Aug. 2, 1938. E. S. PEARCE 2,125,581

APPARATUS FOR CONDITIONING AIR

Filed Jan. 4, 1934 5 Sheets-Sheet 1

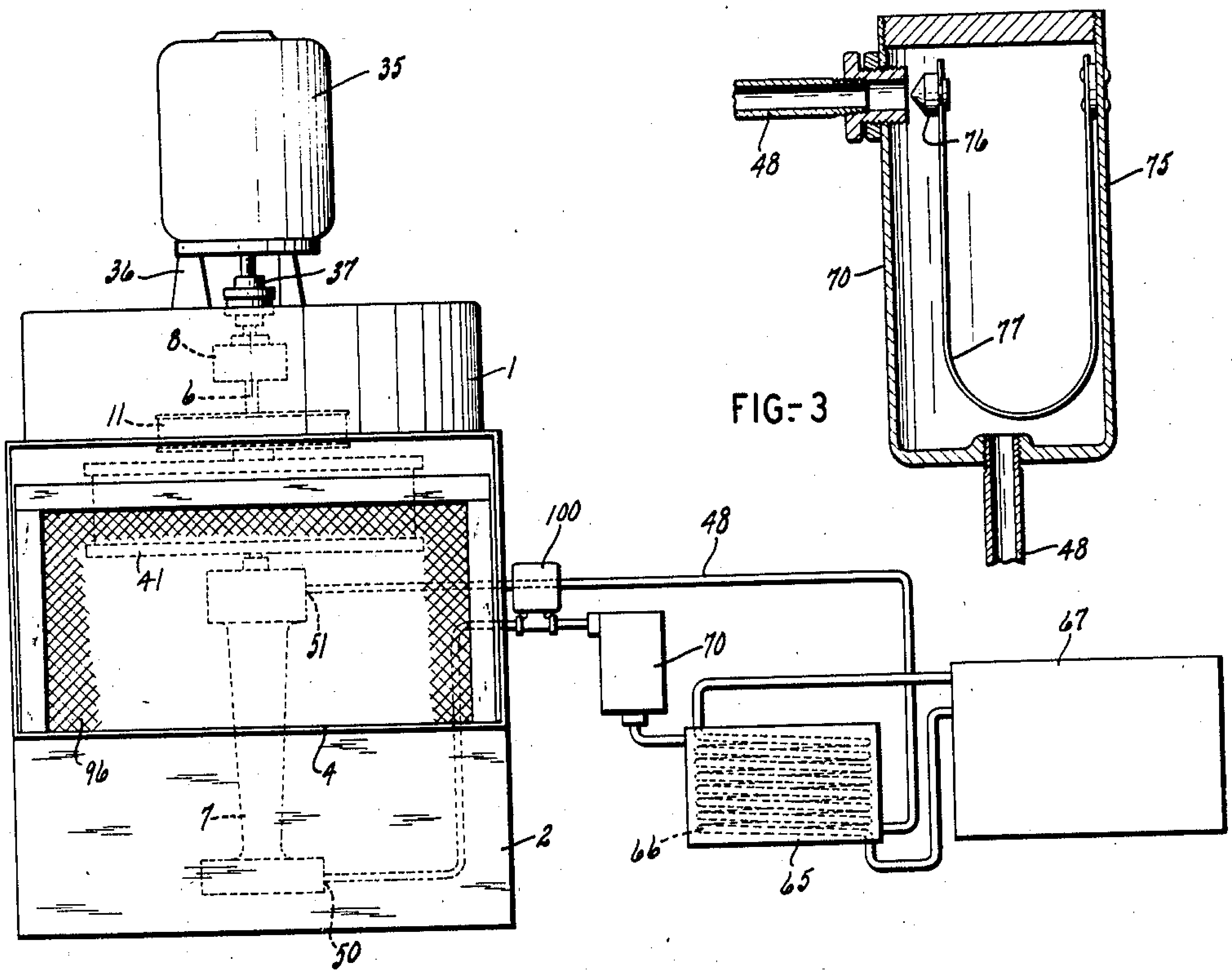

FIG.-3

FIG.-1

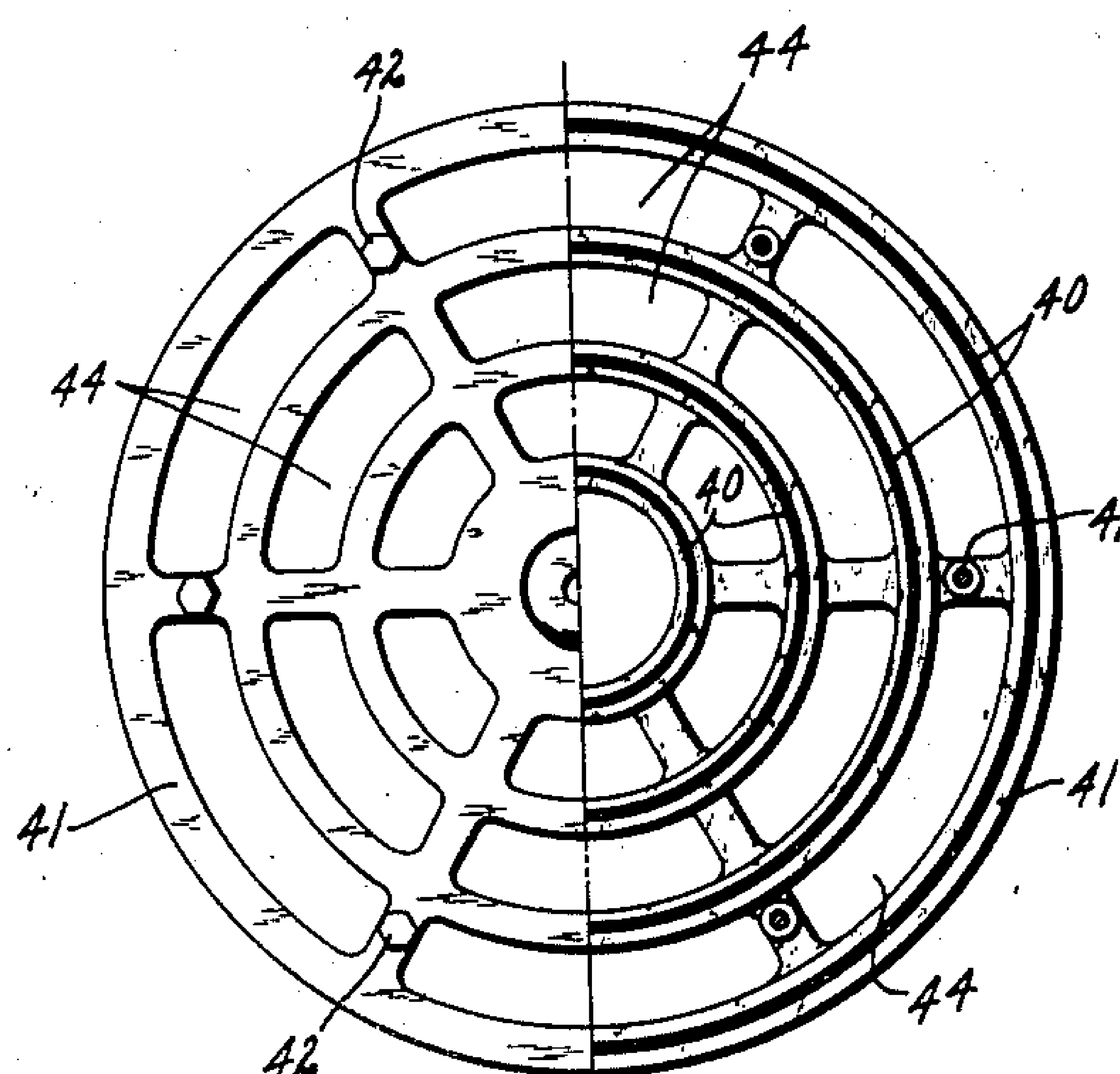

FIG.-2

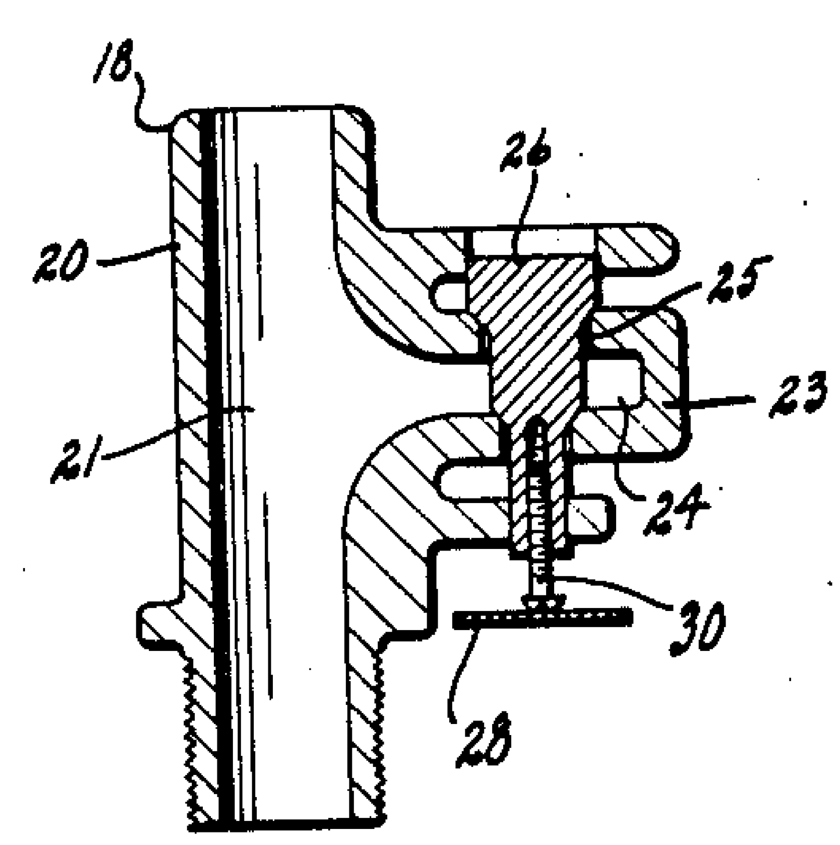

FIG.-4

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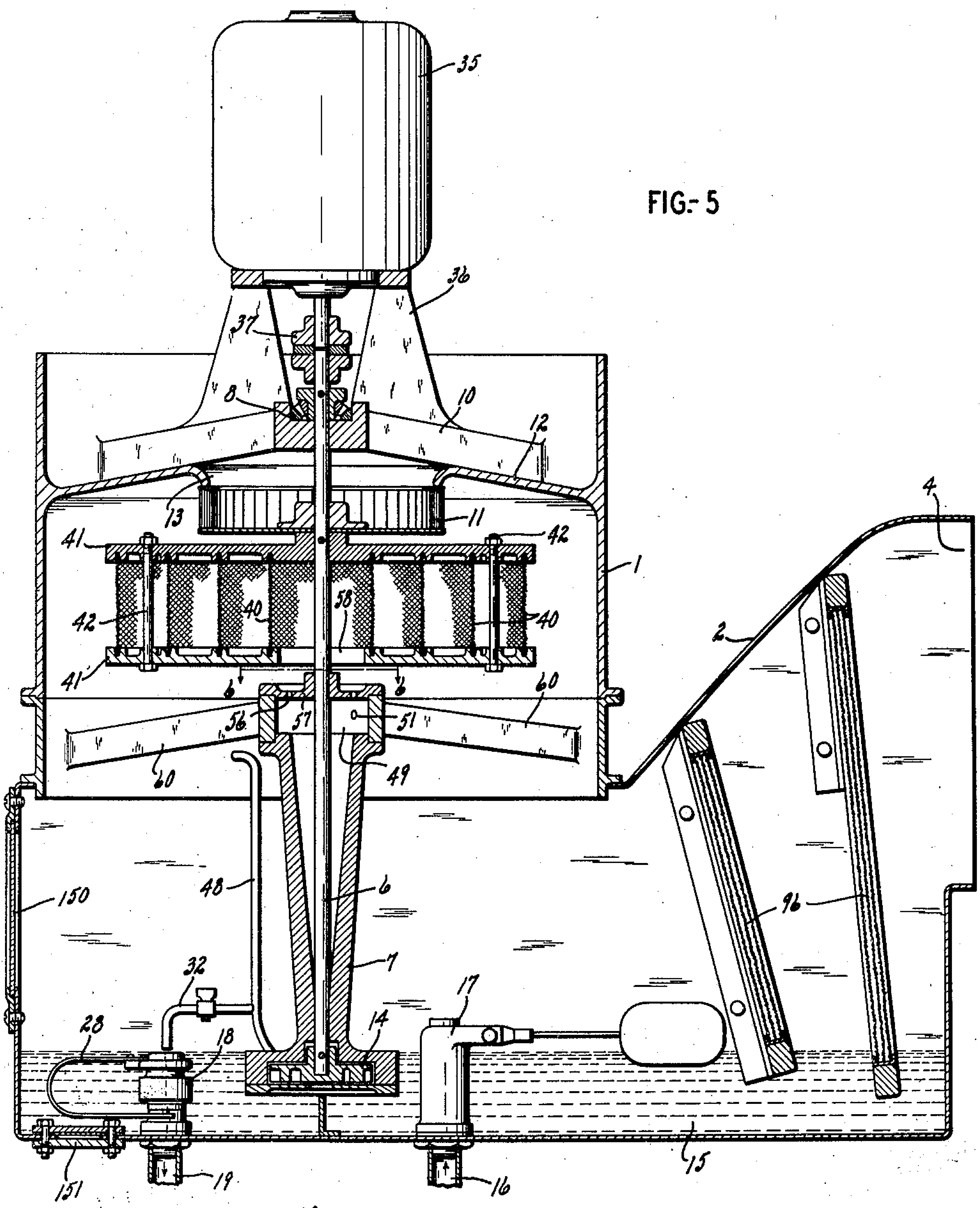

FIG.-5

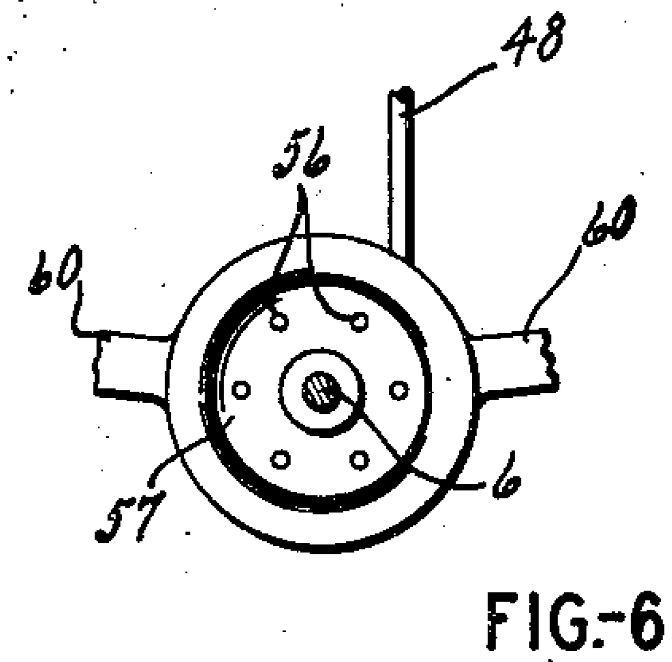

FIG.-6

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Aug. 2, 1938. E. S. PEARCE 2,125,581

APPARATUS FOR CONDITIONING AIR

Filed Jan. 4, 1934 5 Sheets-Sheet 3

FIG-7

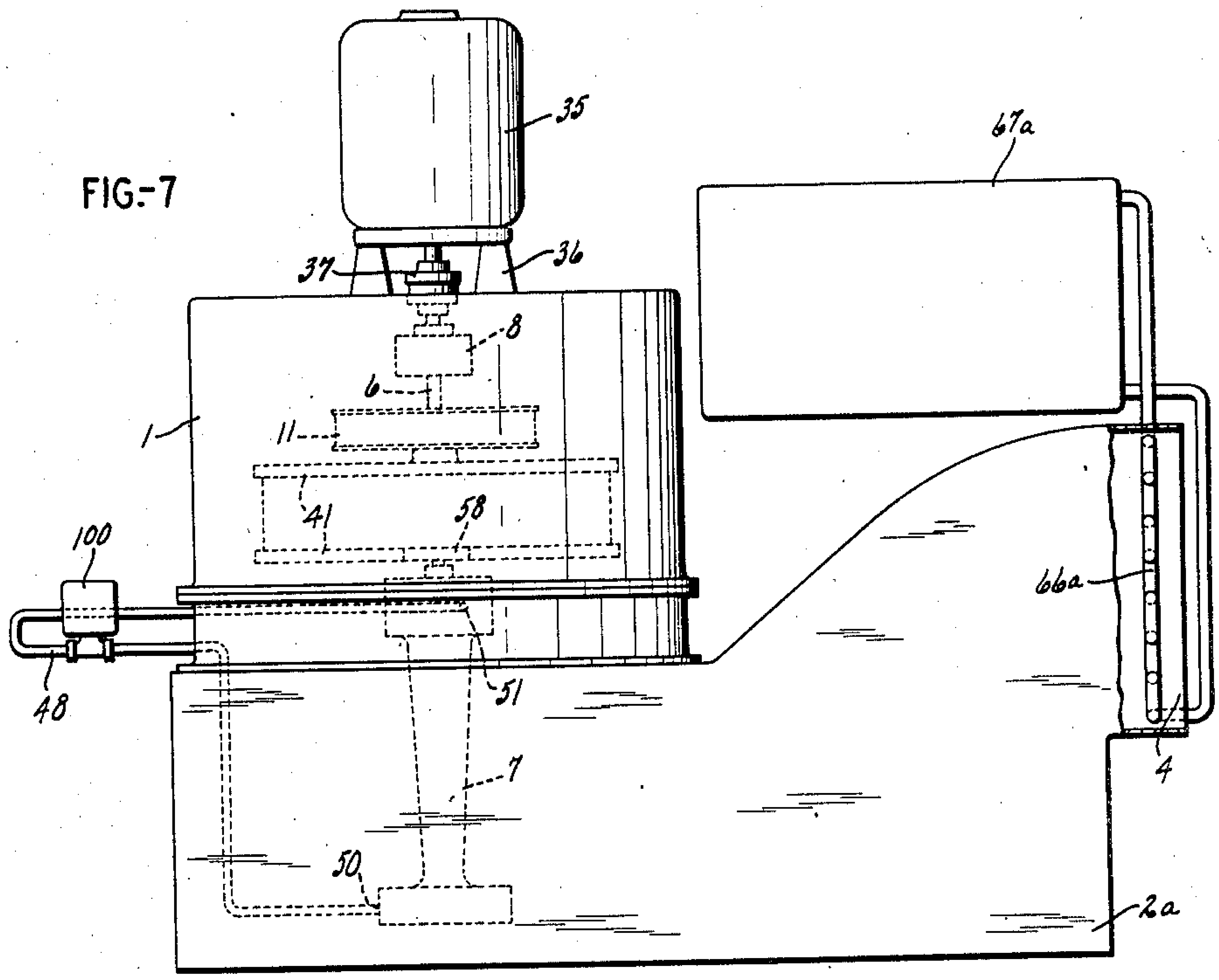
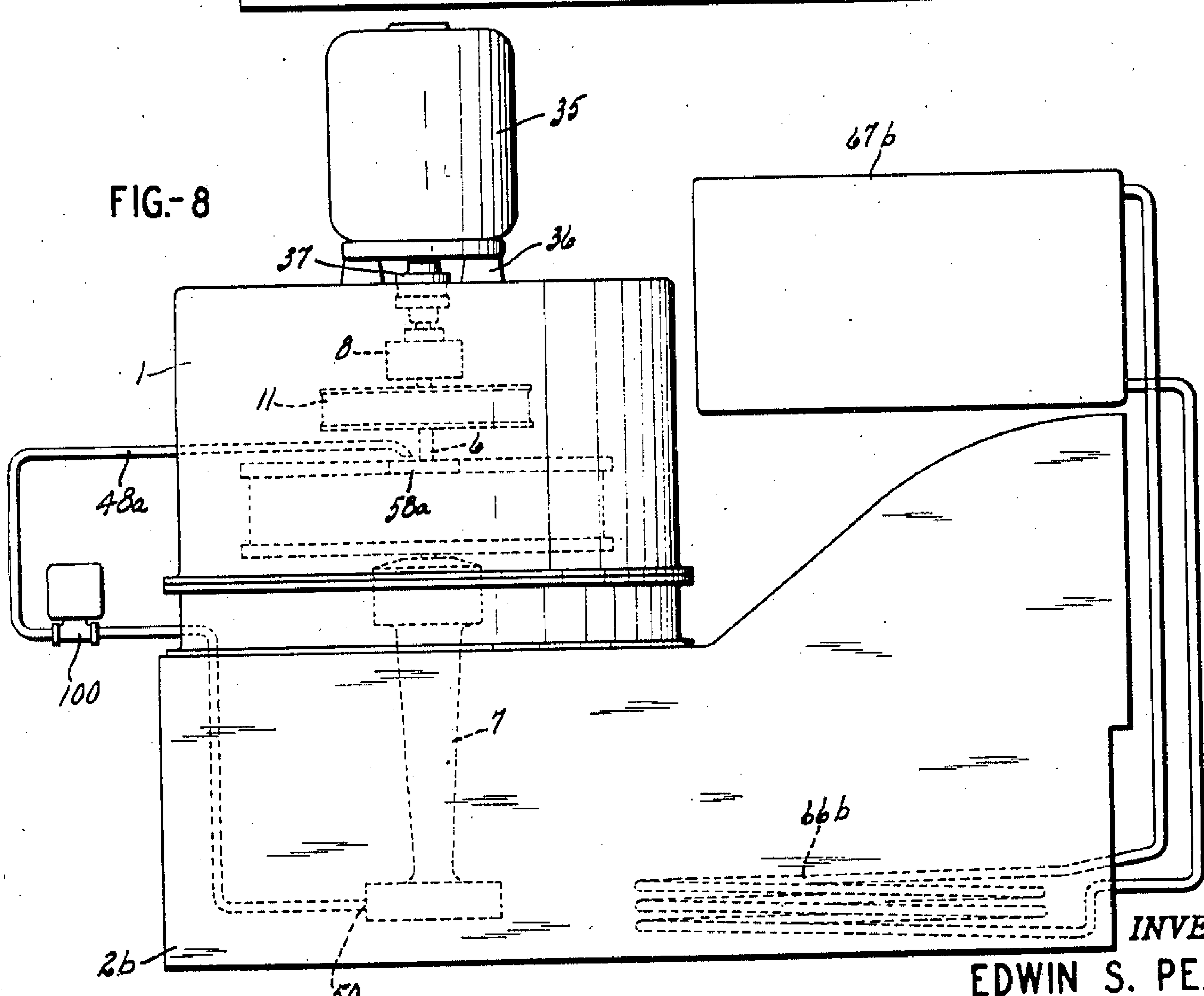


FIG-8



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APPARATUS FOR CONDITIONING AIR

Filed Jan. 4, 1934 5 Sheets-Sheet 4

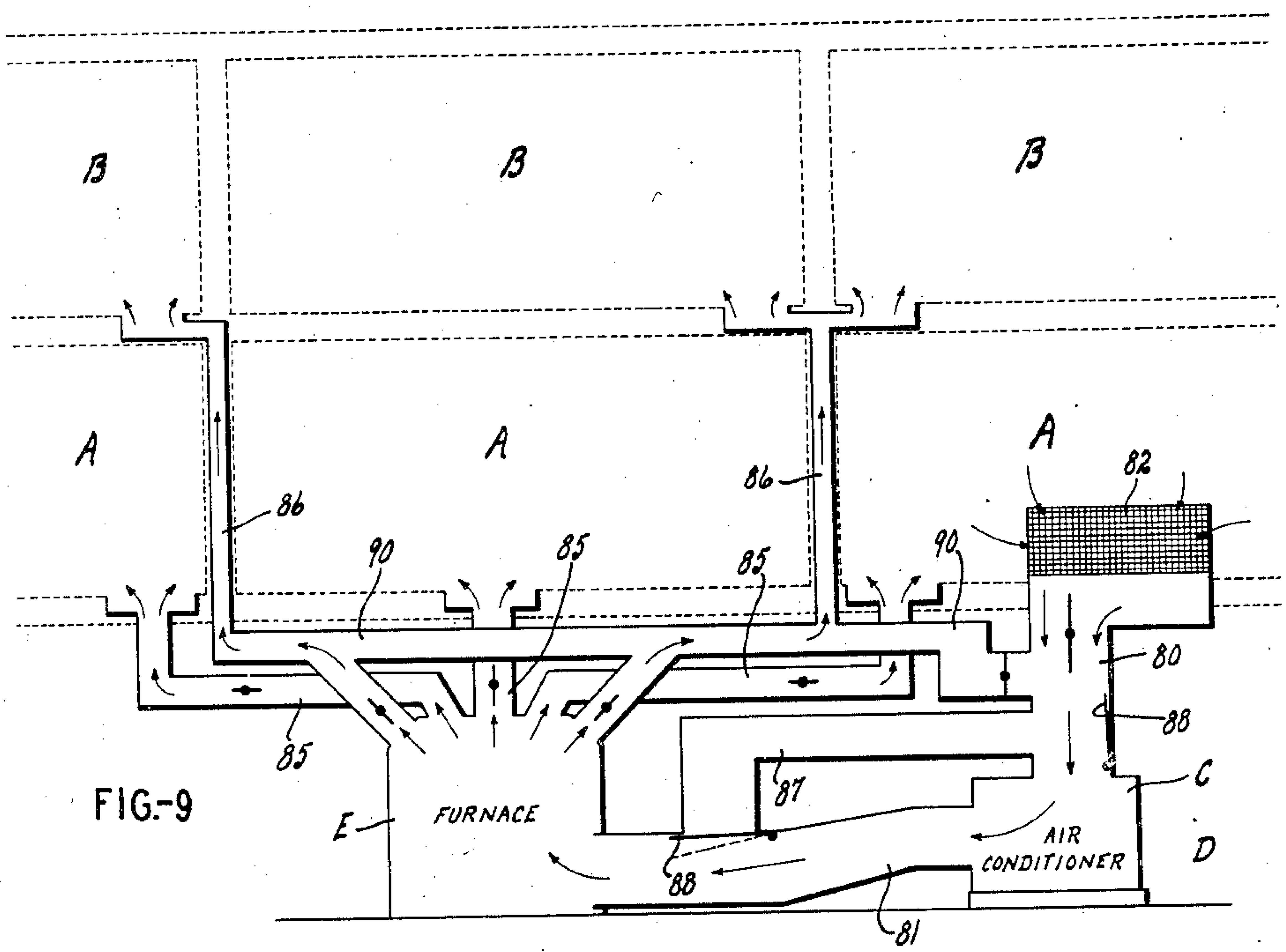

FIG.-9

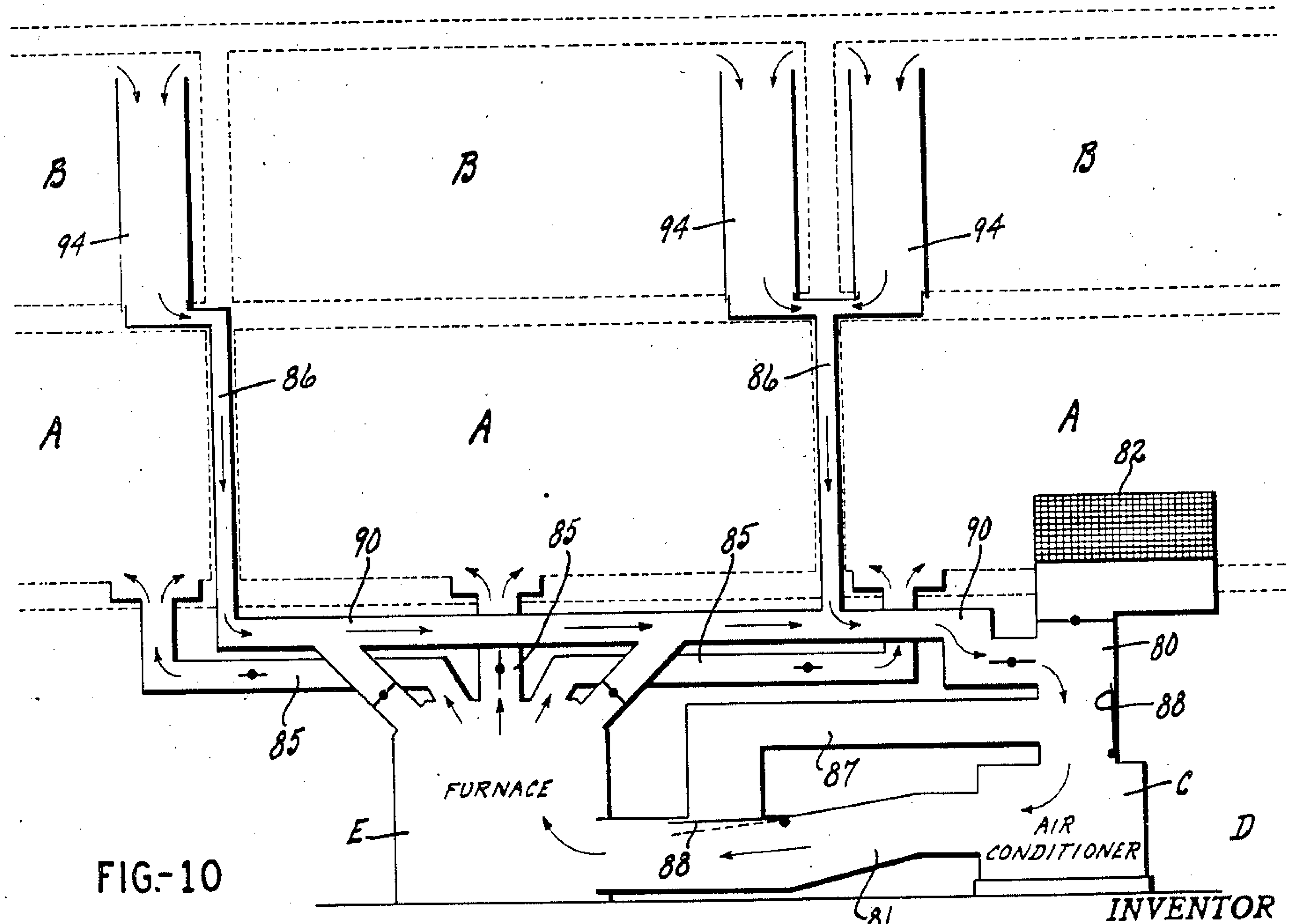

FIG.-10

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Aug. 2, 1938. E. S. PEARCE 2,125,581

APPARATUS FOR CONDITIONING AIR

Filed Jan. 4, 1934 5 Sheets-Sheet 5

FIG.-11

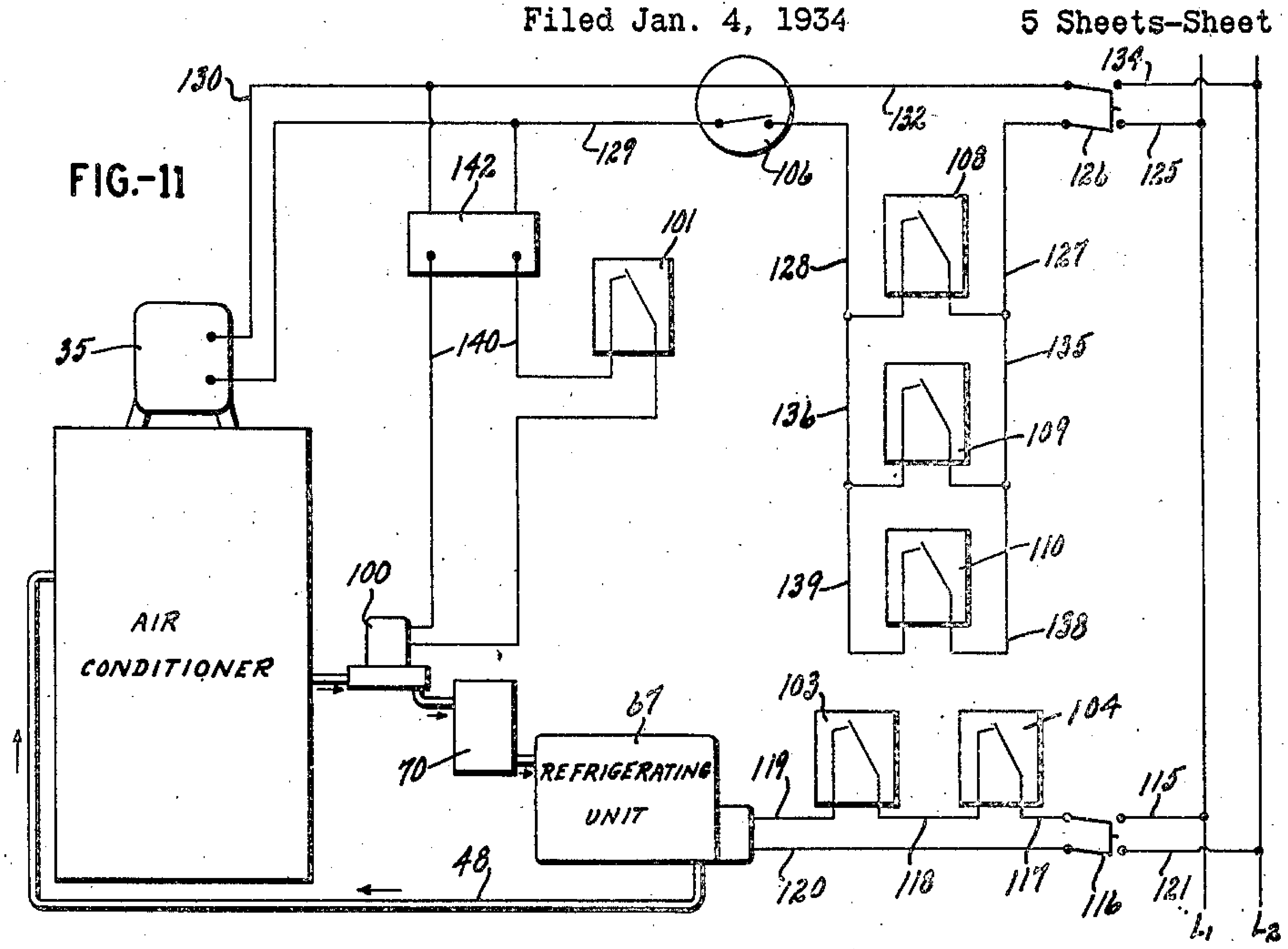
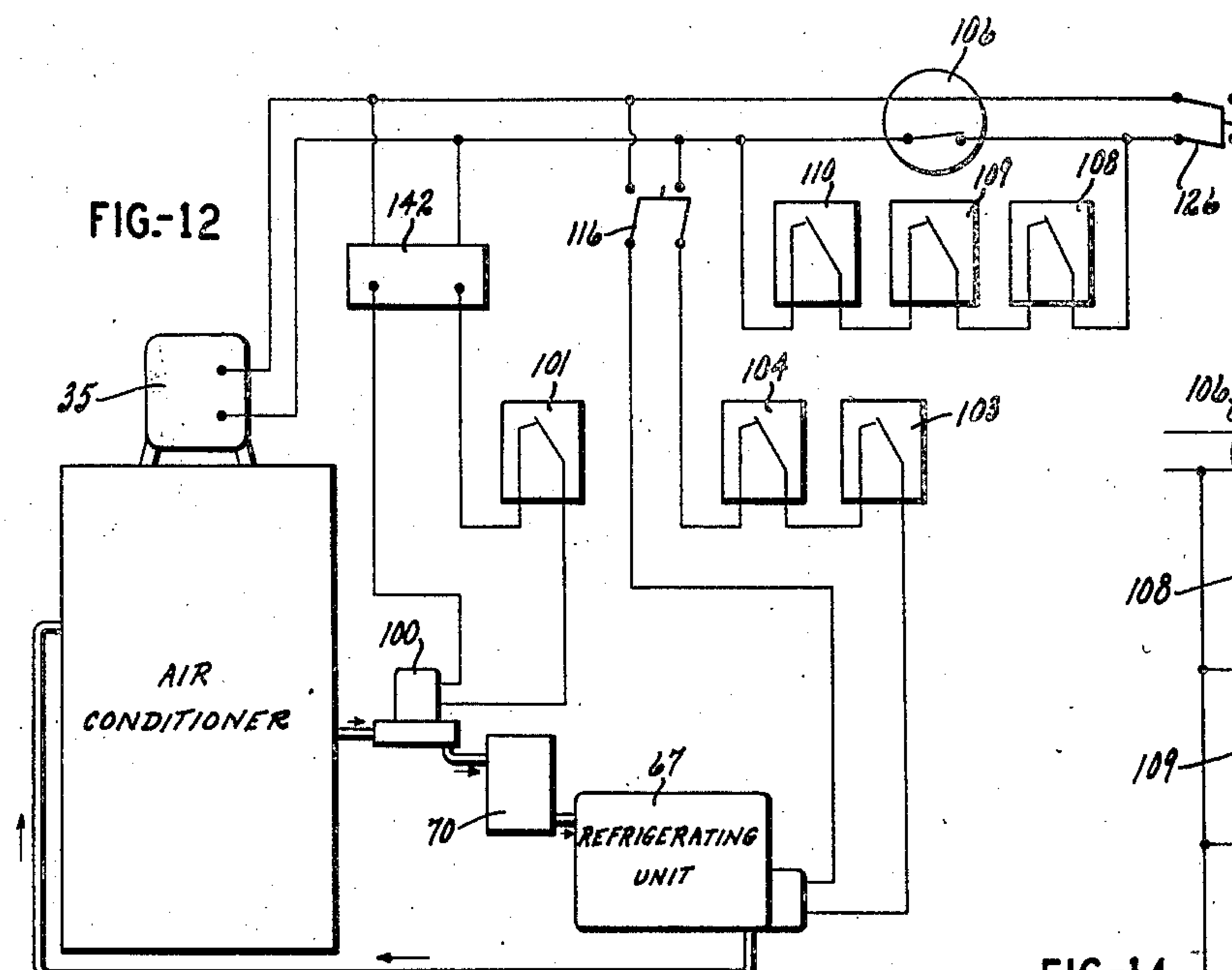


FIG.-12



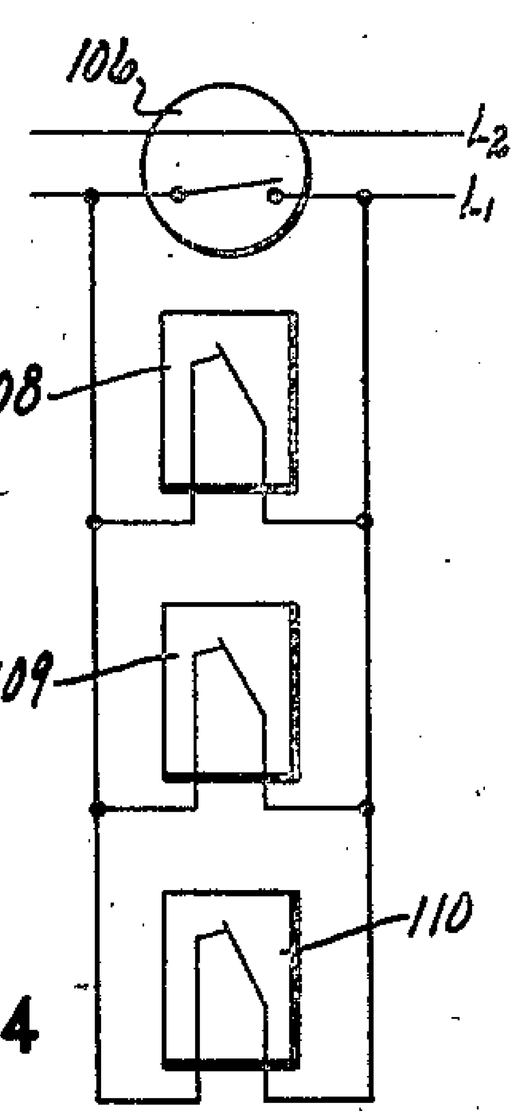


FIG.-14

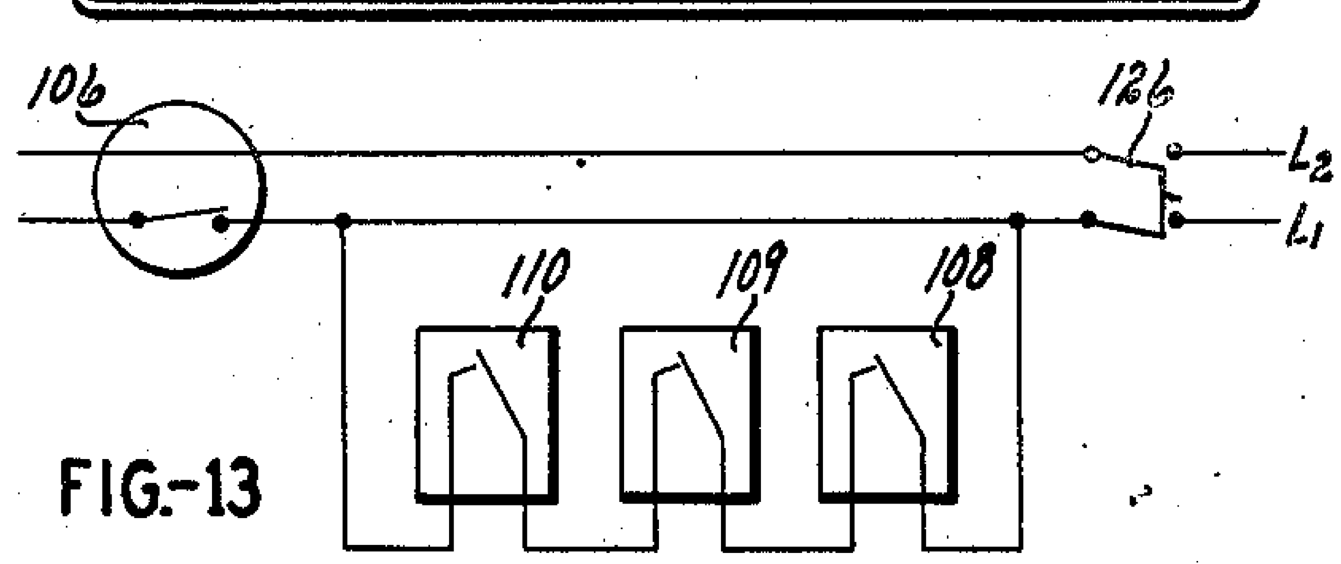


FIG.-13

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UNITED STATES PATENT OFFICE

2,125,581

APPARATUS FOR CONDITIONING AIR

Edwin S. Pearce, Indianapolis, Ind.

Application January 4, 1934, Serial No. 705,262

9 Claims. (Cl. 261—90)

This invention relates to improvements in apparatus for conditioning air, such as are used for producing and maintaining desirable atmospheric conditions in rooms or other enclosures.

The general object of the present invention is the provision of improved air conditioning apparatus, said apparatus being of simple and inexpensive character and its use enabling air to be efficiently and effectively cleaned, the temperature thereof reduced, if necessary, and the moisture content or humidity thereof properly regulated.

A further object of the present invention is the provision of improved air conditioning apparatus which is adapted for use with various types of air heating means, the present apparatus being especially suitable for use with residential air heating systems, particularly of the warm air type, inasmuch as the regular air ducts of said warm air systems may be used for the delivery to the present air conditioning apparatus of air for conditioning and for the delivery from said apparatus of air conditioned thereby.

A further object of the present invention is the provision of improved apparatus for conditioning air, by the use of which apparatus air not only can be efficiently and economically conditioned but also, can be readily supplied with aromatic odors and/or with a moisture content made up in part of germ-killing antiseptics and the like.

A further object of the present invention is the provision of improved air conditioning apparatus and improved control means therefor, said control means being of simple and inexpensive form and susceptible of wide modification to enable any desired results or control effects to be obtained.

Further objects of the present invention are in part obvious and in part will appear more in detail hereinafter.

The invention will be readily understood from the following description thereof, reference being had to the accompanying drawings in which Fig. 1 is a side elevation of one form of the present improved air conditioning apparatus, by the use of which, as well as by the use of other embodiments of the invention here illustrated, the present improved air conditioning methods may be practiced; Fig. 2 is an enlarged top plan view, partly in elevation and partly in section, of the centrifugal water atomizer of said apparatus; Fig. 3 is an enlarged detail vertical sectional view of the thermo-regulating valve in the water circulating system of said apparatus; Fig. 4 is an enlarged detail vertical sectional view of the water overflow and thermal outlet valve of said apparatus; Fig. 5 is an enlarged vertical sectional view of the main unit of said apparatus, said view being in a plane normal to Fig. 1; Fig. 6 is a detail cross-sectional view on the line 6—6, Fig. 5, and showing the upper end of the centrifugal pump pedestal; Fig. 7 is a side elevation of another form of the present improved air conditioning apparatus, said view being taken at right angles to Fig. 1 and showing a different arrangement of the water cooling unit; Fig. 8 is a side elevation of another form of the present apparatus, said view being similar to Fig. 7 but showing a different arrangement of the water cooling unit; Figs. 9 and 10 are sort of diagrammatic views of a residential installation of the present improved air conditioning apparatus, as used in conjunction with a warm air heating system, Fig. 9 showing the installation as used in the winter time and Fig. 10 showing said installation as used in the summer time; Figs. 11 and 12 are views, more or less diagrammatic, of control circuits for the present air conditioning apparatus; and Figs. 13 and 14 are similar views of modified portions of such circuits.

As shown in the accompanying drawings, particularly in Fig. 5 thereof, the main unit of the present improved air conditioning apparatus includes a suitable casing 1 of generally cylindrical form and having an open upper end for the reception of air to be conditioned, the lower portion of said casing having a lateral extension 2 provided with a suitable outlet opening 4 for the conditioned air.

Rotatably mounted in said casing is a vertically disposed shaft 6, the lower end portion of which is suitably supported in a centrally and vertically disposed centrifugal pump pedestal 7 suitably mounted in said casing. The upper end portion of said shaft is suitably supported in a suitable thrust bearing 8, here shown as of the tapered roller type and carried by suitable supporting means 10 with which the casing 1 is integrally or otherwise suitably provided.

Suitably mounted on the upper end portion of said shaft, below the bearing 8, for rotation with said shaft in the upper portion of said casing, is a multi-vane fan wheel 11 and a suitable water atomizer, said atomizer being arranged just below said fan wheel and having a construction and function hereinafter described. The function of said fan wheel, upon rotation thereof with the shaft 6, is to draw or pull air downwardly into the casing 1 through its open upper end, and for the purpose of restricting such casing air inlet to a size corresponding to that of said fan wheel, said casing is provided just above the level of said fan wheel with an inwardly extending, annular flange 12, the opening 13 at the center of which constitutes the casing air inlet, said opening having a diameter approximately equal to that of said fan wheel.

In the base of the centrifugal pump pedestal 7 is a centrifugal pump impeller 14 suitably connected to the lower end of shaft 6 for rotation therewith, said impeller lying within a body of water 15 which the lower end of the casing 1 contains in use of the present apparatus. For supplying water to said casing, a suitable water inlet pipe 16 is provided, the amount of water so supplied to said casing through said pipe being controlled by a suitable float-actuated valve 17 located within said casing.

In order to effect the discharge of water from said casing when the temperature of said water exceeds a predetermined degree, a suitable discharge valve 18 is mounted in the bottom wall of said casing, said valve communicating at its lower end with a suitable water discharge pipe 19. As best shown in Fig. 4, said discharge valve includes a suitable body portion 20 having its lower end threaded or otherwise formed for suitable securement to the water discharge pipe 19, said body portion being provided with a vertically disposed through passage 21 communicating at all times wtih said discharge pipe and constituting an over-flow passage for the water in said casing should its level become too high. Intermediate its ends, said valve body portion is provided with a lateral extension 23, the chamber 24 of which is in constant communication with the vertically disposed over-flow passage 21. Said valve extension chamber 24 also has direct communication with the water in the casing 1 through a suitable port 25 with which cooperates a vertically movable valve member 26, said valve member being operable by a thermal element 28 of general U-form, one of the ends thereof being connected to the valve body portion 20 (see Fig. 5) and the other end thereof being positioned below a vertically disposed screw 30 adjustably secured to said valve member 26.

When the temperature of the water in the casing 1 exceeds a predetermined degree, determined by the setting of the adjusting screw 30, the free end of said thermal element raises and, acting through said screw 30, lifts the valve member 26 from its seat, with consequent opening of the port 25 controlled thereby. Upon such opening of said port, the water in said casing flows through said port, the valve extension chamber 24 and the valve over-flow passage 21 to the water discharge pipe 19. When such removal of water occurs, the float-actuated valve 17 is automatically operated to effect a replenishment of the supply of water in the casing 1 from the water inlet pipe 16, said incoming water having a temperature, of course, considerably less than that of the outgoing or discharged water. In this way, the desired quantity of water in the casing 1 is maintained and at a temperature not greater than that for which the discharge valve 18 is set. By properly adjusting the valve member screw 30, any desired clearance can be provided between the head of said screw and the free end of the thermal element 28 cooperating therewith, and in that way, the discharge of water from the casing 1 can be effected whenever the temperature of said water exceeds any predetermined degree.

If desired and as shown in Fig. 5, means may be provided for discharging from the casing 1 a portion of its water 15 whenever the shaft 6 is rotating, the means here shown for that purpose comprising a valve controlled pipe 32 connected to the water conduit 48 hereinafter referred to and leading to the overflow passage 21 of the thermal outlet valve 18.

Although any suitable means may be provided for rotating the shaft 6 and the parts secured thereto, an electric motor, such as that indicated at 35, is preferred, said motor being here shown as mounted upon suitable supporting means 36 with which the upper end portion of the casing 1 is integrally or otherwise suitably provided, said motor being connected to the upper end of said shaft by means of a flexible coupling 37.

As best shown in Figs. 2 and 5, the water atomizer, mounted on the shaft 6 for rotation therewith beneath the fan wheel 11, includes a series of nested and concentric perforated cylinders 40, four such cylinders being here shown. For maintaining said cylinders in such nested and concentric relation and for effecting their securement to the shaft 6 for rotation therewith, said cylinders are provided with plate-like top and bottom walls 41, said walls being interconnected by bolts 42 or the like and said top wall being pinned or otherwise suitably secured to the shaft 6 so that the entire atomizer structure rotates therewith. As shown, the top and bottom walls 41 of said atomizer structure are suitably perforated, said walls in the present embodiment of the invention being provided with concentric series of circumferentially arranged slots 44.

Upon rotation of the shaft 6, and hence rotation of the centrifugal pump impeller 14 secured thereto, some of the water 15 in the lower end of the casing 1 is discharged by said impeller into a suitable conduit 48 (see Fig. 5) and delivered thereby to a chamber 49 in the upper end of the pump pedestal 7, said conduit having its lower end connected at 50 (see Fig. 1) to the base of said pedestal and its upper end connected at 51 to the upper end of said pedestal. From said pedestal chamber 49, the water is discharged through suitable perforations 56 in the pedestal cap 57 into the inner one of the four atomizer cylinders 40, the plate-like bottom wall 41 of said cylinders being provided with a centrally disposed opening 58 for the passage of said water and the extension therethrough of the shaft 6.

For supporting said pedestal upper end, the casing 1 is provided with suitable supporting means 60, said means being either integral with said casing, as shown, or separate therefrom and suitably secured thereto. If desired, the pedestal 7 may be provided with a constant water supply for lubricating purposes, said water being taken either from the casing 1 or from any other suitable place, all as will be readily understood.

Rotation of said atomizer cylinders 40, effected by rotation of the shaft 6 to which they are secured, causes the water discharged into the inner or central cylinder to be thrown by centrifugal force radially outward at a high velocity, said water passing in turn, in the form of a relatively dense mist, through the perforated peripheral walls of the four cylinders. If the diameters of said cylinders, from the inner or central one to the outer one, are respectively three and one-fourth inches, six and one-half inches, nine and seven-eighths inches and thirteen and one-fourth inches, and if said cylinders are rotated at a standard motor speed of seventeen hundred revolutions per minute, then for each one inch depth of said cylinders, there is presented, per minute, to the water discharged into the inner cylinder, a perforated linear surface area, over which said water is spread when thrown outwardly, of approximately 178,560 square inches or 1,240 square feet. If said cylinders have a depth of three inches each, then the linear surface area presented per minute to said water when thrown outwardly is approximately 3,720 square feet. If two hundred and fifty cubic inches of water are delivered per minute to the inner or central atomizer cylinder, the dispersion of the water in covering that amount of linear surface area is reduced to a film thickness of about .0009 of an inch.

Rotation of the shaft **6** and the parts secured thereto not only causes water to be discharged into the inner atomizer cylinder and to be thrown by centrifugal force horizontally outward in the form of a relatively dense mist or spray through the perforated peripheral walls of the several atomizer cylinders, but also, due to the action of the fan wheel **11** rotating with said shaft, causes air to be drawn or pulled down into the casing **1** through the casing air inlet **13**. The path of such incoming air is down around said atomizer cylinders and down through the outer portions thereof, then upwardly into said cylinders, then radially outward therethrough, and then downwardly again to the air outlet **4** of the casing. As a result, finely divided particles of water are "shot into" the incoming air streams, which air streams also come in contact with the finely dispersed water films on the surfaces of said cylinders. Inasmuch as the fan wheel **11** and the several atomizer cylinders are rotating in the same direction and at the same angular speed, the downwardly moving body of air and the outwardly moving relatively dense body of water, as well as mixtures thereof, are subjected within the casing **1** to great centrifugal force, one of the results of which is the separation from the air of its free water and dirt, such water and dirt falling to the bottom of said casing.

Such intimate contacting of the incoming air with said finely divided particles of water not only effects a thorough cleaning of the air but also effects a reduction in the temperature and the moisture content thereof. Part of said reduction is due to evaporation of water, and part to the relatively low temperature of said water, the temperature of said water and the quantity thereof used in relation to a certain quantity of air being very important, and hence requiring careful control.

If the water supply for the casing **1** has a temperature of fifty to sixty degrees Fahrenheit, no cooling of said water, before or after its delivery to said casing, is necessary to render it suitable for air conditioning use, although said water may become too warm, through use, for that purpose, in which event it will be automatically discharged from the casing **1** through the thermal discharge valve **18**. If, however, the water supply for said casing has a temperature greater than that just mentioned, some mechanical refrigeration or cooling of said water must be resorted to and in the several embodiments of the invention here illustrated, said water is subjected, either before or after its delivery to the casing **1**, to the cooling effects of the cooling coils of a suitable refrigerating unit.

In the embodiment of the invention shown in Fig. 1, the conduit **48** for conducting water from the casing **1** to the pump pedestal chamber **49**, from which chamber said water is discharged into the inner atomizer cylinder **40**, has arranged therein a suitable container **65** in which are located suitable cooling coils **66** of a suitable refrigerating unit **67**. In passing through said container **65** on its way to said pump pedestal chamber **49**, the water in conduit **48** is cooled by the coils **66** in said container to the desired degree for proper air conditioning use in the casing **1**.

In the embodiment of the invention shown in Fig. 7, the cooling coils **66*a*** of the refrigerating unit **67*a*** are located in the conditioned air outlet **4** of the casing extension **2*a***, the effect of such coils on the outgoing air being to further reduce the temperature and the moisture content thereof.

In the embodiment of the invention shown in Fig. 8, the cooling coils **66*b*** of the refrigerating unit **67*b*** are located in the lower end of the casing extension **2*b*** and hence within the water therein, the effect of said coils on such water being to maintain said water at the desired temperature for proper air conditioning use in said casing.

Instead of being located in the lower end of the casing **16** within the water therein, as shown in Fig. 8, said cooling coils may be located in the upper portion of said casing, in position to be contacted by the downwardly moving air and the outwardly moving water therein. Or, said cooling coils may be located in the water supply line **16** for the casing **1**, (see Fig. 5) in which case, the water supplied to the casing **1** will be in a sufficiently cooled state at the time of its delivery to effect proper air conditioning in said casing.

Any of the above water cooling arrangements are satisfactory, the three shown being merely illustrative.

In the water cooling arrangement of Fig. 1, a thermal valve **70** is suitably arranged in the water conduit **48** for regulating the amount of water supplied to the cooling container **65** in said conduit, such regulation being responsive to the temperature and humidity conditions of the air entering the present apparatus for conditioning. Because of the use of said thermal regulating valve, the water cooling arrangement of Fig. 1 is a preferred one, although the other water cooling arrangements illustrated and/or described are satisfactory for the purpose.

As best shown in Fig. 3, the thermal regulating valve **70** in the water conduit **48** of Fig. 1 comprises a suitable casing **75** connected in the water conduit **48** so as to receive water at its upper end and to discharge water at its lower end. Located within said casing and cooperating with its water inlet is a suitable valve member **76** carried by and movable with the free end portion of a generally U-shaped bi-metallic or thermal metal element **77**, the other end portion of said element being suitably secured to said casing. Said thermal element is of such character and is so arranged in said valve casing that the valve member **76** carried thereby is effective to reduce the amount of water allowed to enter said valve casing upon an increase in the temperature of said water, and hence to reduce the amount of water permitted to flow to the cooling container **65**.

In the cooling of air having a temperature of ninety degrees Fahrenheit and a relative humidity of sixty per cent, it is not necessary to add water to said air, and due to the high moisture content of said air, there will be a relatively lower reduction in the temperature thereof due to water evaporation in the casing 1. Therefore, the water flowing through conduit 48 to the thermal valve casing 75 will be of increased temperature, with the result that the water inlet of said valve casing will be restricted by the thermal element valve member 76 therein. By thus reducing the amount of water flowing through said thermal valve casing to the cooling coils 66, said water will be cooled to a lower degree, and thus be enabled, when it contacts the incoming pair in the casing 1, to effect a reduction of the temperature of said air and a reduction in the moisture content thereof.

Conversely, if the air entering the main casing 1 for conditioning therein has a temperature of ninety degrees Fahrenheit and a relative humidity of twenty per cent, evaporation of the water contacted with said air effects a reduction in the temperature thereof, and hence a reduction in the temperature of said water. The water flowing through the conduit 48 will therefore be cooler and the effect thereof upon the thermal element valve member 76 will be the complete opening of the water inlet of the thermal valve casing 75 so as to permit maximum flow to the cooling coils 66. As a result, said coils will not be able to cool said water to as low a degree as before, when effective upon less water, so that the water delivered to the casing 1, for contact with the air of ninety degrees temperature and twenty per cent humidity, is quite able to effect a reduction in the temperature of said air and an increase in the moisture content thereof.

From the foregoing description of the present improved air conditioning apparatus, it will be apparent that said apparatus is capable of efficient and effective use in the conditioning of air by removing therefrom dirt and other foreign particles therein, by reducing the temperature thereof, if necessary, and by properly regulating its moisture content. No air heating means is included in the present air conditioning apparatus, inasmuch as said apparatus is intended primarily as an adjunct to any suitable air heating means. For residential conditioning of air, the present apparatus is most desirable, especially if used in conjunction with warm air heating systems, as the regular air ducts of said systems are suitable for use in the delivery of air to said apparatus for conditioning thereby and in the delivery of conditioned air from said apparatus to the desired rooms or enclosures.

For purposes of illustration, Figs. 9 and 10 of the accompanying drawings show in diagrammatic form the present improved air conditioning apparatus as used in a typical residence in conjunction with a typical residential warm air heating system.

Fig. 9 shows said air conditioning apparatus and said air heating system as used in the winter time to supply conditioned air to the six rooms of said residence, three of said rooms, marked A, being located on the first floor, and the other three rooms, marked B, being located on the second floor. The present improved air conditioning apparatus, marked C, is located in the basement D of the residence, said apparatus being suitably connected in the normal cold air supply line for the furnace E of the residence, said supply line, consisting of the ducts 80 and 81, receiving air from one of the lower rooms A through the normal cold air register 82 therein.

In said air conditioning apparatus C, the air delivered thereto by the duct 80 from said first floor room A is properly cleaned, the temperature thereof is reduced, if necessary, and the moisture content thereof is regulated so that it is of the proper degree for maximum comfort. The air so conditioned then flows from said air conditioning apparatus C by way of the duct 81 into the furnace E, where it is heated to the extent necessary, after which said air flows into each of the first floor rooms A through the usual first floor warm air ducts 85 and into each of the second floor rooms B through the usual second floor warm air ducts 86, the path of the air, both before and after conditioning thereof, being indicated by the arrows. As shown, the regulating dampers of all ducts now in use are open.

If for any reason it is desired to by-pass the air conditioning apparatus C, either in whole or in part, that can be done easily and conveniently in the installation of Figs. 9 and 10 by merely connecting ducts 80 and 81 by a duct 87, and by properly regulating the two dampers 88 of said ducts. Normally, the by-pass duct 87 will be closed by its damper 88, as shown.

Fig. 10 shows said installation as it is used in the summer time, the air conditioning apparatus C receiving air for conditioning, during such period, from each of the three second floor rooms B, rather than from a single first floor room A, as in the winter time. For delivering such air from said second floor rooms to said air conditioning apparatus, the second floor warm air ducts 86 are utilized, said ducts communicating, not with the furnace E as they do in the winter time, but with a horizontally disposed basement duct 90, communicating with the air conditioning apparatus C by means of the cold air duct 80, the damper of said duct 90 being now in open position, as shown. After being conditioned in such apparatus in the manner hereinbefore described, the air delivered thereto from said second floor rooms flows to the furnace E through the duct 81. From said furnace, which is now not functioning as an air heating means, the conditioned air flows to the first floor rooms A through the regular first floor warm air ducts 85, part of said air in time finding its way to the second floor rooms B.

In the winter time, therefore, in the installation here shown, the air is removed from a single first floor room, is conditioned in the present air conditioning apparatus, is then heated by the furnace with which said apparatus is used, and is then delivered to all rooms, both first floor rooms and second floor rooms. In the summer time, the air is removed from all second floor rooms, is conditioned in the present apparatus, and is then delivered through the cold furnace to the first floor rooms only, an arrangement which is most satisfactory in residential air conditioning.

If desired and as shown in Fig. 10, suitable supplemental ducts 94 may be placed over the registers of the second floor warm air ducts 86, so that the air withdrawn from said second floor rooms, for air conditioning purposes in the summer time, will be the hottest air in said rooms, namely, that air lying just below the ceilings of said rooms. By so doing, the effectiveness of the present air conditioning apparatus can be materially increased at very slight increased cost. During the winter time, the ducts 94 are preferably removed. As in Fig. 9, the arrows of Fig. 10

show the path of the air, both before and after conditioning thereof, and the dampers of the several ducts are positioned as shown. It is to be understood, of course, that the installation here shown is illustrative only and that modifications thereof can be made, as desired.

In the embodiments of the invention shown in Figs. 1, 5 and 7, the delivery end of the water conduit **48** is connected to the upper end of the pump pedestal **7**, the water in said conduit discharging into the chamber **49** of said pedestal upper end and thereafter being discharged from said chamber into the inner one of the atomizer cylinders **40**, as heretofore described. In the embodiment of the invention shown in Fig. 8, the delivery end of the water conduit **48a** overlies said inner atomizer cylinder, the top wall of said atomizer cylinders, in this embodiment, preferably being provided with a centrally disposed opening **58a** for the passage of said water similar to the corresponding opening **58** in the bottom wall **41** of the atomizer cylinders of the embodiments of the invention shown in Figs. 1, 5 and 7. In the embodiment of the invention shown in Fig. 8, the bottom wall of the atomizer cylinders may be pinned or otherwise suitably secured to the shaft **6** so that said atomizer cylinders will rotate therewith.

If desired, the present air conditioning apparatus may be provided with one or more air filter screens **96**, (see Fig. 5) two such screens, of any suitable construction, being here shown as arranged in the casing extension **2** adjacent the air outlet **4** thereof.

As will be readily understood, various control devices, connected in various circuits and in various combinations, may be used with the present improved air conditioning apparatus, depending upon the particular results or control effects desired.

In Figs. 11, 12, 13 and 14 of the accompanying drawings, several control circuits are shown for purposes of illustration only, it being understood that the present invention is not limited to any particular control circuit or to any particular combination of control devices. For simplicity of illustration, two wire line circuits employing line voltage control devices, with the exception of solenoid valves, are shown, said control devices being diagrammatically illustrated for the sake of clearness. By the use of proper transformers, relays, etc., multi-wire, multi-phase alternating current or direct current circuits may be employed, with control devices of the three wire type, etc., all as will be readily understood.

In the two control circuits here chosen for illustration, Figs. 11 and 12, a suitable solenoid valve **100** is arranged in the water conduit **48** for controlling the amount of water flowing through said conduit to the thermal valve **70** therein, said solenoid valve being controlled by a humidostat **101** located in a room which receives air conditioned by the present air conditioning apparatus. The regulation by said solenoid valve of the flow of water through the conduit **48** is therefore responsive to the moisture condition of air previously conditioned by the present apparatus, whereas the regulation by the hereinbefore referred to thermal valve **70** of the flow of water through said conduit **48** is responsive to the temperature and moisture condition of air entering the present apparatus for conditioning. While the use of both of said valves is preferable, the use of either one may be omitted, if desired, all as will be readily understood.

For controlling the refrigerating unit **67** of said apparatus, a humidostat **103** and a thermostat **104** are provided, said devices being connected in series and being located in a room which receives air conditioned by the present apparatus.

Each of the circuits of Figs. 11 and 12 also has arranged therein a suitable time switch **106**, the one here shown being of standard design and adapted to close the circuit, so far as it is concerned, once each cycle and to maintain said circuit closed for any selected portion of said cycle. The cycle may be a day or an hour or any other suitable time period, and if it is an hour, for example, the circuit is closed, as to said time switch, once each hour and is maintained closed for as long a portion of said period as was previously decided upon.

Also included in each of said two circuits, as well as in each of the fragmentary circuit portions of Figs. 13 and 14, are a humidostat **108**, a thermostat **109** and a furnacestat **110**, said furnacestat being a temperature sensitive device controlling electrically the operation of the air conditioning apparatus in accordance with furnace temperature.

Referring more in detail to the circuit of Fig. 11, it will be noted that line current for operating the refrigerating unit **67** flows from line L**1** to line **115**, manually operable line switch and overload cut-out **116**, if closed, line **117**, thermostat **104**, if in circuit closing position, line **118**, humidostat **103**, if in circuit closing position, line **119**, refrigerating unit **67**, line **120**, switch **116**, and line **121** to line L2. Said refrigerating unit is therefore operated only when both the humidostat **103** and the thermostat **104** are respectively affected by moisture and temperature conditions requiring correction. It is to be understood, of course, that either the humidostat **103** or the thermostat **104** may be used independently of the other, if desired, and that said devices may be connected to line L**1** either before the time switch **106**, as in Fig. 11, or after said switch, as in Fig. 12. It is also to be understood that the time switch **106**, instead of having other control devices in circuit with it, as shown, may be arranged in an independent circuit, and thus be effective to effect operation of the present air conditioning apparatus regardless of the open or closed condition of other control devices.

For operating the motor **35** of the present air conditioning apparatus, in the circuit of Fig. 11, line current flows from line L**1** to line **125**, manually operable line switch and over-load cut-out **126**, if closed, line **127**, humidostat **108**, if in circuit closing position, line **128**, time switch **106**, if closed, line **129**, motor **35** of the air conditioning apparatus, line **130**, time switch **106**, line **132**, switch **126** and line **134** to L2. If the humidostat **108** is not in circuit closing position, (and it will not be when the air to which it is responsive does not require a correction as to its moisture content), then current flows from line **127**, line **135**, thermostat **109**, if in circuit closing position, and line **136** to line **128**, and then on as before. If the thermostat **109** is not in circuit closing position, (and it will not be when the air to which it is responsive does not require a correction as to its temperature), current flows from line **135**, line **138**, furnacestat **110**, if in circuit closing position, line **139**, line **136**, line **128** and then on as before. Inasmuch as the humidostat **108**, the thermostat **109** and the furnacestat **110** are connected in parallel, operating current will flow to the motor **35** if the condition which any one of said devices controls is in need of correction, provided, of course, that the line switch 126 and the time switch 106 are closed. It is to be understood, of course, that any one of said three control devices 108, 109 and 110, may be used independently of the others, and that a combination of any two of them may be employed. Furthermore, it is to be understood that said three control devices or any combination thereof may be connected in parallel, as in Figs. 11 and 14, or in series, as in Figs. 12 and 13, and that said devices, or any combination thereof, may be connected in series with the time switch 106, as in Figs. 11 and 13, or in parallel therewith, as in Figs. 12 and 14.

As shown in the circuits of both Figs. 11 and 12, the solenoid valve 100 for controlling the water flow through conduit 48 is arranged in a low voltage circuit 140 by the use of a suitable transformer 142, said circuit including the humidostat 101 heretofore referred to. The solenoid valve 100 is therefore operated in response to said humidostat 101, which device assumes circuit closing position only when the air to which it is responsive is in need of correction. It is to be understood, of course, that the solenoid valve 100 is not operated, even when the humidostat 101 is in circuit closing position, unless all control devices ahead of it, if any, are closed. In the circuit of Fig. 11, operation of the solenoid valve 100 is dependent upon the time switch 106 and one of the three control devices 108, 109 and 110, whereas in the circuit of Fig. 12, operation of said solenoid valve is dependent upon either the time switch 106 or all of said three control devices 108, 109 and 110.

From the foregoing more or less detailed description of the circuit of Fig. 11, the circuit of Fig. 12 and the fragmentary circuit portions of Figs. 13 and 14 should be clear, the control devices of the circuits of Figs. 12, 13 and 14 having the same reference characters as used thereon in the circuit of Fig. 11.

As heretofore mentioned, the control circuits and the control devices thereof here illustrated and described are illustrative only, being susceptible of much modification. Likewise, the air conditioning apparatus itself as herein illustrated is capable of undergoing considerable change without departing from either the scope or the spirit of the present invention.

In connection with the cleaning of air, by the use of the present improved air conditioning apparatus, it is interesting to note the results of tests conducted to determine the extent to which said apparatus sterilizes air by the mechanical removal of bacteria therefrom. Cultures made from the air entering the casing 1 of the present air conditioning apparatus for conditioning therein disclosed that said air had a bacteria organism content of one hundred and fifty organisms per liter. Cultures made of the air leaving said casing, after being conditioned therein, disclosed that the organism content of said air had been reduced by said air conditioning to eight organisms per liter, a most remarkable reduction. The intimate contacting of the air entering the casing 1 of the present apparatus by the finely divided water particles results in a most complete transfer from said air to said water of substantially all of the bacteria in said air, the air being left in as pure a state as is advisable if a sufficient bacteria resistance is to be maintained.

If desired, water soluble antiseptic substances, in proper quantities, may be placed in the circulating water of the present air conditioning apparatus, for subsequent partial transfer to the conditioned air as a part of its moisture content. Likewise, water soluble aromatic substances, such as oil of pine needles, may be placed in said water, with consequent transfer of the pleasing odor thereof to the conditioned air, all as will be readily understood.

For purposes of inspection, the casing 1 is preferably provided with a suitable glass door 150, Fig. 5, and for clean out purposes, said casing is preferably provided with a suitable clean out door 151, Fig. 5.

Further features and advantages of the present improved apparatus for and methods of conditioning air will be readily apparent to those skilled in the art to which they relate.

What I claim is:

1. Air conditioning apparatus, comprising a casing having an air inlet and an air outlet, means for producing a flow of air through said casing from the inlet to the outlet thereof, a shaft rotatably mounted in said casing, a water atomizer mounted on said shaft for rotation therewith and arranged in the path of the air as it flows through said casing, tubular means surrounding said shaft and having a perforated end head adjacent said water atomizer, a supply of water in said casing, and means within the other end of said tubular means and operable during rotation of said shaft for delivering water from said water supply to the perforated end head of said tubular means, from which said water passes to said atomizer for intimate contact with the air as it flows through said casing.

2. Air conditioning apparatus, comprising a casing having an air inlet and an air outlet, means for forcing air through said casing, a water atomizer in said casing between the air inlet and the air outlet thereof, a supply of water in said casing, conduit means for delivering water from said water supply to said atomizer for intimate contact with the air as it flows through said casing, water cooling means in said conduit means, valve means in said conduit means between said water supply and said cooling means, and means sensitive to temperature of the water in said casing for operating said valve means, to thereby control the amount of water permitted to flow through said conduit means to said cooling means and hence to said atomizer.

3. Air conditioning apparatus, comprising a generally vertically disposed casing having an upper air inlet and a lower air outlet, means for producing a flow of air through said casing from the inlet to the outlet thereof, a generally vertically disposed shaft rotatably mounted in said casing, a water atomizer mounted on said shaft for rotation therewith and arranged in the path of the air as it flows through said casing, tubular means surrounding said shaft below said water atomizer and provided with a perforated head at its upper end, a supply of water in said casing into which the lower end of said tubular means extends, and means mounted on and rotatable with said shaft, within the lower end of said tubular means, for delivering water from said water supply to said perforated end head of said tubular means, from which end head said water passes to said atomizer for intimate contact with the air as it flows through said casing.

4. Air conditioning apparatus, comprising a casing having an air inlet, an air outlet and a

bottom portion containing a pool of water, a water atomizer arranged in said casing, means for supplying water from said pool to said atomizer for atomization thereby, means for effecting a flow of air through said casing and said atomizer, and means responsive to the rise of temperature of the water in the casing for causing water to flow from said casing and means responsive to the flow of water in the casing for supplying cool water thereto, thereby maintaining the temperature of the water in said casing at the desired temperature.

5. Air conditioning apparatus, comprising a generally vertically disposed casing having an upper air inlet and an air outlet adjacent the lower portion, air moving means in said casing adjacent the inlet thereof for producing a positive downward flow of air through said casing, a centrifugal atomizer arranged below said air moving means comprising a plurality of finely perforated cylinders supported in spaced relation by means of end frames, and means for forcing water through said cylinders, said air moving means being so arranged with respect to said atomizer that air will be forced between the spaced cylinders and will be intimately mixed with water particles as they are forced outwardly through the perforations in said cylinders.

6. Air conditioning apparatus, comprising a casing having an air inlet and an air outlet, a shaft rotatably mounted in said casing, a water atomizer having upper and lower reticulated walls and spaced concentric cylindrical screens clamped therebetween, the open spaces in the reticulated walls being arranged between said screens and the upper wall of said atomizer having a solid central portion for rigid securement to said shaft, and means mounted on the upper wall of the atomizer for forcing at least a portion of the air outwardly above the atomizer and circulating it upwardly through the spaces between the concentric screens and outwardly through the screens whereby the air may be brought into intimate contact with finely divided particles of water forced outwardly through the screen by centrifugal action.

7. Air conditioning apparatus, comprising a casing having an air inlet and an air outlet, air moving means in said casing, a water atomizer mounted in said casing between the inlet and outlet thereof, a pool of water in said casing below said atomizer, means for supplying water from said pool to said atomizer, said casing also being provided with a water inlet and a water outlet, valve means for said water outlet, operating means for said valve means sensitive to the temperature of the water in said casing whereby water may be drained from said casing when it exceeds a predetermined temperature, and float controlled operating means for said inlet valve responsive to the fall of liquid in said casing whereby additional liquid may be supplied to said casing and the level and temperature of the pool of liquid in said casing may be controlled.

8. An air conditioning apparatus including a rotatable water atomizer having a plurality of cylindrical screens in concentric spaced relationship, said atomizer being provided with reticulated end walls, one of said end walls being provided with an opening leading into the inner cylinder, a casing for a cooling fluid arranged adjacent said opening and being provided with perforations whereby cooling fluid may be drawn in comminuted form into the inner cylinder during the rotation of said atomizer, and means for forcing air between the spaces in the cylindrical screens during the rotation of said atomizer.

9. An air conditioning apparatus including a water atomizer having a plurality of cylindrical screens in concentric spaced relationship, said atomizer being provided with upper and lower reticulated end walls, the lower wall being provided with an opening leading into the interior of the inner cylinder, a casing for cooling fluid located below the atomizer, said casing being provided with a series of apertures located below the inner cylinder, means for centrifugally rotating said atomizer to draw water in comminuted form from said casing into the interior of the inner cylinder and to force it outwardly through said screens, and means for forcing air through the spaces between the cylinders to intimately mix the air with the finely divided particles which are being forced outwardly.

EDWIN S. PEARCE.