(No Model.)

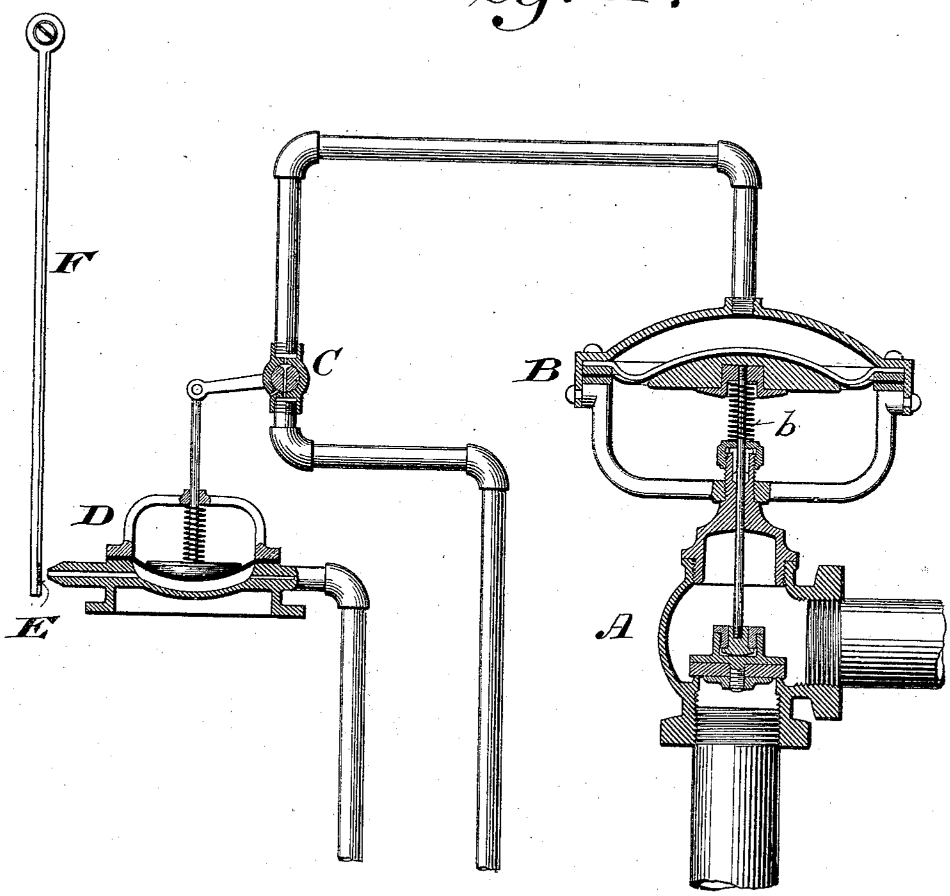
3 Sheets—Sheet 1.

W. S. JOHNSON.

HEAT REGULATING APPARATUS.

No. 542,733. Patented July 16, 1895.

Fig. 1.



Witnesses

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(No Model.) 3 Sheets—Sheet 2.

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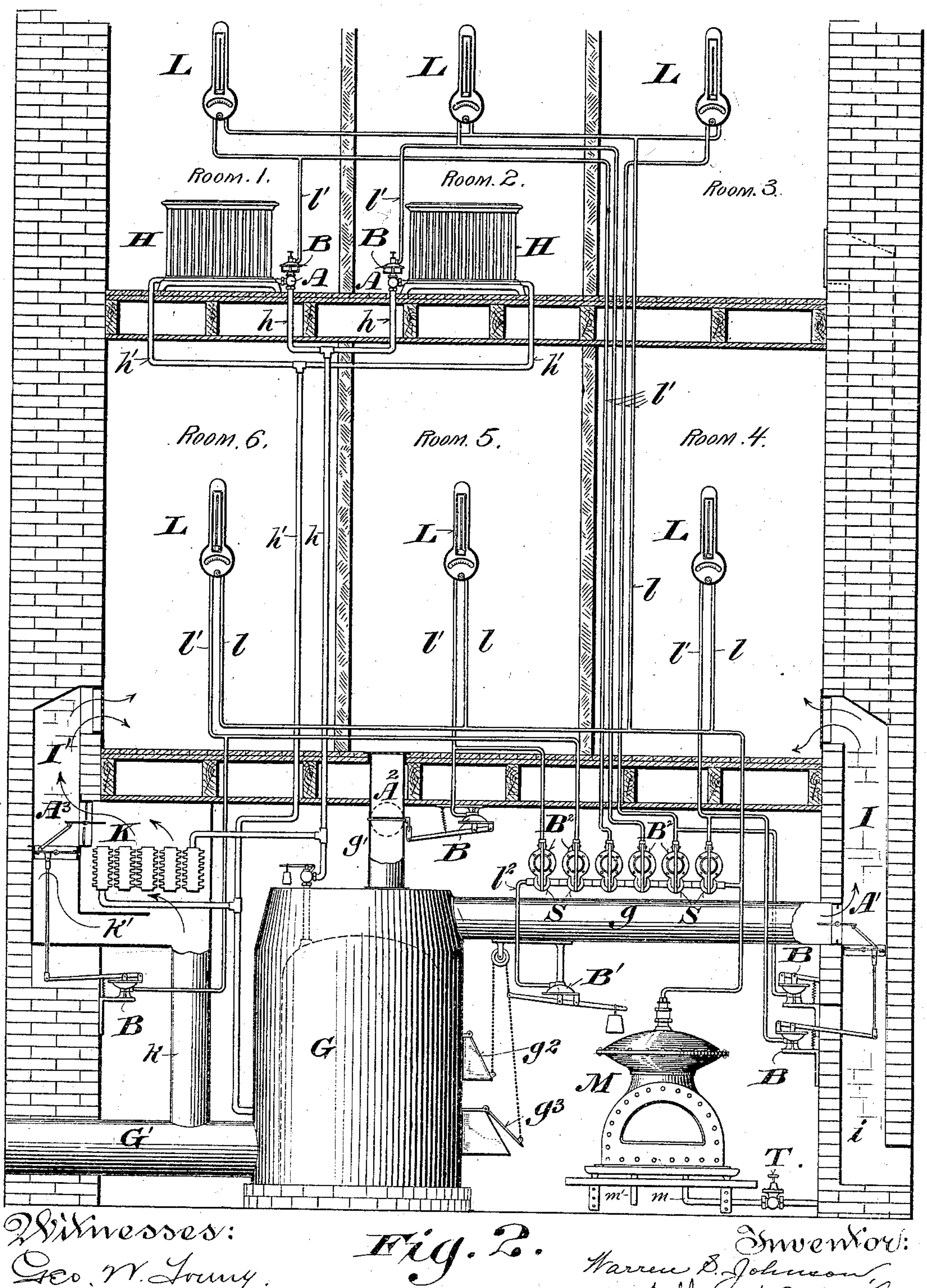

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Fig. 2.

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(No Model.)

3 Sheets—Sheet 3.

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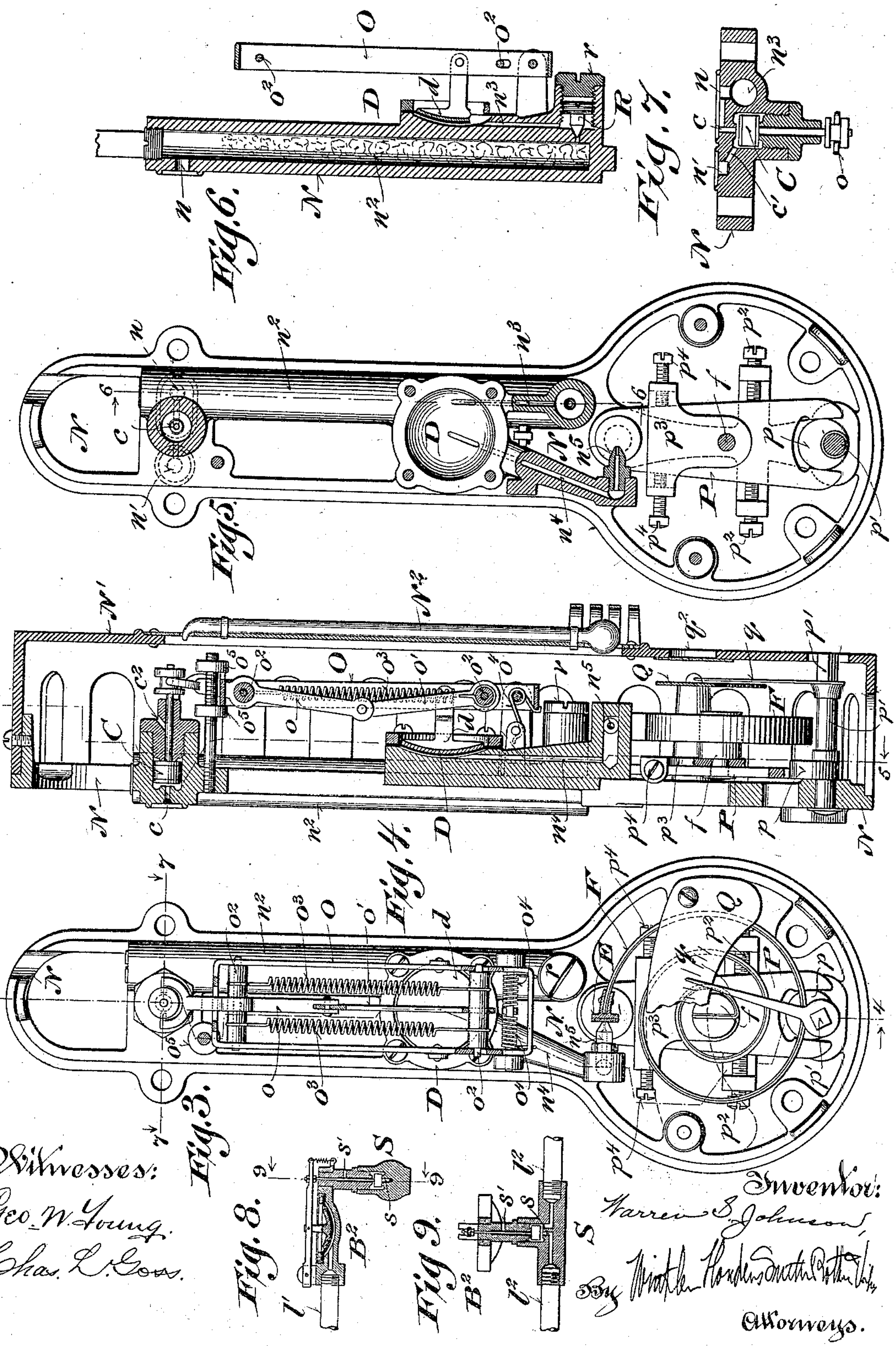

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Geo. W. Young.
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UNITED STATES PATENT OFFICE.

WARREN S. JOHNSON, OF MILWAUKEE, WISCONSIN.

HEAT-REGULATING APPARATUS.

SPECIFICATION forming part of Letters Patent No. 542,733, dated July 16, 1895.

Application filed June 4, 1894. Serial No. 513,497. (No model.)

To all whom it may concern:

Be it known that I, WARREN S. JOHNSON, of Milwaukee, in the county of Milwaukee and State of Wisconsin, have invented certain new and useful Improvements in Heat-Regulating Apparatus; and I do hereby declare that the following is a full, clear, and exact description of the invention, which will enable others skilled in the art to which it pertains to make and use the same, reference being had to the accompanying drawings, and to the letters and figures of reference marked thereon, which form a part of this specification.

My invention relates to apparatus designed primarily to automatically control, through the medium of a fluid under pressure, the supply of heat to one or a number of apartments. Its main objects are to dispense with the agency of electricity in the operation of apparatus of this class and to employ a fluid under pressure as the medium not only for actuating, but also for controlling the operation of the main heat-controlling valves or dampers, and generally to improve the construction and operation of apparatus of this class.

It consists, essentially, of the combination of the following elements: First, a main heat-regulating or controlling valve or damper; second, a fluid-pressure motor connected therewith; third, a secondary valve controlling the admission and release of the fluid-pressure medium to and from said motor; fourth, a secondary fluid-pressure motor connected with the secondary valve; fifth, a tertiary or thermal valve controlling the release of the fluid-pressure medium from said secondary motor, and, sixth, a thermostat or thermal motor connected with said thermal or tertiary valve and movable by variations of temperature in the surrounding medium; and it consists, further, of certain peculiarities in the construction and arrangement of component parts of the apparatus as hereinafter particularly described, and pointed out in the claims.

During the past ten years I have obtained many patents relating to temperature-regulation. My present invention is the result of extended experience, and its object is to produce apparatus which will secure the advantages of prior devices of its class, but which can be made and maintained at a lower cost.

With this end in view I have omitted some elements that were essential in my former inventions, and have supplied other elements that I have found to be necessary in a complete practicable system which does not employ electricity.

While many forms of heat-regulating apparatus have been devised, the only form which has hitherto been found practicable under all conditions is that which employs electricity and a fluid under pressure to control and operate the main valves or dampers. As the methods of heating are so diverse and the controlling devices must be correspondingly modified, many of my patents are for inventions intended to meet particular conditions in the practical use of artificial heat. On March 6, 1888, under the title "Temperature-Regulating System," a patent was granted to me which embraced all the elements essential to a complete practicable system of temperature-regulation employing electricity as the primary force to secure the operation of the main heat-controlling valves.

It is evident that in apparatus and systems designed for the automatic regulation of temperature a change of temperature is the initiative which brings into action the force which actuates the heat-controlling valves. A slight change of temperature cannot of itself release energy sufficient to operate valves of a practicable size, and in all practical apparatus or systems the variation of temperature simply brings into action through the agency of, but without strain upon the thermostat, some force, as electricity, which in its turn brings into action some greater force, as a fluid under pressure, to perform the actual work of operating the heat-controlling valves. This was the mode of operation of the system patented by me March 6, 1888.

On March 17, 1885, a patent was granted to me under the title of "Thermal-Pneumatic Temperature-Regulator," for a device designed to control the main valves of heat-regulating apparatus by fluid pressure, the fluid pressure being controlled by a thermostat directly without the intermediate use of electricity. In other words, in this device I utilized the expansion and contraction of substances resulting from changes of temperature to produce the power for operating small and delicate valves controlling a fluid-pressure medium, which, in turn, operated the main valves. In this device I dispensed with electricity. My present invention secures the advantages of apparatus employing electricity without the use of electricity, and has also advantages peculiar to itself arising from the action of the thermostat alone directly upon the fluid pressure. In order to secure these advantages I dispense with some of the elements or devices which I have previously employed and patented and supply other elements or devices which are found to be essential to a complete apparatus and system.

In order that my invention may be more easily and clearly understood than by reference to the apparatus as actually made and used, I show in—

Figure 1 a simple diagram of an elemental portion of the system or apparatus in which A designates a main heat-controlling valve; B, a fluid-pressure motor comprising an expansion-chamber and a movable part which is connected with said valve; C, a three-way valve hereinbefore referred to as the secondary-valve controlling the admission and release of the fluid-pressure medium from the expansion-chamber of motor B; D, a fluid-pressure motor hereinbefore referred to as the "secondary" motor, comprising an expansion-chamber and a movable part which is connected with the valve C; E, a tertiary or thermal valve controlling the outlet of the expansion-chamber of motor D, and F a thermostat or thermal motor with which the valve E is connected.

In order to properly define the three-way valve above mentioned, I may say that valves of this nature are often called "supply" and "waste" valves. They are also called "triple" valves. In the patent granted to me March 17, 1885, I have designated a valve of this kind a "double" valve, meaning that when it closed one port it opened another. Essentially a valve of the kind in question is a supply and waste, and in this case it serves to admit a fluid-pressure medium into and to allow it to escape from the expansion-chamber of the motor connected with the main valve. The motors connected with the main and secondary valves may be supplied with fluid pressure from the same or different sources, the particular sources of supply being of minor importance.

Although as stated, the primary and secondary motors may be supplied with fluid pressure from different sources, it is preferable to supply them from the same source to prevent a failure of the fluid-pressure supply to the secondary motor D from causing the heat-controlling valve or damper A to be permanently closed, which is obviously undesirable and might occur if each motor were supplied from an independent source of fluid-pressure, because the failure of fluid-pressure supply to the motor D would operate through the valve C to establish communication between the motor B and its source of fluid-pressure supply, which, if independent and in operative condition, would close the main valve A and hold it closed while such conditions lasted, irrespective of the operation of the thermostat, while if both motors were supplied from the same source any failure of fluid pressure that would cause the valve C to open communication between such source and the motor B independently of the thermostat would also deprive the motor B of fluid pressure and allow the main valve A to open or remain open as long as the fluid pressure was lacking. Herein resides one of the important advantages in the employment of fluid pressure for the actuation of both motors as against the use of fluid pressure for one, and another agent, as electricity, for actuation for the other motor, the present plan enabling me to derive power from a common source and thus obviate the difficulty above pointed out.

Another and a far more important advantage in the employment of fluid pressure for both motors is found in the exceeding delicacy of regulation thereby attainable, and which cannot be reached by any other means within my knowledge.

Hitherto the closest regulation attained, so far as I am able to learn, has been secured through the agency of electricity, the circuit being closed or opened thermostatically; but it is essential in any electrical appliance of the kind that the movement of the thermostatic strip or bar be sufficient to certainly break the circuit and to prevent sparking or accidental short-circuiting. Commonly the variation permitted either way from the normal or prescribed temperature is 2° Fahrenheit, and only very carefully-constructed electrical apparatus will regulate within these limits. The present system, however, is so exceedingly delicate, owing to the fact that fluid pressure is employed in the secondary motor, and to the further fact that the thermostat has only to close or open a very minute orifice without the intervention of any links, joints, or moving parts whatever, that a good mercurial thermometer is incapable of showing any deviation from the predetermined degree, although the apparatus may operate many times. The thermostat is absolutely free and unaffected by any other than temperature changes, and exerts no force other than that of moving an infinitesimal distance, sufficient to cover or uncover a minute orifice and stop the escape of air therefrom. This orifice is so small and the area of the diaphragm of the motor is relatively so large that the diaphragm will move the instant the thermostat carries its pad against the nipple in which the opening is formed. Incidentally the cost of manufacture, installment, and maintenance is greatly less than with electrical apparatus, while the danger of rendering the entire apparatus inoperative through a single short circuit is completely eliminated. For these reasons I regard the employment of fluid-pressure motors for the main and secondary valves a matter of great importance.

It will be noticed that while the fluid-pressure supply to the primary motor is controlled by a three-way valve the fluid-pressure supply to the secondary motor is not so controlled, but is constantly open, the outlet only of the secondary motor being controlled by the valve E and thermostat. It follows, therefore, that when said valve is open there will be a constant waste of fluid pressure from the expansion-chamber of the secondary motor, and to render it operative the supply-opening must be smaller than the waste-opening, the supply-opening being in practice made so small that the loss of fluid pressure from this cause is immaterial.

The operation of this elemental portion of the apparatus, which constitutes what might be called the "unit" of fluid-pressure control, may be explained as follows: Assuming that the temperature of the apartment which the apparatus controls has reached the desired limit, the thermostat F will cause the valve E to open the outlet of motor D. The area of the fluid-pressure-supply pipe to said motor being smaller than that of the outlet, as above stated, the expansion-chamber of said motor is allowed to collapse, and the secondary valve C is moved by a spring or other device acting in opposition to the fluid pressure in said motor, so as to admit fluid pressure into the expansion-chamber of motor B and thereby close the main valve A, as shown in Fig. 1. While the temperature remains at or above the desired limit, the valve E will be held open by the thermostat and the main valve A will be held closed by motor B, which is in direct communication with the source of fluid-pressure supply as long as the secondary valve C remains in the position shown. Suppose now that the temperature falls below the desired limit. The valve E will be closed by the action of the thermostat F and fluid pressure constantly supplied to the expansion-chamber of motor D will thus be caused to accumulate therein and to shift the secondary valve C so as to cut off the expansion-chamber of motor B from its fluid-pressure supply and open it to exhaust. Said expansion-chamber being thus permitted to collapse, the main valve A will be opened by a spring or other device acting in opposition to the fluid pressure, and heat will be again admitted to the apartment. When the temperature rises to the desired limit, the valve E will be again opened by the thermostat and the main valve closed through the joint action of the secondary motor D, the secondary valve C, and the primary motor B, as above explained.

It will be observed that when the main valve is closed, thus shutting off the supply of heat, the thermal or tertiary valve E is open, and vice versa. This relative arrangement of the valves is of advantage in that less fluid pressure will be lost than if the arrangement were otherwise, because while the apparatus is in operation there is much more time when the main valve is open and heat is being admitted to the apartment than when it is closed. The importance of this relative arrangement will be apparent when it is remembered that it is common to have several hundred rooms connected in one system and that the aggregate loss is consequently considerable. It is usual to employ hydraulic air-compressors for this apparatus and the water is supplied at a given price. Hence the less the waste of air the less will be the amount of water used, and this in turn determines the expense of running the apparatus, air-compression being the only item of expense under the present system.

It is essential in the practical operation of apparatus of this kind that the opening and closing of the main valve be prompt and complete. This is particularly true in the case of steam-heating apparatus where the main valve is connected with a steam supply-pipe. To effect this it is necessary that the operation of the secondary valve be prompt and complete also. This is easily accomplished when the secondary valve is operated by electricity, but when it is to be operated by fluid pressure controlled by the direct action of a thermostatic device its operation will manifestly be gradual and uncertain unless special provision is made to cause its instantaneous movement from one extreme position to the other. For the reasons just stated, the form of secondary valve and its operating connections shown in the diagram are impracticable, because the gradual movement of the thermostat, causing a gradual filling and depletion of the expansion-chamber of the secondary motor, would cause a like retarded operation of the secondary valve, and this would, in turn, produce a retarded and uncertain operation of the main valve; but in the apparatus as actually constructed, and as hereinafter explained, I have provided for the instantaneous operation of the secondary valve.

In the most approved system of heating at the present day, especially in school and public buildings, the indirect method is employed instead of the direct—that is, a current of fresh air is heated and introduced into the room or apartment to be warmed, and this current of air which conveys the heat also serves the purpose of ventilation. If a single heat-controlling valve or damper, as shown in Fig. 1, were employed, it is obvious that the closing of such valve or damper would interfere with ventilation. In order to avoid interference with the ventilation and at the same time to control the temperature, I employ in connection with my system a double form of damper so arranged that in one position it will exclude the heated air from and admit a current of fresh cool air to the apartment, the temperature of which is controlled thereby. In this way more perfect and accurate control of the temperature is secured, inasmuch as by this system of heating a more prompt and positive action of the thermostat is produced, a condition most favorable to the satisfactory operation of the controlling connections between it and the main valve or damper, as above explained.

Thus far I have considered my invention as applied to temperature-regulation only, and so far as a single unit of the system is concerned, it serves only as a heat regulator and ventilator, but when it is incorporated in a system it performs the additional function of distributing the heat derived from a common source to a number of apartments as required. By means of the joint action of the thermostats and fluid-pressure-controlling devices when incorporated in the system, I not only regulate the temperature of individual apartments, but I at the same time distribute the heat as required to the several apartments so that none will be supplied to the exclusion of others. It is essential not only that the heat be properly regulated and distributed to the several apartments included in the system, but also for economy and safety that the generation of heat be limited according to the demand upon the common source which supplies it. The control of the drafts of a furnace or other generator of heat by means of the joint action of two or more thermostats is not new *per se*. In a patent granted to me February 21, 1888, devices for this special purpose are described and comprehensively claimed; but such devices being essential to a complete and perfect system of heat regulation and distribution, and my improved fluid-pressure-controlling apparatus being specially suited for use in connection therewith I have introduced and shown them as a part of my improved system.

Having thus stated the general objects and nature of my invention, I will now particularly describe the construction and operation of the apparatus embodying the invention in a complete and practicable form by reference to the remaining figures of the drawings, in which—

Fig. 2 is a general view of a complete system of apparatus embodying the invention. Fig. 3 is a front elevation, on a greatly-enlarged scale, of one of the thermostatic fluid-pressure-controlling devices or instruments, the cover being removed and portions broken away to disclose the mechanism more clearly. Fig. 4 is a vertical section of the same, including the cover, on the line 4 4, Fig. 3. Fig. 5 is a section on the line 5 5, Fig. 4; Fig. 6, a section on the line 6 6, Fig. 5; Fig. 7, a cross-section on the line 7 7, Fig. 3; and Figs. 8 and 9 sections on an enlarged scale of one of the supply and waste valves through which the several thermostatic fluid-pressure-controlling devices jointly control the draft of the heater, Fig. 9 being a section on the line 9 9, Fig. 8.

Referring to Fig. 2, G designates a source of heat which, for convenience of illustration, I have shown as a combination heater constructed and arranged to heat air and supply it directly to certain apartments and also to generate steam or hot water, which may be employed, as shown, to heat certain apartments either by the direct or the indirect method. For the purpose of illustration I have shown rooms 1 and 2 provided with radiators H H, which are connected by supply and return pipes h h' with the boiler of the heater. The supply of the heating medium to each radiator is controlled by a valve A, like or similar to that shown in Fig. 1. Rooms 3 and 4 I have shown as supplied with warm or cool air through heating and ventilating flues I, having a hot-air-supply connection g with the heater and a cool-air-supply connection i controlled by a double damper A′. Room 5 I have shown connected directly with the heater by a hot-air pipe g', provided with a single damper A^2, and in connection with room 6 I have shown an indirect method of heating by steam or hot water.

K represents a steam coil or radiator inclosed in a box or casing, which is supplied with fresh, cool air through a pipe k and has an opening into a flue I′, leading to the room. k' is a by-passage connecting the air-supply pipe or duct k with the flue I′, and A^3 is a double damper like or similar to that above mentioned, controlling the opening of said flue into the heater-box and into the by-passage and arranged to open one when it closes the other.

The heater K may be connected, as shown, with the supply and return pipes h h' or directly with the boiler, and the air-supply pipe k may be connected, as shown, with the cool-air duct G′, leading from any convenient and suitable point into the casing of the heater.

It will be observed that no provision is made for ventilation in connection with the heating appliances of rooms 1 and 2, that room 5 has no provision for ventilation apart from that incidental to the supply of heated air, which is obviously interrupted when the single controlling-damper is closed, but that rooms 3, 4, and 6 are supplied with fresh cool air when the supply of heat thereto is shut off. Consequently the methods of heating shown in connection with rooms 3, 4, and 6 are most suitable for school and public buildings, while those shown in connection with rooms 1, 2, and 5 are suitable and commonly employed for dwellings and offices. Each of the main heat-controlling valves or dampers hereinbefore mentioned is connected with and arranged to be operated by a fluid-pressure motor B, like or similar to that hereinbefore explained. Each of the several rooms or apartments, the temperature of which is to be controlled, is provided with a thermostatic fluid-pressure-controlling instrument L, which is connected by a supply-pipe l with a source of fluid pressure, which in the present case I have shown to be a hydraulic air-compressor M, having water supply and waste connections m and m'. Each fluid-pressure-controlling instrument is also connected by a delivery-pipe l' with the expansion-chamber of the motor B, connected with the valve or damper which controls the admission of heat to the apartment in which such instrument is located.

I will now describe in detail, by reference to Figs. 3 to 7, inclusive, one of the thermostatic fluid-pressure-controlling instruments comprising the secondary valve, the secondary fluid-pressure motor, the tertiary or thermal valve, and the thermostat or thermal motor hereinbefore referred to, and all of which may be conveniently associated in a single instrument and mounted on a common base.

N designates the base of the instrument. It is formed near the upper end with connections n n', as shown in Figs. 5, 6, and 7, for the fluid-pressure supply and delivery pipes l and l'. The supply connection n communicates through a port or passage c and the delivery connection n' through a port or connection c' with the chamber of the supply and waste valve C, which has a waste or exhaust port or passage c^2, as shown in Fig. 4. The supply connection also communicates constantly through passages n^2 and n^3, as shown in Fig. 6, with the expansion-chamber of the secondary motor D, which has a waste or exhaust passage n^4 leading therefrom and terminating in a nipple n^5, as shown in Figs. 3, 4, and 5.

C is a supply and waste valve arranged to alternately open and close the supply and waste ports or passages c and c^2, opening into and out of opposite ends of its chamber. It is hereinbefore mentioned as the "secondary" valve, which controls the supply and release of the fluid-pressure medium to and from the primary motor B.

O is a rectangular frame pivoted at or near its lower end to the base N and connected with the movable part or diaphragm-plate d of the secondary motor D, and constituting in effect a simple lever of the third class.

o o' are the members of a toggle-joint pivotally connected with the frame O on opposite sides of their jointed connection with each other by cross-bars or pins o^2 o^2. The holes in frame O for the lower pivot-pin o^2 are elongated, as shown, to permit the toggle-joint to knuckle in either direction. The upper member o is extended above the upper pivot-pin and forked to engage with a groove in the head of the stem of valve C. The upper and lower pivot-pins o^2 are connected on opposite sides of the toggle-joint by springs o^3 o^3, which tend to carry and hold the joint between its members to the extreme limit of its movement on either side of a straight line passing through its pivot connections with frame O. o^4 o^4 are springs acting upon the frame O in opposition to the fluid-pressure motor D.

o^5 o^5 are adjustable stops for limiting the movement of the upper free end of frame O in either direction.

The purpose of the mechanism above described, connecting the secondary motor D with the supply and waste valve C, is to instantly and completely shift said valve from one of the ports which it controls to the other, notwithstanding the gradual or slow movement of said motor, for reasons hereinbefore explained.

F designates a thermal expansion-strip constituting the thermostat or thermal motor hereinbefore referred to. It is made of two strips of metal having different coefficients of expansion, and for the sake of compactness is preferably constructed in the form of a spiral, as shown. It is provided at its free end with a valve E, hereinbefore called the "thermal" or "tertiary" valve, which is arranged according to variations in the temperature of the surrounding medium, to open and close the waste-port in the end of nipple n^5, and thus release or confine the fluid-pressure medium from or in the expansion-chamber of the secondary motor D. At its opposite end said expansion-strip is attached to a stud f, which is pivoted in a lever P, fulcrumed at one end to the base N and forked at the opposite end.

p is a cam accurately fitted between the prongs of said lever and provided with a stem p', which is journaled at its rear end in the base N and formed at its front end with a key-head.

Q is a scale supported over the expansion-strip F by posts on the base and graduated to designate degrees of temperature.

q is an index-hand mounted upon the stem p' and projecting at its free end into proximity with the graduated scale Q, so as to indicate thereon the degree of temperature at which the instrument is set to open or close the valve E, and thereby admit or release fluid pressure to and from the primary motor B through the agency of the connections hereinbefore explained.

p^2 p^2 are screws threaded in ears on base N on opposite sides of lever P, and constituting adjustable stops for limiting its movement in either direction at the desired point or for locking it in any desired position.

p^3 is an arm or plate attached to the stud f and provided in rearwardly-projecting ears on opposite sides of lever P with adjusting-screws p^4 p^4, whereby it may be turned in either direction and secured in any desired position. Means are thus afforded for adjusting the valve E with reference to its seat or the waste-port in the end of nipple n^5, independently of the cam p and its connections.

R is a cone-shaped valve having a similarlyshaped seat in the opening from passage n^2 into the valve-chamber out of which the passage n^3 leads to the expansion-chamber of motor D. It is formed with a screw-threaded stem or head which engages with an internal thread cut in the valve-chamber, as shown in Fig. 6, whereby the area of the opening may be accurately adjusted and the supply of fluid pressure to the secondary motor D exactly regulated. The valve-chamber is closed by a screw-cap r. The valve R serves an important purpose in this connection, because the inlet-passage which it controls is so exceedingly small that it is impossible to drill it to gage. It is therefore necessary to employ the pin or cone valve R, forcing the same so closely to its seat that the air can escape only at such rate that if allowed to pass through water it will produce approximately from seventy-five to one hundred small bubbles per minute. In practice, I have operated with an opening of far less capacity, though the above is deemed to be about the proper opening.

The instrument is provided with a cover N′, which, with the base N, constitutes a housing for the mechanism hereinbefore described and prevents unwarranted meddling therewith. It is formed with a glass or mica closed opening q^2, through which the graduated scale Q is exposed to view and with an opening through which access is had to the key-head of stem p'.

The operation of this part of the apparatus may be explained as follows: Assuming that the temperature in the room in which the instrument L is located falls to or below the limit at which the main heat-controlling valve or damper is to be opened, the thermal expansion-strip F contracts, carrying the valve E against the nipple n^5, thereby closing the waste opening or passage n^4 from the expansion-chamber of motor D, as shown in Fig. 3. Compressed air being constantly supplied to said chamber through the passages n^2 and n^3 and through the supply-pipe l from the compressor M or other source of fluid pressure, will accumulate in said chamber, forcing its movable part d outwardly. As the expansion-chamber is gradually filled, the frame O will be moved slowly outward from the position in which it is shown in Fig. 4. The valve C, being seated against the waste port or passage c^2, cannot be moved farther outward and its grooved head being engaged by the upper forked end of member o of the toggle-joint, motor D gradually moves the members of said joint toward a straight line against the tension of the springs o^3 o^3, which tend to knuckle the joint when it passes the center in either direction. As soon as the members o and o' of said toggle-joint are carried by the slow outward movement of frame O past the center or a straight line, the springs o^3 operate to instantly complete the outward movement of said joint and to shift the valve C from the waste-port c^2 against the supply-port of passage c. Communication is thus closed between the supply and delivery connections n and n' of the instrument through the ports or passages c and c'. The expansion-chamber of the primary motor B, with which the instrument is connected through pipe l', is thus cut off from the fluid-pressure-supply pipe l and opened to exhaust through the waste port or passage c^2 and said pipe l', now in communication therewith. The diaphragm or movable wall of the primary motor is allowed to collapse or recede, and a spring b, as shown in Fig. 1, or other device acting against the fluid pressure, is permitted to promptly and completely open the main valve or damper. Heat being now admitted into the room raises the temperature, which, when it has reached the desired degree, opens valve E by the expansion of strip F. The fluid-pressure-supply opening to the expansion-chamber of the secondary motor D, having been permanently adjusted by the regulating-valve R to an area smaller than the area of the waste-opening from said chamber through the passage n^4 and nipple n^5, the accumulated compressed air in said expansion-chamber is allowed to escape therefrom faster than it enters through its supply connection, and the movable part d of said motor is thus permitted to slowly recede. The springs o^4, acting in opposition to the fluid pressure in said motor, slowly swing the frame O backward, holding the valve C in the meantime snugly against the supply-port c. As soon, however, as the members of the toggle-joint are carried past a straight line, the springs o^3 instantly complete their movement and shift the valve C from the supply-port c to the waste-port c^2, in the manner above explained. The movement of the frame O in either direction being limited by the stops o^5 o^5, prevents its continued movement from ultimately reversing the position of the valve C. The exhaust-port c^2 being now closed, and communication between the supply and delivery pipes l and l' established, compressed air is again admitted into the expansion-chamber of the fluid-motor B, thereby promptly and completely closing the main valve or damper against the tension of spring b.

When the instrument is tested the expansion-strip F and valve E are set by means of the adjusting-screws p^4 p^4 to open the waste-port or passage of motor D, according to the indication of the index q upon the scale Q, and in practical use the instrument may be set to close the main heat-controlling valve or damper at any degree of temperature by turning the index-hand q to that degree, as designated on the scale Q. This operates at the same time through the cam p to shift the lever P and expansion-strip F, so as to cause the valve E to open when the temperature rises to the degree indicated.

It will be observed by reference to Fig. 1 that when the main heat-controlling valve or damper is closed the thermostatic valve E is open, and vice versa, for the purpose, as hereinbefore stated, of avoiding waste of fluid pressure.

My improved thermostatic fluid-pressure-controlling devices serve not only to regulate the temperature of the individual room or rooms in which they are located, but also, when incorporated in a system, as shown in Fig. 2, to distribute the heat as required to the several apartments. Without some such system of distribution some of the apartments deriving their supply of heat from a common source, on account of more favorable location or other conditions, would receive more than the requisite amount of heat to the exclusion of others less favorably located or conditioned.

With my improved apparatus the thermostatic fluid-pressure-controlling devices in those rooms or apartments which, by reason of their more favorable location or otherwise, would first be supplied with heat from a common source to the exclusion of others, shut off the supply of heat therefrom when the temperature reaches the desired limit therein, and the entire energy of the heater is thus applied to raising the temperature in the remaining room or rooms which are less favorably located, or which from other causes would otherwise receive less than their due supply of heat. In this way the apparatus not only regulates the temperature of the individual apartments, but distributes it as required to the several rooms, automatically shutting it off from such as do not need it and directing the entire energy of the heater to such as do need it.

In addition to the regulation of the temperature of individual rooms and the distribution of heat to several apartments supplied from a common source, my improved apparatus and system contemplates the control of the source of artificial heat, whereby economy and safety are secured as well as more perfect regulation.

Referring again to Fig. 2, g^2 and g^3 designate the check and main draft dampers of the heater G. B′ is a fluid-pressure motor similar to the primary motor shown in Fig. 1, consisting of an expansion-chamber and a movable part which is connected with said dampers, so as to close one when it opens the other. The expansion-chamber of this motor is connected by a pipe l^2 with the air-compressor M or other source of fluid pressure. The fluid-pressure-supply pipe l^2 is provided with a series of supply and waste valves S S, (shown in detail in Figs. 8 and 9,) and each connected with a fluid-pressure motor B^2, which is in turn connected with the delivery-pipe l' leading from one of the thermostatic fluid-pressure-controlling instruments L.

By reference to Figs. 8 and 9 it will be observed that when fluid-pressure is admitted to motor B^2 and its diaphragm expanded, the valve S connected therewith will open its supply-port s and close its exhaust-port s'. Thus when all the valves S are in the position above stated, communication will be established between the air-compressor or source of fluid-pressure supply and the expansion-chamber of motor B′, which will thus be caused to open the check-damper g^2 and close the main-draft damper g^3 and check the fire in the heater.

It will be seen that the joint action of all the thermostatic fluid-pressure-controlling instruments L L is required to open the several valves S S and thereby check the draft of the heater. On the other hand, the operation of a single instrument L is sufficient to close the valve S connected therewith, and thus, by cutting off the fluid-pressure supply from motor B′ and opening it to exhaust, open the draft of the heater. Whenever an instrument L operates to close the valve or damper, admitting heat into the room in which such instrument is located, it also operates through the connected motor B^2 to open the supply-port s of the corresponding valve S. Thus when the temperature in all the apartments supplied by the heater has reached the required limit, the draft of the heater will be closed by the joint action of all the instruments L L, but when the temperature in any apartment falls below the required limit the draft of the heater will be opened by the sole action of the individual instrument L in that apartment and its connection.

In connection with a fluid-pressure motor, such as D, having a constantly-open restricted fluid-pressure-supply connection and an outlet of larger area governed by a relief-valve it is essential to its practical operation that the fluid pressure be held within certain limits for which the supply and relief openings are proportioned and adjusted, because material fluctuations or a considerable excess of pressure above the proper limit would prevent the depletion of the expansion-chamber of the motor and render it inoperative or its operation uncertain. It is also necessary that the compressed air or fluid-pressure medium should be free from dust or impurities by which the minute inlet or supply opening would be clogged or obstructed. I therefore apply a reducing-valve T to the water-supply connection m of the air-compressor M, as shown in Fig. 2, or any other suitable form of governor, to the source of fluid pressure or its connections in any way that will maintain a practically uniform pressure or prevent it from rising above a certain limit. I also fill the passage n^2 with cotton or other suitable filtering material, as shown in Fig. 6. A thermometer N^2, secured to the front of the case or cover, enables the occupant of the room to ascertain whether or not the apparatus is operated properly.

I claim—

1. In a valve or damper-controlling apparatus, the combination of a primary, a secondary, and a tertiary valve; fluid pressure motors for actuating the primary and secondary valves; and a thermostatic motor for actuat-

ing the tertiary valve; the primary valve serving to regulate the heat supply; the secondary valve serving to control the delivery and release of fluid pressure to and from the primary valve motor; and the tertiary valve serving to open and close an outlet of the fluid pressure motor of the secondary valve and thereby to control the fluid pressure of the secondary valve motor.

2. In heat regulating apparatus the combination of a main heat-controlling valve or damper, a primary fluid pressure motor connected therewith, a secondary valve controlling the supply and release of fluid pressure to and from said motor, a secondary fluid pressure motor connected with said secondary valve, a tertiary valve controlling the release of fluid pressure from the secondary motor, and a thermostat arranged to actuate said tertiary valve, the main valve being arranged to close when the tertiary valve opens and vice versa, substantially as and for the purposes set forth.

3. In combination with a main heat-controlling valve or damper, a fluid-pressure motor for actuating said valve or damper, a second valve controlling said fluid-pressure motor, a second fluid-pressure motor controlling said second valve, and a thermostat controlling the relative supply and waste of fluid in the second fluid-pressure motor.

4. In combination with a valve or like device, and with a slowly-acting motor having a movable member, a pivoted frame or lever connected with the movable member of said motor, a toggle joint carried by said frame and connected with the valve or like device, and a spring tending to carry the members of the toggle joint out of line with each other, substantially as and for the purpose set forth.

5. In combination with a valve or like device, and with a slowly-acting motor having a movable member, a pivoted frame or lever connected with the movable member of said motor, stops to limit the play of said frame, a toggle-joint carried by said frame and connected with the valve or like device, and a spring, tending to carry the members of the toggle-joint out of line with each other; whereby the initial action of the motor is caused to move the frame and to shift the toggle from one to the other side of its central line, without affecting the valve, and the spring is caused thereupon to throw the valve instantaneously its entire distance regardless of the continuing movement of the motor and frame.

6. In combination with valve C and fluid-pressure motor D, swinging frame O, toggle-joint o o' pivotally connected with frame O, and having an extension beyond its pivot to engage the stem of valve C, and a spring o^3 connected at one end with the toggle joint and at the other end with frame O,—all substantially as described and shown.

7. In heat regulating apparatus the combination with a main heat controlling valve or damper, and a fluid pressure motor connected therewith, of a thermostatic fluid pressure controlling instrument governing the operation of said motor, and comprising a supply and waste valve, a secondary fluid pressure motor connected therewith having a constant fluid pressure supply connection and an outlet of larger area, a valve controlling said outlet, and a thermal expansion strip arranged to actuate said valve, substantially as and for the purposes set forth.

8. In heat regulating apparatus the combination with a main heat controlling valve or damper, and a fluid pressure motor connected therewith, of thermostatic fluid pressure controlling mechanism governing the operation of said motor and comprising a supply and waste valve, a secondary fluid pressure motor connected therewith having an outlet, and a fluid supply connection provided with a regulating valve, a valve controlling said outlet and a thermostat arranged to actuate said outlet valve, substantially as and for the purposes set forth.

9. In heat regulating apparatus, the combination of a movable block or lever; an indicator arm connected with and serving to move said block; a scale over which the indicator moves; a stud pivotally connected with the movable block; a screw for adjusting said stud relatively to the block; and a thermostatic bar or strip carried by the stud; the screw serving to adjust the thermostatic bar or strip relatively to the indicator arm, and the indicator arm serving to adjust said bar or strip relatively to the scale, substantially as explained.

10. In heat regulating apparatus the combination with a heat-controlling valve or damper, and a fluid pressure motor connected therewith, of a thermostatic fluid pressure controlling instrument comprising a suitable base and cover, a supply and waste valve, a secondary fluid pressure motor connected therewith, a lever pivoted to said base, a thermal expansion strip pivotally connected with said lever and provided with a valve which controls the operation of the secondary motor, a cam engaging with said lever and provided with a key stem accessible through an opening in the cover, a scale exposed through an opening in the cover, an index connected with said cam, and arranged to indicate upon said scale the degree of temperature at which the instrument is set to open or close said thermostatic valve, an arm or plate attached to the pivotal connection of the expansion strip, and a screw arranged to turn the same and to adjust the thermostatic valve with reference to its seat, substantially as and for the purposes set forth.

11. In heat regulating apparatus, the combination with a source of fluid pressure, of an automatic governor for regulating such pressure, a fluid-pressure motor connected

with said source of fluid pressure by a restricted passage and having a relief opening of normally greater area than its inlet, a valve controlling said relief opening, a thermostatic motor for operating said relief valve, a main valve or damper, and intermediate mechanism whereby said main valve or damper is operated and controlled through said fluid-pressure motor.

12. In heat regulating apparatus the combination of a motor for producing fluid pressure, an automatic governor for controlling said motor or pressure, an expansion chamber subject to the action of the fluid pressure produced by said motor, a restricted opening between said chamber and said fluid pressure motor, a relief opening from said expansion chamber having a greater normal opening than said inlet opening, a valve controlling said relief opening, a thermal motor for operating said relief valve, a main valve and intermediate mechanism between said expansion chamber and said main valve, whereby said main valve is operated through the movements of said expansion chamber, substantially as and for the purposes set forth.

13. In heat regulating apparatus the combination with a main heat controlling valve or damper and a source of fluid pressure supply, of a fluid pressure motor governing the operation of said main valve or damper, and having a constantly open restricted passage communicating with said source of fluid pressure supply, and an outlet or relief passage of greater area, a filter between said restricted supply opening and the source of fluid pressure, a relief valve controlling said outlet, and a thermal motor for operating said relief valve, substantially as and for the purposes set forth.

In testimony that I claim the foregoing as my own I affix my signature in presence of two witnesses.

WARREN S. JOHNSON.

Witnesses:
CHAS. L. GOSS,
M. L. EMERY.