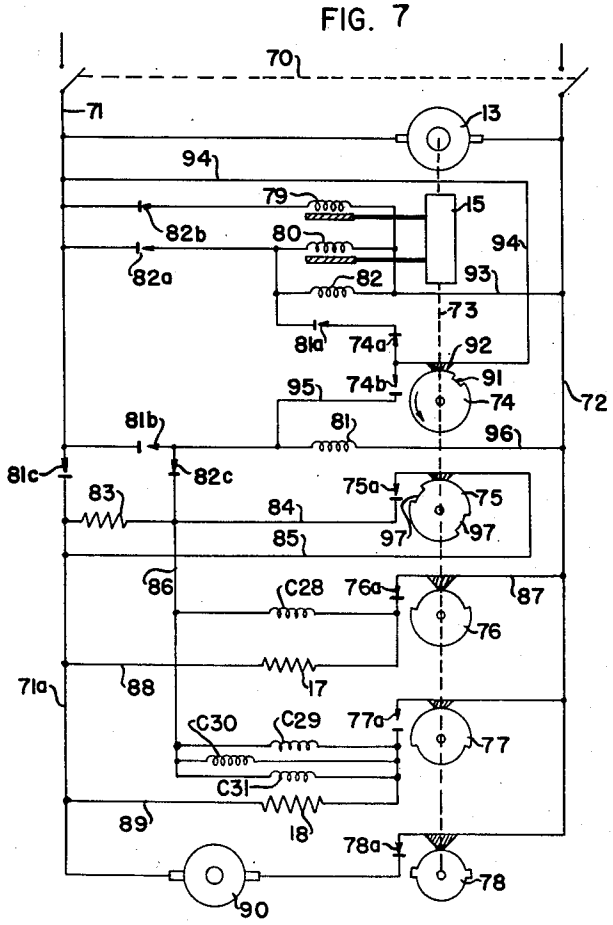


FIG. 7



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United States Patent Office 2,783,547 Patented Mar. 5, 1957

2,783,547

DESICCATING APPARATUS

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Application April 9, 1954, Serial No. 422,212

4 Claims. (Cl. 34—53)

This invention relates to desiccating apparatus, that is, apparatus for maintaining the air in an enclosed space in a dry condition by removing the air-borne moisture. More particularly, the invention relates to apparatus for removing the moisture from the air in an enclosure by circulating the air through a drying chamber and returning the dried air to the enclosure. The specific purpose of the invention is to maintain in a dry condition the air within the sealed casing of optical or electronic equipment and certain precision instruments whose operation is impaired by the presence of moist air within the casing.

The apparatus comprises two chambers, each containing a drying agent or dessicant that can be reactivated by the application of heat and the passing of atmospheric air through it to remove the moisture. These chambers are each equipped with an electric heater and suitable switches to control the supply of heating current. A piping system connects the chambers with the casing of the instrument to be dried, and a set of electromagnetic or solenoid operated valves is so arranged in this piping that by opening certain of these valves and closing others the air from the casing can be circulated through one of the drying chambers while the other chamber is opened for the circulation of atmospheric air therethrough. An air pump produces the desired air flow.

The operation of the various parts of this mechanism is coordinated by an electrical timing mechanism, the purpose of which is to provide both an automatic cycle of continuous operation, and an automatic starting cycle. This timing mechanism causes periodic operation of the solenoid valves and the heater switches for the purpose of interchanging or transferring the two drying chambers from side to side of the piping system with a short period between when both drying chambers are cut off from the instrument casing. This allows the drying chamber which has been reactivated during the preceding period to cool, so as to avoid the circulation of heated air through the instrument casing.

The purpose of the starting cycle is to control the drying mechanism as to prevent a drying chamber whose drying agent may have become saturated with moisture, because of a period of disuse, from being connected with the instrument casing. Accordingly, the timing mechanism is arranged to bring about a short reactivating period of one of the drying chambers prior to its connection with the instrument casing. As soon as such drying period is completed, the regular or normal cycle of operation commences.

For a fuller understanding of the invention, reference may be made to the accompanying drawings, in which

Fig. 1 is a plan view of the desiccating apparatus;

Fig. 2 is a view partly in elevation and partly in vertical section of the solenoid operated valves, the section being taken on line 2—2 of Fig. 3 through the lower horizontal valve and through the right-hand vertical valve;

Fig. 3 is a vertical section taken on broken line 3—3 of Fig. 2;

Fig. 4 is a horizontal section taken on line 4—4 of Fig. 3;

Fig. 5 is a view in elevation of the two drying chambers looking from the left of Fig. 1;

Fig. 6 is a diagrammatic view showing the piping connections of the various parts of the desiccating apparatus and its connection to an instrument casing; and

Fig. 7 is a diagram of electrical connections.

The apparatus is mounted on a substantially square base 1 having vertical sides which house a portion of the apparatus beneath the base (Figs. 1 and 2). Narrow mounting flanges 2 project from opposite sides of the bottom of the base and are provided with appropriate holes for mounting screws or bolts. The base is preferably cast of a lightweight metal such as magnesium, and all other parts of the apparatus are also made of magnesium, or a magnesium alloy, where possible, in order to reduce the weight to a minimum.

The two drying chambers are indicated generally by numerals 3 and 4 (Fig. 5), the upper chamber 3 being shown in section in Fig. 1, and these chambers being mounted one above the other on top of base 1. The chambers are identical and each consists of a tubular body or casing 3*a* of heat resistant glass closed at its ends by headers 3*b*, the assembly being held together by four lengthwise bolts as shown in Fig. 5. Each chamber is filled with a loose mass or bed 3*c* of a highly absorbent material, such as silica gel, through which air may be readily passed first to carry moisture to the bed and later to remove it therefrom. The two headers are provided with air passages or channels 3*d* as shown in Fig. 1 for distributing the air at one end of the bed and collecting it at the other.

The set of solenoid operated valves is indicated generally by numeral 5, three of these valves being mounted above base 1, and one beneath. A dual air pump 6 (Fig. 1) is mounted on top of base 1 and comprises two separate pumping sections 6*a* and 6*b* driven by means of a single electric motor 7.

Electric power for operating the apparatus is supplied by means of a cable 8 having a plug 9 which is received within a receptacle 10 mounted inside of the base and having a lead to a removable plug 11 which is received within a receptacle mounted on the motor. This enables the pump and motor unit to be readily disconnected for servicing or replacement, if necessary. All other electrical connections between the parts of the apparatus are made by means of plugs and receptacles, and all piping connections include joints which can be readily disassembled in order that replacement or servicing of parts may be speedily accomplished.

The timing mechanism is indicated generally by reference numeral 12 and includes an operating motor 13 and housing 14 within which there is a set of reduction gearing 15, shown diagrammatically in Fig. 7 together with a series of cam-actuated switches. The purpose of such mechanism is to coordinate the operation of the solenoid valves 5 and electric heaters 16 and 17 which are provided within each of the drying chambers 3 and 4, respectively. Such heaters are rod-like in shape and are located within metal tubes 18 which are provided with extended heat transfer surface preferably in the form of metal fins 18*a* secured in heat conducting contact with the tubes and extending into the mass of silica gel in each drying chamber so as to rapidly heat such mass when current is applied to either heater.

Referring briefly to Fig. 6, the apparatus is connected to dry the interior of an instrument casing 19, indicated in dot-and-dash outline, by flexible tubing sections 20 and 21. Tubing 20 is connected to the valve set 5 at the bottom and return tubing 21 is connected thereto at the

top. The connections between the valve set, the air pump and the two drying chambers are made by means of small flexible piping. Thus a short pipe 22 leads from the lower right-hand corner of valve set 5 to section 6a of the air pump. The opposite side of this pump section is connected to upper drying chamber 3 by a pipe 23, and the opposite end of this drying chamber is connected by a pipe 24 to the upper right-hand corner of valve set 5.

The connections for the second, or lower, drying chamber 4 are similar, the left-hand lower corner of valve set 5 being connected by a pipe 25 to the second and separate pumping section 6b, and a pipe 26 connecting the opposite side of this pumping section with one end of drying chamber 4. The opposite end of this drying chamber is connected by a pipe 27 with the upper left-hand corner of the valve set 5.

The construction of the four valves of the valve set, to be described presently in detail, is such that by properly operating the valves the air from casing 19 can be drawn through tubing 20 and circulated by the air pump through drying chamber 4 and back to the casing 19. At the same time the other section of the air pump will be drawing in atmospheric air through valve set 5 and passing it through the drying chamber 3. Alternatively, by shifting the valves of valve set 5 drying chamber 3 can be connected with the instrument casing 19 and atmospheric air passed through the disconnected or isolated drying chamber 4.

Referring now to Figs. 2–5, the detailed construction of the air valves of valve set 5 is as follows. All four of the valves are alike in that each has a casing comprising a magnesium casting provided with external heat radiating fins, and also having a longitudinal central bore within which the valve mechanism is received. The two vertical valves 28 and 29 are identical with each other, and the two horizontal valves 30 and 31 are identical with each other. Accordingly, a detailed description of only one of each of these valves will be given.

Referring to right-hand vertical valve 28, this valve has an operating coil C28 which is mounted upon a spool 33 of non-magnetic lightweight metal, preferably magnesium, this spool being held within the central bore of the valve housing by means of a snap ring 34 at the bottom which holds the upper end of the spool against a shoulder at the top of the bore. Slidably mounted with a longitudinal central aperture in spool 33 are a two valve members 35 and 36 which are made of magnetic material, preferably steel. The lower end of valve member 35 has a head or disk which closes against a valve seat 37 on the base casting 1 to which the lower ends of the casings of valves 28 and 29 are bolted. The head of valve member 36 closes against a valve seat 38 formed within an extension 39 at the upper end of valve casing 28.

The two valves are normally closed being held against their respective seats by means of coil springs 40. Valve member 35 controls communication between an air intake chamber 41 above the valve seat and an axial passage 42 below the valve seat and in base 1. Passage 42 communicates by a lateral passage 43 with a lengthwise passage 65 in valve 30, both passages thus being connected to pipe 22 which leads to air pump chamber 6a, and thence to drying chamber 3. Intake chamber 41 which is an annular chamber above valve seat 37 is in communication with the outside or atmospheric air through drilled passages 44 in base 1 (Fig. 3), the air entering through a screen 45 on the front vertical face of the base casting. There is a similar intake 45a at the lower end of valve 29 (see Fig. 1). The upper valve 36 controls communication between pipe 24 (from drying chamber 3) through a lateral passage 46 in the housing of valve 31, and an exhaust or air discharge passage 47, in the valve extension 39, which is preferably also covered by screening. A similar air discharge 47a is arranged at the upper end of the air valve 29.

The energization of operating coil C28 of valve 28 causes the valve members 35 and 36 to be simultaneously drawn into the coil thereby opening both valves. Valve members 35 and 36 constitute the operating cores of the solenoid coil 32, and in order to reduce the air gap between the ends of these members when the valves are in open position, a fixed plug 48 of magnetic material is preferably placed between the inner ends of these valve members. Valve members 35 and 36 and plug 48 are the only magnetizable members employed in the construction, and since there is no magnetic circuit connecting the outer ends of the solenoid cores 35 and 36, a high initial current is sent through the coil C28 to ensure opening of the valves, and this current is thereafter reduced, as will be described. This applies to all four air valves 28—31.

The construction of the lower and upper horizontal valves 30 and 31 being alike, the details of only the lower valve 30 will be given. These valves are the casing transfer valves, that is, they transfer the instrument casing 19 from one side to the other of the drying system, or in other words, serve to connect the pipes 20 and 21, at one part of the operating cycle, with drying chamber 3, and at another part with drying chamber 4. These valves have a connection at the center of their respective casings, that is, centrally between the ends thereof, for the respective pipes 20 and 21, the connection for pipe 20 being shown in Figs. 3 and 4 and that for pipe 21 in Figs. 2 and 3. Communication between the pipe 20 and the respective annular valve chambers 49 and 50 at the ends of valve 30 is obtained by the following construction.

The casing of valve 30 has a lengthwise cylindrical bore 51 extending from end to end, the casing being mounted between two end castings 52 and 53, the latter being secured by suitable screws to bosses formed on the underside of base casting 1 (Fig. 2). The corresponding end castings of valve 31 are similarly mounted on the tops of valves 29 and 30.

Slid into the cylindrical bore 51 there are two supporting members 54 and 55 for the operating coil C30 of this valve and its spool which is similar to spool 33 described in connection with valve 28. Supporting members 54 and 55 each have cylindrical outer surfaces and an internal cylindrical bore 57 of appropriate diameter to receive the coil C30 and its spool. The two supporting members are alike except that member 54 at the right (Fig. 2) is provided with a shoulder adjacent valve chamber 49 against which the right end of the spool is seated, and supporting member 55 has a groove to receive the snap ring which holds the opposite end of the spool in position.

Supporting members 54 and 55 are provided with longitudinal scalloped shaped channels 58 which extend radially outward beyond the diameter of coil C30 and its supporting spool, and these form air passages between the connection for tube 20 and valve chambers 49 and 50. These two channels 58, which are diametrically opposite one another, are connected centrally of the valve casing, and opposite the end of tube 20, by means of an annular space 59 which is left between the inner ends of supporting members 54 and 55.

The valve members of valve 30 are shown at 60 and 62. Valve member 62 is threadedly connected with valve member 60 as shown in Fig. 2 so that they move together, simultaneously opening one valve and closing the other. Valve member 60 is of magnetizable material such as steel and extends less than half-way to the center of operating coil C30, whereas valve member 62 is of non-magnetic material, such as brass or bronze. A coil spring 64 holds the valve member 60 normally closed and valve member 62 normally open.

The head of valve member 60 closes against a valve seat 61 in end casting 52 surrounding a passage 65 which communicates with passages 43 and 42 from valve 28 and also communicates with pipe 22 to pump section 6a. The head of valve member 62, at the opposite end, co-

operates with a valve seat 63 in end casting 53 and controls communication between valve chamber 50 and passage 66 together with a passage 67 which connects with a passage 68 in base casting 1 and thereby with the lower chamber of valve 29. Pipe 25 is connected to these passages.

When operating coil C30 is not energized, valve members 60 and 62 are in their normal positions whereby tube 20 from the instrument casing 19 is connected to pipe 25 which leads to pump section 6b and thence to drying chamber 4. On the other hand when coil C30 is energized valve member 62 is closed and valve member 60 opened, so that outflow tube 20 from the casing 19 is connected to the other side of the system, namely, to pipe 22 and pump section 6a and thence to drying chamber 3. By energizing the operating coil of upper valve 31 simultaneously with the operating coil of valve 30, the connections between the return tube 21 to instrument casing 19 can be similarly transferred from one side to the other of the system simultaneously with the transfer of tube 20 (Fig. 6). In this way the opposite ends of the drying chambers 3 and 4 can be connected for circulation of the air from the instrument casing through one, or the other, of the drying chambers.

If it is desired to pressurize the drying circuit, this can be done by means of a connection to tubing 20 indicated at 69 and which leads from any suitable source of air under the desired pressure.

From Fig. 6 it will be understood that the operating coil of the right-hand vertical valve 28 is energized opening its two valve members, and that the operating coil of the left-hand valve 29 is de-energized so as to leave its two valve members closed. Air is being pumped by the pump section 6a entering the system at 45 into the bottom of valve 28, passing through passageway 42 to pipe 22, to pump section 6a, thence through pipe 23 and through the drying chamber 3, and from the opposite end of this chamber through pipe 24 to passageway 46 at the top of air valve 28, thence downwardly through its upper valve and out through the exhaust passage 47. Thus while air is being circulated from the instrument casing 19 through drying chamber 4 atmospheric air is being passed through drying chamber 3 to aid in reactivating the drying agent therein. Valves 30 and 31 have been referred to as the transfer valves for the instrument casing 19. Valves 28 and 29 are the reactivating circuit valves for the drying chambers 3 and 4.

By leaving the operating coils of casing transfer valves 30 and 31 de-energized, their valve members will be in the position shown in Fig. 6 so that casing 19 will be connected with drying chamber 4. If, at the same time, reactivation air valve 28 is energized and reactivation valve 29 de-energized, the valve members of the former will be opened and the valve members of the latter closed, so that pump section 6a will circulate air through drying chamber 3, in the manner described above.

To transfer the instrument casing 19 to the other side of the drying system, the operating coil of reactivation air valve 28 is de-energized and the pump motor 90 is de-energized, stopping the flow of air through drying chambers 3 and 4, for a period of ten minutes. This permits the recently reactivated desiccant to cool before being put into service. During this time, the pneumatic system is completely sealed from the outside atmosphere. Transfer valve coils C30 and C31 are then energized, together with valve 29. This reverses the position of all the valves shown in Fig. 6. That is to say, the left-hand valve members of valves 30 and 31 are closed and their right-hand members opened, while the two valve members of valve 28 are closed and the two valve members of valve 29 opened. In this manner casing 19 is connected with drying chamber 3, the circulation of air in this circuit being produced by pump section 6a, and the pump section 6b circulates atmospheric air through the drying

chamber 4 to reactivate the silica gel therein. In this latter reactivating circuit, air is drawn in through inlet 45a at the lower part of air valve 29 and enters passage 68, then pipe 25, to pump section 6b, thence through pipe 26 to drying chamber 4. At the opposite end of this chamber the air leaves through pipe 27 and is conveyed to the upper end of air valve 29 and is discharged through exhaust port 47a.

During the periods that reactivation air is being circulated through the respective drying chambers 3 and 4, their corresponding electrical heating elements 17 or 18, as the case may be, are supplied with heating current so as to raise the temperature of the silica gel and thus accelerate removal of the moisture which has been absorbed during the previous period of connection with instrument casing 19. The operation of the air valves 28—31 and the supply of such heating current to the heaters is controlled by the timing mechanism 12, the circuit connections of which are shown diagrammatically in Fig. 7. This timing mechanism provides for both the automatic starting cycle of operation, and the automatic normal cycle of operation previously referred to.

Referring now to Fig. 7, the closing of main switch 70 energizes timing motor 13 through conductors 71 and 72. The input shaft of the gear box 15 is rotated continuously so long as the main switch is closed. The output shaft 73 mounts a series of cams 74, 75, 76, 77 and 78 which actuate control switches to be described. The gear train is so arranged that, when a clutch coil 79 of the gear box is energized, shaft 73 will operate at one revolution per minute. However, when a clutch coil is energized, instead of coil 79, the rotation of shaft 73 is slowed down to one revolution every two hours. Rotation is always in the counterclockwise direction as indicated by the arrow. A sequence relay 81 has three normally open contacts 81a, 81b and 81c. A change relay 82 has one normally open contact 82a and two normally closed contacts 82b and 82c.

Cam 76 operates switch 76a to control the circuits of valve operating coil C28 and heater 17. The coil circuit is from a conductor 86 through the coil and thence through switch 76a and conductor 87 to supply conductor 72. In a similar manner cam 77 operates switch 77a to control the circuits of valve operating coils C29, C30 and C31, and heater 18. The circuit of heater 17 is from supply conductor 71a through a conductor 88 to the heater and through switch 76a and conductor 87 to conductor 72. The circuit of heater 18 is from supply conductor 71a through a conductor 89 to the heater and thence through switch 77a to return conductor 72.

Cam operated switch 78 operates switch 78a to control the pump driving motor 90, the circuit of which is from supply conductor 71a through the motor and thence through switch 78a to return conductor 72.

Cams 75—78 are the cycling cams, that is to say, they take the drying apparatus through a cycle, during which the drying chambers 3 and 4 are successively connected to the instrument casing 19 for a predetermined period, and, at the same time, the drying agent in the unconnected or isolated drying chamber is being reactivated. A ten-minute cooling period occurs between each transfer or changeover, and a fifteen minute partial reactivation of drying chamber 3 takes place when the apparatus is started up after a shutdown—all of which will be described in detail below.

The operation is as follows:

In order for the cam switches 75—78 to carry out the starting and operating cycles, it is necessary to commence the two-hour rotation of shaft 73 upon which these cams are mounted at a particular angular position or zero point. Cam 74 operates in effect as a setting cam for setting the cam shaft 73 at such zero point or starting position. This is accomplished by

the devices and circuits controlled by cam switches 74*a* and 74*b*. Such zero point is the angular position of cam shaft 73 when the valley 91 of cam 74 is at the top of its travel as indicated in Fig. 7 where the follower 92 will rest in valley 91.

Valley 91 is extremely short in angular length so that when the apparatus is shut down follower 92 is apt to be resting somewhere upon the high part of setting cam 74. Assuming this condition, when main switch 70 is closed to start up the apparatus, the one-minute clutch coil 79 will be energized from line conductor 71 through normally closed relay contacts 82*b* and a conductor 93 to return conductor 72. This causes shaft 73 and all of the cams thereon to commence rotation at the rate of one revolution per minute. No other circuits are closed until valley 91 reaches follower 92 because relay contacts 81*b* and 81*c* are open, thus cutting off the supply of current to conductors 86 and 71*a*, respectively.

Cam follower 92 operates two switches 74*a* and 74*b*, and as the follower drops into valley 91 it opens switch 74*a* and closes 74*b*. This energizes sequence relay 81, the circuit being from supply line 71 through a conductor 94 through switch 74*b* and conductor 95 to relay 81 and thence through conductor 96 to return supply line 72. Sequence relay 81 now closes its contacts 81*a* and 81*b* and 81*c*.

The closing of relay contacts 81*b* completes a holding circuit for sequence relay 81, and energizes conductor 86 through closed contacts 82*c* which short circuit a resistor 83 which is later put in circuit to limit the current to air valve operating coils C28 through C31. Inasmuch as cam switch 76*a* is closed the energizing of conductor 86 supplies current to air valve coil C28. Valve coils C29, C30 and C31 remain de-energized because cam switch 77*a* is open.

The closing of relay contacts 81*c* to energize conductor 71*a* closes the heating circuit through heater 17 of drying chamber 3 and also starts the air pump motor 90 because cam switch 78*a* is closed. Energizing valve coil C28 opens both valve members of valve 28 and places drying chamber 3 in reactivation circuit, as may be seen from Fig. 6 and understood from the previous description.

Follower 92 remains in valley 91 of the setting cam 74 for only about five seconds, whereupon cam switch contacts 74*b* are reopened and contacts 74*a* reclosed. Inasmuch as relay contacts 81*a* are now closed a circuit is completed to energize change relay 82. This circuit is from conductor 94 through switch contacts 74*a* and 81*a* to coil 82, and thence, through conductor 93 to the return supply line 72. Energizing relay 82 closes relay contacts 82*a* and opens relay contacts 82*b* and 82*c*. Opening contacts 82*b* de-energizes the high speed clutch coil 79, and the closing of contacts 82*a* energizes the two-hour cutch coil 80 so that cam shaft 73 now commences to rotate at the rate of one revolution every two hours.

The opening of relay contacts 82*c* breaks a short circuit around resistor 83 to reduce the current through coil C28.

The angular position of cam 76 is such that after a partial reactivating period of fifteen minutes cam 76 will open switch 76*a* thereby opening the circuits of valve coil C28 and heater 17. After a further period of ten minutes, to allow the partially reactivated drying chamber 3 to cool, cam 77 will close cam switch 77*a* thereby energizing valve coils C29, C30 and C31, and the heater 18 of drying chamber 4. By means of these two cams 76 and 77 the transfer has been made and a fifty minute period commences during which drying chamber 3 is in drying circuit with the instrument casing 19, and reactivation air is being circulated through drying chamber 4 which is also being heated.

During the ten minute interval prior to the fifty minute period cam 78 opens switch 78*a* and closes down the air pump motor 90, restarting this motor at the same time that cam 77 closes switch 77*a*.

The opening of relay contacts 82*c* not only broke a short circuit through contacts 81*b* around resistor 83, to reduce the operating current of coil C28 at the starting up of the desiccating apparatus, but also conditioned cam switch 75*a* to control a second short circuit around resistor 83 through conductor 84, switch 75*a* and conductor 85. From that point on, as long as the apparatus is kept in operation, at the beginning of each fifty minute period, one of the two valleys 97 of cam 75 will cause the closing of switch 75*a* for a few seconds to temporarily increase the current through air valve coil C28, or coils C29, 30 and 31, whichever of these two groups is being energized. Accordingly, at the end of the ten minute interval referred to in the previous paragraph, one of the valleys 97 of cam 75 will close switch 75*a*, reopening it again a few seconds later, thus temporarily to increase the current through coils C29, C30 and C31 to insure the movement of their valve members.

After a period of fifty minutes cam 77 will again open switch 77*a* and cam 78 will again open switch 78*a* shutting down the system for another ten minutes. At the end of such period cam 76 will reclose switch 76*a*, re-energizing valve coil C28 and heater 17. One of the valleys 97 of cam 75 will receive its cam follower closing switch 75*a* for a few seconds thereby short circuiting resistor 83 through conductors 84 and 85 to temporarily increase their operating current and insure the opening of valve 28. Cam 76 will retain valve coil C28 and heater 17 energized for fifty minutes, at the end of which a complete cycle of operation including the starting cycle will have been completed.

When the main switch 70 is opened in order to shut down the system, sequence relay 81 and change relay 82 and clutch coil 80 will be de-energized thus causing contacts 81*a*, 81*b*, 81*c* and 82*a* to open. The opening of contacts 81*b* and 81*c* de-energizes all of the valve operating coils C28—C31 and the pump motor 90, if they happen to be energized at the time of shut down. In this condition both valve members of valves 28 and 29 will be closed so that the system is sealed from the outside atmosphere.

It will be understood that changes may be made in the construction and operation of the mechanism as above set forth without departing from the spirit of the invention, the scope of which is set forth in the appended claims.

We claim:

1. In desiccating apparatus for maintaining the air within an enclosure in dry condition, a drying chamber connected in a closed air circulating circuit with said enclosure comprising an elongated tubular casing, a metal tube having a fin structure on its exterior surface, a mass of loose drying material filling the space between said finned tube and the interior wall of the casing and the spaces of the fin structure of said tube, and an electrical heating element disposed within said tube for transferring heat to said drying material to facilitate the reactivation thereof, said casing being closed at its ends by headers each having a pipe connection therein and air channels in its inner surface for distributing the air uniformly to the mass at one end and collecting the air from said mass at the opposite end.

2. In desiccating apparatus for maintaining the air within an enclosure in dry condition, two chambers each containing a drying agent capable of being reactivated, piping and valve mechanism connecting said enclosure and said drying chambers in drying and reactivating circuits, said valve mechanism comprising two double one-way valves each having two simultaneously opening valve members and two two-way valves each having two valve

members attached to a common actuating member so that when one valve member closes the other opens and also each having a mid-connection including a chamber common to said two valve members, said valves being connected together with one valve chamber of each two-way valve connected to a valve chamber of one of the one-way valves to form four common connections, the opposite ends of one of said drying chambers being connected respectively to two of said common connections at corresponding ends of said respective two-way valves, and the other drying chamber being connected to the common connections at the opposite ends of said two-way valves, said enclosure being connected to the respective mid-connections of said two-way valves, and mechanism for periodically actuating said valves to cause first one and then the other of said drying chambers to be connected in closed circuit with said enclosure and simultaneously to connect the other drying chamber to the atmosphere through the two valve chambers of one of said double one-way valves.

3. In desiccating apparatus for maintaining the air within an enclosure in dry condition, two drying chambers each containing a drying agent capable of being reactivated, electric heaters associated with said chambers to assist in reactivating the drying agent therein and switching devices for controlling said heaters, piping and electromagnetically operated valve mechanism connecting said enclosure and said drying chambers in drying and reactivating circuits, said drying circuit including said enclosure, one of said drying chambers and a pump, said reactivating circuit including the other drying chamber and a pump and drawing in atmospheric air and circulating it through said drying chamber and discharging it to atmosphere together with the moisture removed from said chamber, and timing mechanism for actuating said valve mechanism and said heater switches, comprising a reduction gearing driven by a timing motor and having a two-speed output cam shaft controlled by high and low speed electromagnetic clutch operating coils, said high speed coil being energized when the starting switch is closed to place the apparatus in operation, cycling control cams mounted on said output shaft, switches operated by said cams, circuits controlled by said switches for controlling said electromagnetically operated valve mechanism and said heater switching devices for causing periodic interchange of said drying chambers in said drying and reactivating circuits according to a predetermined cycle, and means for setting said cam shaft at a predetermined angular position when starting up the apparatus to start said cycle comprising a setting cam on said cam shaft having a cam formation of short angular length, a cam follower cooperating with said cam and operating a switch, and circuits controlled by said switch for de-energizing said high speed clutch coil and energizing said low speed clutch coil when said cam follower is moved by said cam formation.

4. Desiccating apparatus as claimed in claim 2 in which the two valves of each double two-way valve are biased to closed position and moved to open position by the energization of a common solenoid coil, and wherein the common actuating member of each of the two one-way valves is biased in one direction and moved in the opposite direction by the energization of a solenoid coil.

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