

Jan. 29, 1952

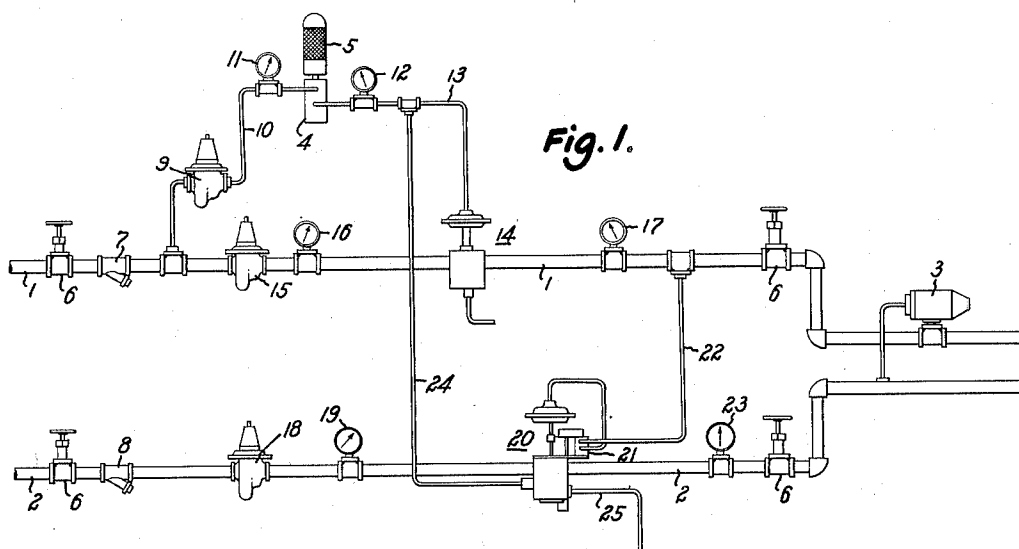
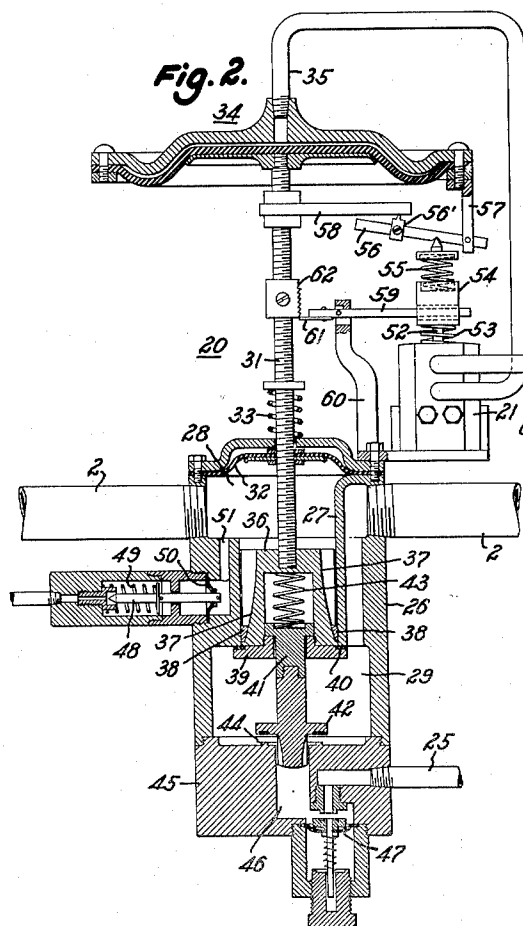
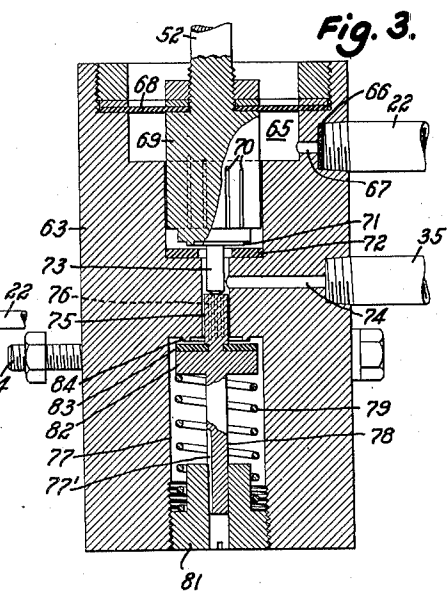
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2,583,986

ATOMIZER SYSTEM

Filed Feb. 8, 1944

2 SHEETS—SHEET 1



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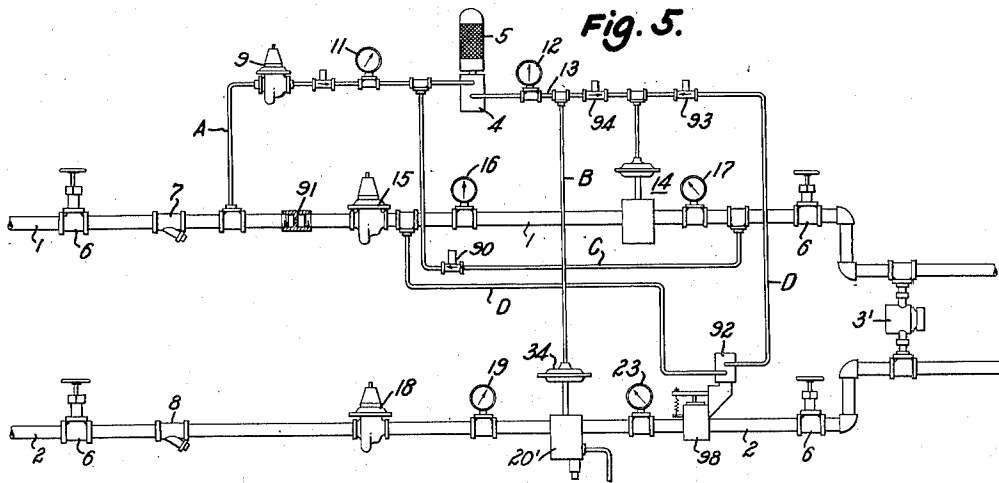
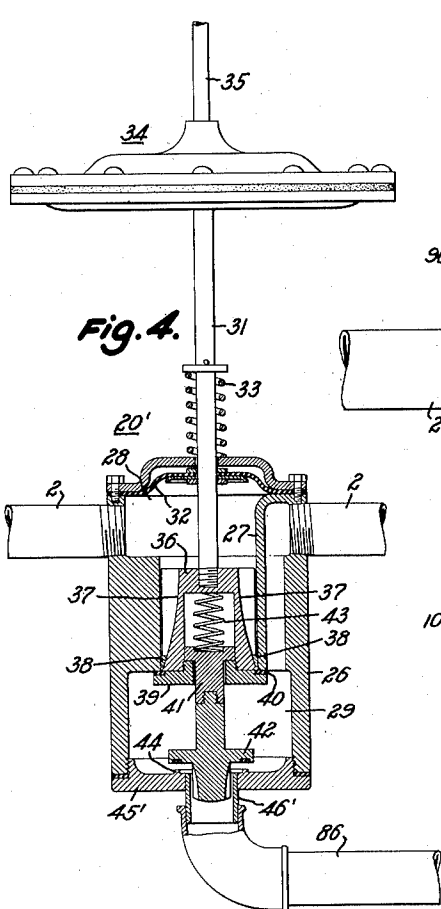
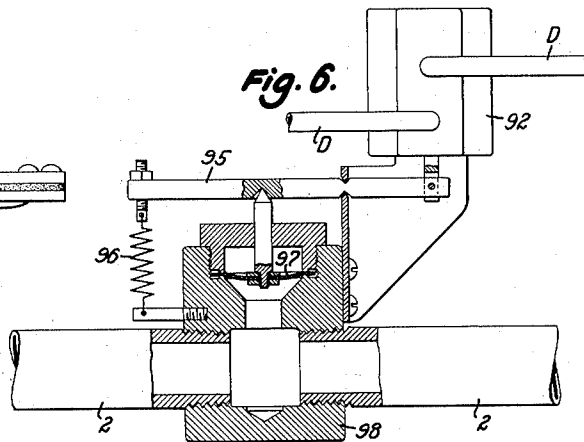
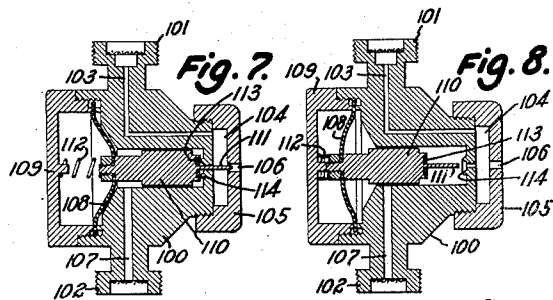
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ATOMIZER SYSTEM

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2 SHEETS—SHEET 2



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UNITED STATES PATENT OFFICE

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ATOMIZER SYSTEM

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4 Claims. (Cl. 137-78)

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This invention relates to atomizer systems of the type in which a liquid is projected from an atomizer head or nozzle, by a pressure gas, and particularly to an atomizer system including devices for automatically controlling the operation of the system and for interrupting the flow of both fluids in the event of an inadvertent failure or substantial decrease in the supply of either one of the fluids.

For simplicity of terminology, the invention will be described as embodied in humidifier systems but it is to be understood that the control elements may be incorporated in systems for atomizing other liquids with air or other gaseous mediums, and that the control elements may be of the illustrated air-operated type or of an electrically-operated type.

The initial cost of the atomizer head or spray nozzle type of humidifier is relatively low but the operating costs of the conventional type atomizers used in such humidifier systems have been relatively high. By using an atomizing principle that requires both air and water under pressure the operating costs of such systems may be substantially lowered. Ordinarily no provision has been made for maintaining automatically a constant operating differential between the air and water pressures supplied to the humidifier system.

Objects of the present invention are to provide novel and efficient atomizer systems of the type in which a gas and a liquid are supplied under pressure to one or more atomizer heads. An object is to provide atomizer systems of the type stated which include control devices for regulating the rate of flow of one or both of the fluids by adjustment of the pressure on one or on both of the fluids. An object is to provide an atomizer system in which a predetermined differential is maintained between the pressures at which the fluids are delivered to the atomizing heads. Another object is to provide atomizer systems of the type stated that include control devices for automatically interrupting operation in the event of a complete or a substantial failure in the supply of either of the pressure fluids. Other objects are to provide novel control elements for use in atomizer systems of the type stated.

These and other objects and advantages of the invention will be apparent from the following specification when taken with the accompanying drawings in which:

Fig. 1 is a fragmentary, and somewhat schematic view, of a humidifier system embodying the invention;

Fig. 2 is a substantially central section through

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the modulating dead-end valve in the water supply line of the humidifier system;

Fig. 3 is a central section through a modulating air control cartridge;

Fig. 4 is a fragmentary central section through the modulating pressure-control valve in the air supply line of the humidifier system;

Fig. 5 is a fragmentary, and somewhat schematic, view of another embodiment of the invention;

Fig. 6 is a fragmentary elevation, with parts in section, of an air cartridge and associated control elements on the water supply line; and

Figs. 7 and 8 are substantially central sections through an atomizer of the Fig. 5 humidifier system, the atomizer being shown in closed and in open position, respectively, in Figs. 7 and 8.

In the atomizer system of Fig. 1, the air line 1 and the water line 2 deliver their respective fluids to a plurality of atomizers 3 under the control of, and at pressures determined by, air cartridge 4 actuated by a regulating element 5 that, in the humidifier system, is a humidostat located in the room or space within which the relative humidity is to be maintained substantially constant. For simplicity of illustration, various unions or pipe couplings that are present in a system of piping have been omitted from the drawings. Manually operable gate valves 6 are preferably provided at the opposite ends of the sections of the fluid supply lines 1, 2 on which the control and indicating elements are located, thereby permitting an isolation of the control section for inspection or repair. The atomizers 3 may be of the type, as disclosed in my prior application Serial No. 446,506 on which Patent No. 2,382,124 has issued, in which the liquid is under greater pressure than the gas.

The power medium for actuating the control and regulating elements is air under pressure that may be delivered from some independent source or, as illustrated in Fig. 1, may be tapped from the air line 1 through a reducing valve 9 that maintains a substantially constant pressure at the inlet line 10 of the air cartridge 4. Pressure gages 11, 12 are preferably arranged on the air line 10 to the air cartridge and on the outlet line 13, respectively. The control air line 13 extends to the air motor of the modulating air valve 14 to regulate the air pressure at the atomizers 3 in accordance with the load demand as determined by the air cartridge 4 and humidostat 5. A reducing valve 15 and pressure gage 16 are preferably arranged on the air line 1 between the strainer 7 and air valve 14 to establish a definite

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normal pressure, and a measure of the pressure, of the air supply to the valve 14. Another gage 17 is preferably located in the air line 1 beyond the valve 14 to register the pressure at which air is supplied to the atomizers 3.

On the water supply line 2, a reducing valve 18 and a gage 19 are arranged between the strainer 8 and a modulating water supply valve and control unit that is identified in Fig. 1 by the reference numeral 20. The detailed construction and method of operation of this assembly will be described later and, for present purposes of description, it is stated that the pressure on the water line 2 beyond the control unit 20 is determined by the displacement of the movable element of an air cartridge 21 in accordance with the air pressure at the atomizers 3, the air pressure at the controlled section of the air line 1 being transmitted to the air cartridge 21 through a pipe connection 22. A pressure gage 23 is located on the water line 2 beyond the control unit 20 to register the pressure at which water is supplied to the atomizer 3. A bleeder line 24 extends from the outlet side of the control unit 20 to the control air line 13 of the modulating air valve 14 and, as will be explained later, the bleeder line 24 is opened when the water pressure drops below a preselected value, thereby venting the control line to close the modulating air valve 14. A pipe 25 extends from the outlet side of the control unit 20 to drain some or all of the water from the end section of the water line 2 when the atomizer system is shut off by an upward closing movement of the three-way valve 14.

The control unit 20 on the water supply line 2, as illustrated in Fig. 2, comprises a "dead end" reducing or pressure modulating valve and associated control elements within a casing 26 that has an interior wall 27 providing inlet and outlet chambers 28, 29 respectively to which the supply and delivery sections of the water line 2 are connected. The stem 31 of the pressure modulating valve is urged towards closed position by water pressure on a diaphragm 32 in the inlet chamber and by an adjustable spring 33, and is moved towards valve-opening position by an air motor 34 that receives pressure air from the cartridge 21 through a connecting pipe 35. The modulating valve comprises an inverted hollow body 36 threaded on the stem 31 and having longitudinally extending arcuate grooves 37 milled in its exterior surface. When the grooves are cut with a thin, disk-shaped cutter, the lower or shallow ends of the grooves are filled with solder 38 to insure an abrupt opening of the valve after an initial idle displacement of the valve body 36. Alternatively, the grooves may be stopped short of the end of the valve body when cut by an end milling tool. A cap 39 is threaded on the valve body 36 and carries a gasket 40 for sealing the modulating valve against leakage when in valve-closed position. The cap 39 is of annular form and the flanged upper section 41 of the stem of a waste valve 42 rests upon and is pressed into engagement with the inner surface of the cap 39 by a spring 43 within the hollow valve body 36. The downward movement of valve stem 31 brings the valve 42 into engagement with a valve seat 44 on the bottom cap 45 of the valve casing 26 just before the grooves 37 of valve body 36 establish communication between the inlet chamber 28 and the outlet chamber 29. The waste or drainage chamber 46 in the cap 45 is therefore closed to outlet chamber 29 when the

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pressure modulating valve 36—40 is open, and is opened to the outlet chamber 29 when the modulating valve is closed. An adjustable check valve 47 controls the flow of water from the waste chamber 46 to the waste pipe 25, thereby trapping water under a desired pressure, according to the setting of the check valve 47, in the pipe line 2 between the control unit 20 and the atomizers 3. The check valve 47 prevents a drainage of water from the pipe line 2 but reduces the water pressure to a value below that at which water may leak from the atomizers 3 when the atomizer system is not in operation. When other operating conditions remain constant, variations in water supply pressure at the valve 20 act upon the diaphragm 32 to move the water modulating valve 36 to compensate for the change in supply pressure and thereby maintain a constant water pressure at the atomizers 3.

The bleeder valve 48 for venting the bleeder line 24 and control air line 13 to atmosphere through a vent port (not shown) in the wall of the valve chamber is biased towards open position by a spring 49 but is normally closed by the water pressure exerted on a diaphragm 50 through a channel 51 that opens into the inlet chamber 28 of the control unit 20. A drop in the pressure of the water supply below a preselected value required for efficient operation results in an opening of the bleeder valve 48; thereby venting the control air line 13 and closing the air modulating valve 14, and, as explained hereinafter, this interruption of pressure air in the forward section of air line 1 leaves the control air line 22 without pressure and results in a closure of the water modulating valve 36 by spring 33 and the water pressure on diaphragm 32.

The control unit 20 includes mechanism that cooperates with the air cartridge 21 to effect a rapid reduction in the rate of water supply to the atomizers 3 in the event of a decrease in the air pressure at the atomizers. This mechanism and the cartridge 21 constitute a safety system for avoiding a short period supply of water to the atomizers at a high rate that precludes efficient atomization. An increasing load demand results in an increasing air pressure at the atomizers 3 as the modulating air valve 14 opens, and in a corresponding increase in the water pressure since the water modulating valve unit 20, as will be explained, responds to the increased air pressure at the forward section of air line 1. When the load demand decreases, however, the air pressure drops more rapidly than the water pressure and, to avoid "wetting," the water pressure must be relieved momentarily by a discharge of water through the waste pipe 25. An appropriate construction for the air cartridge will be described in detail hereinafter and, for purpose of the present explanation, it is stated that upward movement of the stem 52 effects a progressive increase in the pressure at which control air from pipe 22 is supplied to the air motor 34 through the cartridge outlet connection 35, i. e. in a progressive movement of the water modulating valve 36 towards fully open position. The stem 52 of the air cartridge is biased towards valve-open position by a spring 53 that is arranged between the top of the cartridge 21 and a floating seat 54 that is urged downwardly, to oppose the spring 53, by a spring 55 between the seat 54 and a lever 56 pivoted on bracket 57 fixed to the air motor 34 and carrying an adjustable abutment 58 in the path of an arm 59 on the stem 31 of the modulating

water valve. The springs 53, 55 are so related, with respect to the compression of spring 55 as the valve stem 31 is moved downwardly by an increasing demand for water to maintain the desired humidity condition, that the water pressure at the atomizers 3 exceeds the air pressure at the atomizers by a substantially constant pressure difference. A lever 59 is pivoted on a bracket 60 mounted on the casing 26 of the modulating water valve, one end of the lever extending through an opening in the floating spring seat 54 and the other end carrying a spring finger 61 that engages a ratchet bar 62 on the valve stem 31. The spring finger 61 functions as a pawl that permits free downward movement of the valve stem without an accompanying counter-clockwise movement of the lever 59, but the pawl and ratchet turn the lever 59 clockwise, upon upward movement of the valve stem 31, in response to a decrease in the control air pressure applied to the air motor 34 from the forward section of the air supply line 1 and the air cartridge 20. The stem 52 is thereby moved downwardly by the lever 59 to force the air cartridge to closed position to interrupt the supply of control air to the air motor 34 and to bleed the air motor to atmosphere. The water modulating valve 36 is closed by the spring 33 and the water pressure on the diaphragm 32, and the valve stem 31 lifts to carry the ratchet bar 62 above the spring finger or pawl 61 of the lever 59. The air cartridge 21 again controls the air pressure at the motor 34 as soon as the water modulating valve reaches closed position to free the lever 59 from the ratchet bar 61, but the momentary closing of valve 36 and the opening of valve 42 permits water to waste through check valve 47 to pipe 25 and thereby lower the pressure of the water supply to the atomizers 3, thus positively precluding an excess discharge of water upon a decreasing load demand and a drop in the air pressure at the atomizers 3.

The air cartridge 21, which preferably is substantially identical with the air cartridge 4 that is controlled by the humidostat 5, comprises a casing or shell 63 that may be mounted on any convenient bracket or support by bolts 64. The pressure air pipe, which is the connecting pipe 22 to the air supply line 1 for the air cartridge 21, opens into the pressure chamber 65 through a filter 66 and port 67. The upper wall of the pressure chamber is a diaphragm 68 that carries the main valve 69 that has a stem 52, see Fig. 2, extending above the diaphragm for cooperation with control devices that may be the springs 53, 55 and associated mechanism for the air cartridge 21 of Fig. 2 or may be the humidostat 5 for the air cartridge 4 of Fig. 1. The main valve 69 is of generally cylindrical form with a series of fine grooves 70 of different lengths broached into its peripheral surface, an intermediate reduced diameter section including an annular bead 71 for engagement with a gasket or valve seat 72 to seal the main valve when in closed position, and a stem 73 that extends below the outlet passage 74 to engage the upper end of the leak port valve 75. The cylindrical surface of the valve 75 is provided with grooves 76 of different lengths to bleed air from outlet passage 74 and control line 35 in accordance with the adjustment of the valve 75. The vent chamber 77 below valve 75 is open to atmosphere through a groove 77' in the stem 78 of the vent port valve. Valve 75 is urged towards

closed position by a spring 79 that is seated between an adjustable plug 81 and a radial flange 82 on the valve stem that carries a gasket 83 for cooperation with an annular bead 84 on the body of the air cartridge to form a secondary valve that seals the leak port valve when in fully elevated or closed position.

The described air cartridge provides a modulation of the air pressure at the outlet passage 74 of the cartridge by the progressive opening of the grooves 70 of the main valve 69 as it is moved upwardly under the force of spring 79 and the air pressure within the chamber 65, upon a decrease in the force exerted upon the stem 52 by a control device. The leak port valve 75 is also of the modulating type and is urged towards closed position by the spring 79.

The three-way air valve 14 in the supply air line 1 is similar in general construction to the modulating water valve unit 20 but of simpler design since, as illustrated in Fig. 4, the air valve does not include the check valve assembly 47 in the lower cap or the bleeder valve 48 of the water modulating valve. Those elements of the air valve 14 that may be or are substantially identical with corresponding parts of the water valve unit 20 are identified by the same reference numerals but will not be described in detail. The lower cap 45' is a shallow plate threaded into the lower end of the valve body 26 and having a central opening in which the guide cylinder and vent 46' is fixed. The pressure air within the forward section of the supply air line 1 may be vented directly to atmosphere at the lower end of the vent 46' but, preferably, a vent pipe 86 extends from the vent 46' to some remote point at which the escape of air, and incident noise, will not result in disturbance or annoyance.

The atomizer control system illustrated in Fig. 5 has the same general operating characteristics, and the major elements, i. e. reducing valves, gages, air and water control valves, as the previously described system, and such elements as are or may be substantially identical with corresponding elements of the Fig. 1 apparatus are identified by the same reference characters. The differences between the two systems are found in the arrangement and correlation of the control air lines that regulate the operation of the control valve elements in the air supply line 1 and water supply line 2 on which a series of atomizers 3' are arranged. The atomizers 3' are of such construction, as will be described later, that they become operative at a preselected water pressure, and the control air lines are so regulated by the air cartridge 4 and humidostat 5 that pressure air is supplied to air line 1 and pressure water is then supplied to the water line 2. Specific values will be recited to facilitate an understanding of the operation of the atomizer system but it is to be understood that the invention is not limited to the recited values.

The primary control of the modulating air valve 14 by a humidostat 5 is effected by an air cartridge 4 in a control air line, identified generally as control line A, that is substantially identical with the previously described control line that is tapped from the main supply air line 1 and includes a pressure reducing valve 9, a gage 11, the air cartridge 4, a gage 12 and a control air line 13 to the modulating air valve 14. A control air line B connects control air line A to the air motor 34 of the modulating water valve 20' that may be identical with the valve assembly illustrated in Fig. 2 except for

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the elimination of the bleeder valve 48 and its associated elements. The air pressure at the supply end of air line 1 may be about 35 pounds per square inch, and the reducing valve 9 drops the control air pressure at the air cartridge 4 to about 20 pounds. The air motor of the modulating air valve 14 is adjusted to open at this control air pressure as soon as the air cartridge 4 is actuated by the humidostat 5 upon a drop of the relative humidity below a preselected value. The water modulating valve 20' and its air motor 34 are adjusted, however, to prevent opening of the water valve 20' until the control air pressure at the air motor 34 rises to about 30 pounds per square inch. This increase in control air pressure is developed through the control line C that extends between a point on air supply line 1, beyond the modulating valve 14, and the control air line A in advance of the air cartridge 4. A check valve 90 on control line C opens for control air flow in only the direction indicated by the arrow to prevent a bleeding of control air into the forward section of the supply air line 1 when the modulating air valve 14 is closed.

The reducing valve 15 on air supply line 1 may be adjusted to deliver air at about 30 pounds per square inch at the inlet of the modulating air valve 14, and the pressure in the forward section of the air line 1 may vary between about 25 to 30 pounds in accordance with the control air pressure at the air motor of the modulating air valve 14. The initial opening of the valve 14 therefore results in an increased control air pressure in control line A, due to air flow through control line C, and this increased control air pressure is transmitted through lines A and B to effect a somewhat greater opening of air valve 14 and the opening of the water valve 20'. The opening of the air valve 14 a few seconds before water reaches the atomizers 3' results in some waste of pressure air and tends to drop the pressure in the supply air line 1, but this loss is only momentary and may be held to a minimum by providing a metering orifice 91 on supply air line 1 to limit air flow beyond or, as illustrated, to the reducing valve 15, and by appropriate design of the atomizers 3', as will be described later.

A predetermined differential is established between the air pressure and the water pressure at the atomizers 3' by the described control system, and this differential is maintained in spite of slow changes in the pressure at which air is delivered to the supply air line 1 by a compressor. The supply water pressure is approximately constant under all normal operating conditions as the water supply line 2 is usually connected to the local water system. Sudden changes in the available supply air pressure, including a complete failure of supply air, result in control operations similar to the normal shutting down of the humidifier system by the humidostat 5. The modulating water valve 20' must be closed quickly to prevent a discharge of water drops from the atomizers 3' upon a sharp decrease in air pressure at the atomizers.

Assuming normal operation, decreased air pressure results from the reduction in control air pressure at line 13 as the air cartridge 4 is closed by the humidostat 5. The air cartridge 4 acts quickly to lower the air pressure at line 13 which delivers control air to the control line B of water valve 20' and air valve 14. The water valve 20' thus closes quickly, but the closing of the air valve 14 is delayed by a control air line D that extends from the supply air line 1, at a point

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beyond the reducing valve 15, to the air cartridge 92 that is actuated by water pressure at the forward section of the supply water line 2, and then through a check valve 93 to the air motor of the modulating air valve 14. Control line D delivers control air at about the full 30 pounds pressure to the air motor in parallel with the control air delivered from the line 13. A check valve 94 is arranged in the line 13, beyond the line B connection, to prevent a bleeding of control air from line D into lines A and B when the air cartridge 4 is in closed condition. As shown in Fig. 6, the air cartridge 92 is biased towards closed position by a lever 95 and adjustable spring 96, and is actuated to open position by a diaphragm 97 when the water pressure in a fitting 98 on the water line 2 rises above about 17 pounds per square inch, i. e. a pressure somewhat above that at which the check valve 47 in the water waste line of the modulating water valve 20' (see Fig. 2) closes to trap water in the supply line to the atomizers. The air cartridge 92 therefore remains open to deliver control air to the modulating air valve 14 to maintain air flow to the atomizers 3' until the water pressure at the atomizers 3' drops to a preselected value.

The atomizers 3' include mechanism for sealing off the water delivery passage when the water inlet pressure drops below a preselected value, for example 20 pounds per square inch, which is somewhat greater than the critical operating pressures of the waste check valve 47 and of the diaphragm 97 of the air cartridge 92. An appropriate construction for the atomizers 3' of a humidifier system is illustrated in Figs. 7 and 8.

The body 100 of the atomizer has inlets 101, 102 for connection to the air line 1 and water line 2, respectively. A passage 103 extends through the body 100 to connect the air inlet 101 to a mixing chamber 104 between the end of the body 100 and a cap 105 that is threaded upon the atomizer body and has a centrally arranged outlet 106 for the discharge of air and atomized water. A water passage 107 extends from the water inlet 102 to a water chamber having a rear wall formed by a diaphragm 108 that is clamped to the atomizer body by a rear cap 109 and carries a fluted or hexagonally shaped plunger 110 that terminates, at its forward end, in a cleaning pin 111 that extends through the water outlet and into the discharge opening 106 when the diaphragm 108 and plunger 110 are moved forwardly by a spring 112. A gasket 113 on the forward face of the plunger 110 cooperates with an annular rib 114 on the body 100 to form a valve that prevents the flow of water from the atomizer when the plunger is forced into forward position by the spring 112 when the inlet water pressure falls below about 20 pounds per square inch.

As described above, air is admitted to the forward section of the supply air line 1 by air valve 14 before the water valve 20' opens. The waste of air is limited by the cleaning pin 111 that projects into the discharge opening 106 and, shortly after pressure air reaches the atomizers 3', the water valve 20' opens to deliver pressure water to the atomizers 3'. The valve plunger 110 is moved rearwardly by the fluid pressure on diaphragm 108, and the humidifier system is then in operating condition.

When the humidity rises to a selected value, the humidostat 5 closes the air cartridge 4 and the water valve 20' closes at once but the pres-

sure water in line 2 continues to be atomized by the atomizers 3' until the pressure drops to 20 pounds per square inch. The valve 113, 114 then closes and water wastes from the line 2 through check valve 47 until the pressure drops to or somewhat below 17 pounds per square inch. The air supply to the atomizers is cut off by valve 14 when the water pressure drops to about 17 pounds and permits closure of air cartridge 92 in line D by the spring 96.

It is to be noted that the air valve 14 and water valve 20' of the Fig. 5 system are preferably of the modulating type, as described with reference to the Fig. 1 embodiment of the invention, to maintain a desired pressure differential at the atomizers 3' in the event of variation in the supply air pressure. Either, or both, of the fluid supply valves 14, 20' may be of the on-off type however when maximum efficiency in operation is not an essential requirement.

It is to be understood that the invention is not limited to the particular embodiments herein illustrated and described, and that many variations that may occur to those familiar with the design and construction of atomizer systems fall within the spirit of my invention as set forth in the following claims.

I claim:

1. A fluid supply system comprising a gas supply line and a liquid supply line, a control valve in said gas supply line, means associated with said control valve for operating the same and regulating the flow of gas through said gas supply line independently of variations in pressure in the liquid supply line above a preselected value, valve means in the liquid supply line responsive to variations in the pressure of gas in the gas supply line to regulate the flow of liquid through the liquid supply line, and means responsive to pressure in said liquid supply line for closing said control valve on the gas supply line when said liquid pressure drops below said preselected value, said last named means comprising a motor for operating said control valve, and means responsive to the pressure of the liquid at the inlet side of said valve means for effecting a valve-closing operation of said motor.

2. A fluid supply system comprising a gas supply line and a liquid supply line, a control valve in said gas supply line, means associated with said control valve for operating the same and regulating the flow of gas through said gas supply line independently of variations in pressure in the liquid supply line above a preselected value, valve means in the liquid supply line responsive to variations in the pressure of gas in the gas supply line to regulate the flow of liquid through the liquid supply line, and means responsive to pressure in said liquid supply line for closing said control valve on the gas supply line when said liquid pressure drops below said preselected value, said valve means being a modulating valve for maintaining a substantially constant differential between the gas pressure and the liquid pressure at the delivery ends of their respective lines, in combination with means for momentarily closing said modulating valve upon a reduction in gas pressure at the delivery end of the gas supply line and effecting a wasting of the liquid to reduce the liquid pressure at the delivery end of the liquid supply line.

3. A fluid supply system comprising a gas supply line and a liquid supply line, a control valve in said gas supply line, means associated with said control valve for operating the same and regulating the flow of gas through said gas supply line independently of variations in pressure in the liquid supply line above a preselected value, valve means in the liquid supply line responsive to variations in the pressure of gas in the gas supply line to regulate the flow of liquid through the liquid supply line, said valve means being a modulating valve having a gas-pressure motor communicating with said gas supply line beyond the control valve thereof, and means responsive to pressure in said liquid supply line for closing said control valve on the gas supply line when said liquid pressure drops below said preselected value.

4. A fluid supply system comprising a gas supply line and a liquid supply line, a control valve in said gas supply line, means associated with said control valve for operating the same and regulating the flow of gas through said gas supply line independently of variations in pressure in the liquid supply line above a preselected value, valve means in the liquid supply line responsive to variations in the pressure of gas in the gas supply line to regulate the flow of liquid through the liquid supply line, said valve means in the liquid supply line including a modulating valve, a gas-pressure motor for opening said modulating valve, a control pressure line connecting said motor to the gas supply line beyond the control valve thereof, and means including a diaphragm subjected to the pressure in the liquid supply line to said valve means for opposing the opening of said modulating valve, whereby variations in the pressure on the liquid supply line are automatically compensated at the delivery end thereof by movement of said modulating valve in response to varying pressure on said diaphragm, and means responsive to pressure in said liquid supply line for closing said control valve on the gas supply line when said liquid pressure drops below said preselected value.

AGNEW H. BAHNSON, JR.

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