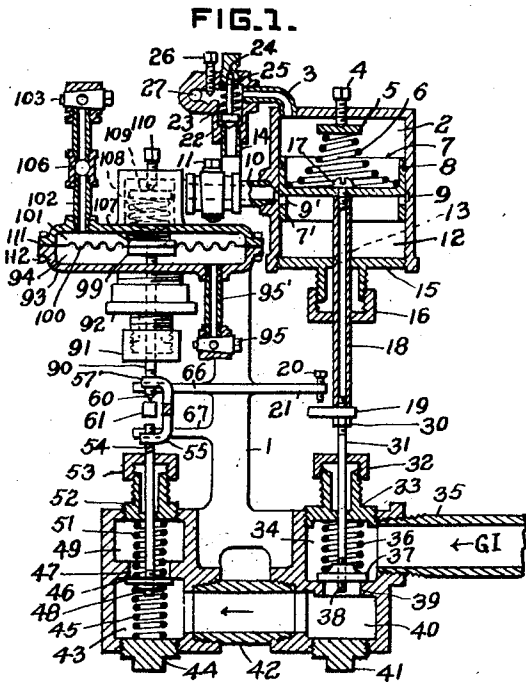
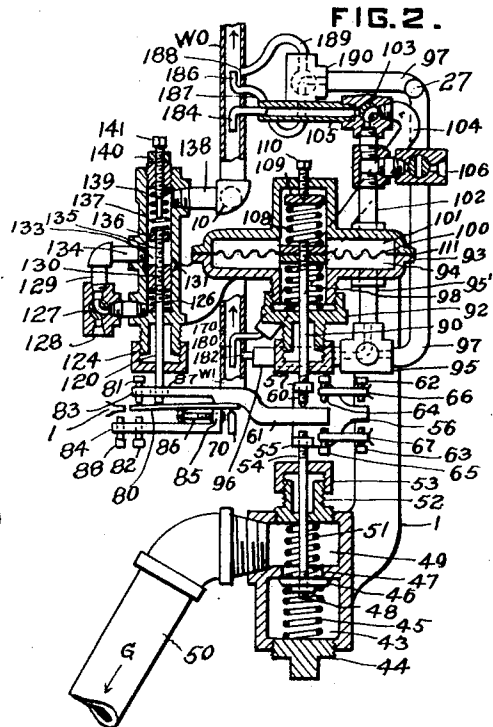
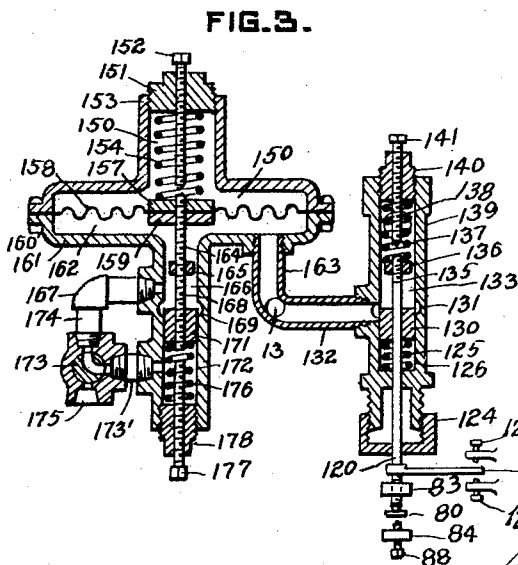
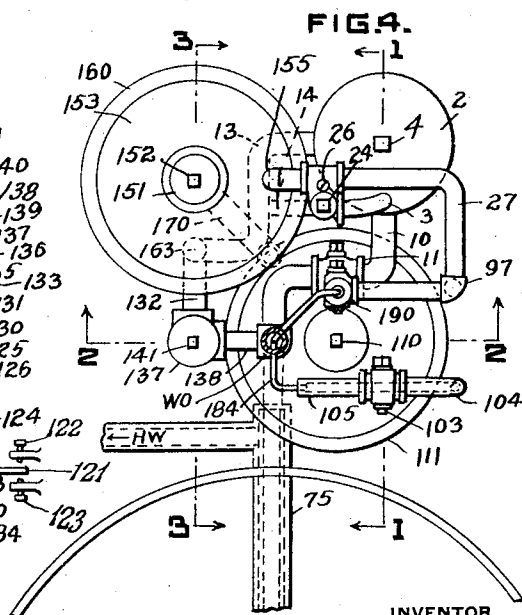


G. S. WALKER.
 AUTOMATIC WATER HEATER.
 APPLICATION FILED SEPT. 16, 1916.

1,404,249.

Patented Jan. 24, 1922.

3 SHEETS—SHEET 1.



WITNESSES

J. Robert Bradley.
 [Signature]

INVENTOR

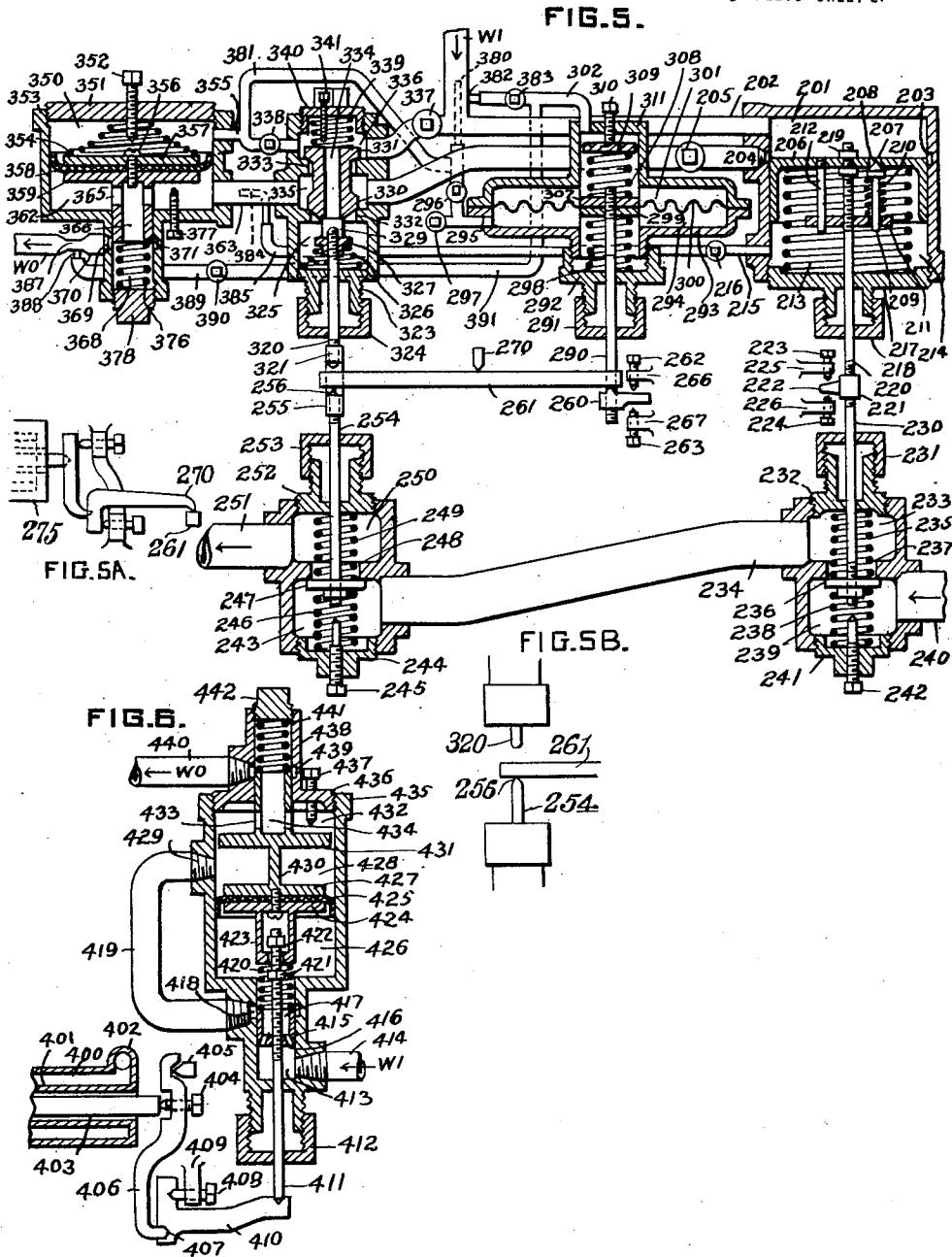
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3 SHEETS—SHEET 2.



WITNESSES
J. Herbert Bradley.
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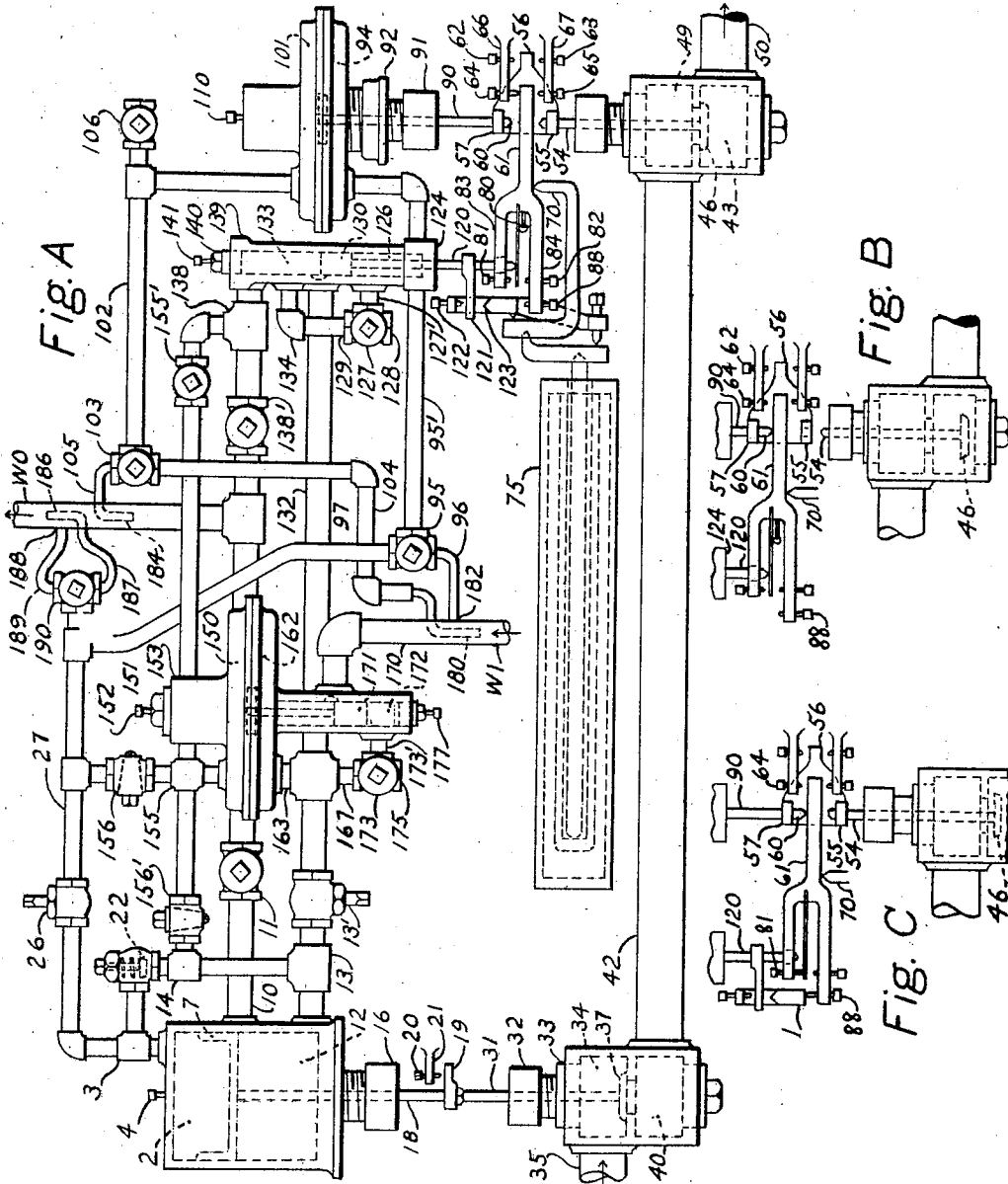
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3 SHEETS—SHEET 3.



INVENTOR
Gilbert S. Walker

UNITED STATES PATENT OFFICE.

GILBERT S. WALKER, OF PITTSBURGH, PENNSYLVANIA.

AUTOMATIC WATER HEATER.

1,404,249.

Specification of Letters Patent. Patented Jan. 24, 1922.

Application filed September 16, 1916. Serial No. 120,451.

To all whom it may concern:

Be it known that I, GILBERT S. WALKER, a citizen of the United States, residing at Pittsburgh, in the county of Allegheny and State of Pennsylvania, (whose post-office address is American Society of Mechanical Engineers, 29 West 39th Street, New York, N. Y.,) have invented a new and useful Improvement in Automatic Water Heaters, of which the following is a specification.

My invention relates particularly to the regulation of the temperature of the water.

All automatic water heaters heretofore produced gave hot water that varied in temperature to an objectionable extent. When the pressure of the water supply fell below normal the temperature of the hot water would be above normal, in spite of the fact that sensitive thermostats were provided to regulate the valves. High supply pressure also resulted in the hot water being below the normal temperature. The regulating devices frequently raced; that is, water too hot and water too cold was delivered alternately in a rythmical manner.

These automatic heaters also gave hotter water in the upper stories than in the basement and first story. This was just the reverse of what is desired by the users. Hotter water is needed in the laundry and kitchen which are usually in the basement and first story, than is needed in the bath and laboratories which are usually in the upper stories.

These heaters also operated much of the time at less than their full capacity due to the fact that the full amount of water could not pass the valves at small differences of water pressure, after the heater had been set for greater difference of pressure. The high price of these heaters frequently induced the user to install one of too small a size, and for him then to find that it seldom gave even the rated amount of water caused dissatisfaction.

I remedy these defects by combining two methods of regulation. Almost any two regulators materially improve the operation. The two regulators must not be so nearly identical that they will act as a single regulator; secondly, they must not oppose each other and neutralize one another's effect; and lastly, they must not interact to cause racing. By this I mean that if movement of regulator A causes regulator B to move, no harm is

done, but if this movement of B causes further movement of A, trouble will come.

Temperature of the water, velocity of the water, friction of the water, difference of water pressure, and back pressure of the water in the hot water pipe, are the principal regulating forces utilized. The regulation is accomplished by restricting the flow of gas to the burners or by restricting the flow of water through the heater.

It will be seen that there are necessarily a large number of ways in which my improvement can be applied to any one heater and there are a large number of different kinds of heaters to which it can be applied. I illustrate and describe a structure that will operate in more than one way, accomplishing, however, similar results. There are, therefore, many parts shown that are equivalents of each other, and any one skilled in the art can readily eliminate many parts, combine others and reduce the structure to very simple form.

Other important improvements will be pointed out farther on.

Referring to the drawings:

Figure 1 is a vertical section of the right side of the regulating mechanism, on line 1—1 of Figure 4.

Figure 2 is a vertical section through the parts of the device nearest to the heater casing, on line 2—2 of Figure 4, looking away from the casing.

Figure 3 is a vertical section through the left hand side of the device, on line 3—3 of Figure 4.

Figure 4 is a plan showing the top of the regulating mechanism.

Figure A is a diagram showing the pipe connections. The parts are distorted for the sake of clearness, but in a general way it is a developed view such as would be obtained by walking around the device starting from the right of Fig. 4.

Figure B shows the three point lever adjusted for a different mode of operation.

Figure C shows the three point lever adjusted for still another mode of operation.

Figure 5 is a vertical section through all the important parts of a modified form of the regulating mechanism. It is diagrammatical in form but suitable details and physical relations of the parts will readily suggest themselves to those familiar with this art.

Figure 5^A shows the thermostat of the same form.

Figure 5^B shows the same form with the water valve disconnected.

5 Figure 6 is a vertical section of the thermostatic water valve and governor valve of another modified form. Some parts not essential to a clear understanding of the present invention are not shown but are well
10 known and can be easily supplied by one familiar with automatic water heaters.

Referring to the preferred form shown in Fig. 1 to Fig. 4; there is attached to the frame 1 a combination water motor and
15 water valve 2, operating the gas valve 37. The numeral 2 designates more particularly the outlet water chamber at the top which communicates with the small water pipe 3. An adjusting screw 4 passes into this chamber and presses against a plate 5 on top of
20 a graduating spring 6. This spring is in the form of a spiral helix in which the increment of deflection divided by the increment of force is not constant, as in an ordinary helical spring, but decreases as the
25 spring is compressed. The lower turns are very flexible but of small total movement while the upper turns are successively stiffer. This form of spring may be substituted at
30 some of the places where ordinary springs are shown. This spring presses down upon the motor piston 7. The upper edge is provided with packing at 8. Attached to the lower face is a ring 7'. The intervening
35 port 9' is adapted to open communication through the port 9 and cock 11 with the pipes 10, 138 and WO. The inlet chamber 12 is in communication with pipes 13 and 14, and through a hand adjusted water valve 13'
40 with pipes 132 and 163. The lower end of the inlet chamber is closed by a screw head 15 and a stuffing box 16. A stem 18 is connected at 17 to the motor piston 7 and passes through the stuffing box. This stem is somewhat larger in diameter than usual
45 so that there will be an appreciable effect due to the unbalanced back pressure on the area of the stem. At the lower end of the stem is an arm 19 adapted to come in contact with an adjustable stop 20 on a bracket
50 21 extending out from the frame 1, for the purpose of limiting the movement of the motor piston so that the port 9 will be uncovered or not uncovered as desired. The arm 19 is held in place by a lock nut 30 threaded on the gas valve stem 31 which
55 latter is screwed into the water valve stem 18. This forms an adjustable connection.

The inlet chamber 12 of the water motor
60 is in communication, through pipe 14, with a safety valve 22. This safety valve is held closed against a small difference of pressure by the spring 23. It is adjustable by a screw plug 24 and is guided by a stem 25. The
65 outlet side of the safety valve is in commu-

nication, through pipe 3, with the chamber 2, and is also in communication, through a graduating valve 26, with pipes 27 and 97. The graduating valve 26 is adjusted so that the motor 7 will move at the desired speed. 70 The net area through the graduating valve is much less than through the open safety valve 22. The strength of the safety valve spring 23 is such that it will be lifted and equalize the pressures when the difference of water
75 pressure between chambers 12 and 2 is more than sufficient to raise the motor 7 against the friction and the springs 6 and 36. These springs are considerably stronger than is necessary to push the piston down against 80 the friction. This insures there always being a larger available force for closing the gas valve than there is for opening it. As a consequence of this, if the piston or other
85 parts should stick, they will stick with the gas valve closed and no accident will occur.

The gas valve stem 31 passes through the stuffing box 32 on the screw head 33. This head closes the inlet gas chamber 34 and can be turned to adjust the pressure on the
90 spring 36 which presses down the gas valve 37. This valve is adjustably attached at 38 to its stem 31 and is adapted to close on its seat 39 and cut off the flow of gas from the inlet gas pipe 35 and chamber 34 to the
95 chamber 40 and pipe 42.

The pipe 42 communicates with the inlet chamber 43 of an auxiliary gas valve 46. The end of the chamber 43 is closed by a screw plug 44 which also serves to adjust the
100 spring 45 that closes the auxiliary gas valve 46 against its seat 47. The outlet gas chamber 49 is in communication with the pipe 50 which leads to the burners of the water heater, not shown. The spring 51 urges the
105 valve away from its seat. The pressure on the spring is regulated by turning the screw head 52 that carries the stuffing box 53. The valve is adjustably connected at 48 to its
110 stem 54.

The upper end of the gas valve stem 54 is detachably connected to the yoke 55. The other half of the yoke carries a removable knife edge 60 bearing on the three point
115 lever 61. The yoke has an arm 56 adapted to come in contact with adjustable stops 62 and 63 in the brackets 66 and 67 attached to the frame 1. The right hand end of the three point lever 61 is also adapted to come
120 in contact with adjustable stops 64 and 65 in brackets 66 and 67 respectively. The thermostat 75 is of well known construction in which the end of the final lever 70 moves
125 upward against the pressure of the springs as the temperature decreases, and this lever 70 retreats downward as the temperature increases. The contact of 70 need not be at the center of the three point lever 61, nor between the points of contact of parts 60 and 120.

One end of the three point lever 61 is formed of a flat spring 80 held at 85 to the main part of the lever 61. At the free end of the flat spring there are adjustable stops 81 and 82 to limit its deflection. These stops are threaded through rigid arms 83 and 84 attached to the rest of the three point lever 61. The rate of deflection of the flat spring per pound of force applied is adjusted by turning the screw 86 in or out and thus changing the point of support and the length of the part of the spring that is free. This permits me to obtain any desired relation between the force applied and the corresponding movement of the valve.

The diaphragm stem 90 is detachably connected to the yoke at 57. This stem passes through the stuffing box 91 and is adjustably connected at 99 and 107 to the diaphragm 100. The screw cap 92 serves to adjust the spring 98. The chamber 94 is in communication with the pipe 95' and through the three-way cock 95 with either pipe 96 or pipe 97. The chamber 101 is in communication with the pipe 102 and through the three-way cock 103 with either pipe 104 or pipe 105, or through cock 106 with the air. The spring 108 which presses on the diaphragm is adjusted by the plate 109 and screw 110. Springs similar to 6 at the top of Fig. 1 are substituted for springs 98 and 108 under certain conditions pointed out later on.

The end of the water valve stem 120 passes through a hole 87 in the arm 83 and rests on spring 80. On the stem 120 is an arm 121 adapted to come in contact with two stops 122 and 123 attached to the frame 1 of the heater. The stem 120 passes through a stuffing box 124 and is adjustably connected to the thermostatically operated piston valve 130. The chamber 126 communicates by a pipe 127' with a three-way cock 127 having a port 128 opening to the air and a port 129 communicating with pipe 134. The piston valve 130 has its farther edge adapted to cover the port 131 which communicates with the pipes 132, 163, 13 and 14. Attached to this piston valve is a stem 135 adjustably connecting a loosely fitting piston 136. The chamber 133 between the piston valve 130 and piston 136 communicates with pipe 134 and port 129. The space between the piston 136 and the cylinder walls is of such area that there will be an appreciable loss of pressure when the quantity of water traversing it is that for which the heater is designed and there will, therefore, be an appreciable closing effect at the port 131. The spring 137 in the chamber 139 tends to open the port in opposition to spring 125 in chamber 126. This spring 137 is adjustable by means of the screw cap 140. The chamber 139 is in communication with the pipe 138, and through cock 138' to pipes 10 and WO, and

through cock 155' to pipe 155. The screw 141 can be adjusted to keep the port 131 always partly open.

A governor water valve is shown at 150 to 178. The end of its outlet water chamber 150 is closed by a plug 151 which can be screwed into the casing 153 more or less to adjust the force of the spring 154 upon the flexible diaphragm 158. There is a screw 152 to limit the movement of the piston valve 171. The chamber 150 communicates, through cock 156, with pipes 97 and 27, through cock 155' to pipe 138, and through cock 156' to pipe 13 and thence through valve 13' to pipe 163. The diaphragm 158 separates the outlet chamber 150 from the intermediate chamber 162 which latter communicates with pipes 163, 132, 13 and 14. The diaphragm is adjustably connected by the stem 164 to a loosely fitting piston 165 that partly obstructs the cylinder 166. The area of the annular water passage between it and the cylinder walls is such that when the desired quantity of water flows the friction and difference of pressure on the two sides of this piston will be sufficient to move it and the attached piston valve 171 to regulate the flow of water. Below this piston the chamber 166 communicates with the pipes 167 and 174. Farther down the port 169 communicates through pipe 170 with the inlet pipe WI. This port 169 is adapted to be closed by the piston valve 171 attached to the stem 168. The lowest chamber 172 communicates by a pipe 173' with the three-way cock 173 having a port 175 opening into the air and a port 174 communicating with the pipe 167 to form a by-pass about the piston valve 171 to balance it. The end of the chamber 172 is closed by a screw plug 178 carrying a screw 177 to limit the piston valve travel. The plug may be screwed in or out to adjust the spring 176. This spring preferably should be graduated as explained in connection with spring 6.

In the water inlet pipe WI near 170 is a Pitot tube 180 having a small opening facing the flow of water. The impact of the molecules of moving water causes a slight increase in the pressure in the pipe 104 and chamber 101, above that in pipe 170. The amount of this increase in pressure measured in feet of head is found by taking the velocity of the water in feet per second, squaring it and dividing by 64. The effect is small and the velocity, therefore, must be made high and the diaphragm 100 on which it acts must be made large.

In the pipe WO is another Pitot tube 184 to increase the pressure in pipe 105 communicating through cock 103 with diaphragm chamber 101.

At 182 there is a Venturi tube with the plane of its opening parallel with the flow of water in the pipe 170. On account of the

restriction in the pipe 170 at this point due to the part 180 the velocity of the water is high and the pressure is below normal by an amount equal to the velocity head ($v^2 \div 2g$).

5 This pressure is transmitted through pipe 96 and three-way cock 95 to chamber 94.

There is also a similar Venturi tube at 188 in pipe WO transmitting its effect through pipe 189 and cock 190 to pipes 97, 27 and 10 155 and to chamber 150.

In the outlet pipe WO there is also an inspirator tube 186 facing away from the flowing water. When the molecules of water pass rapidly by the end of this tube 15 they tend to carry along with them the neighboring molecules in the wake of the tube, thereby producing a suction effect. The pressure in this tube will be lower than that in the Venturi tube 188. The effect 20 will be transmitted through pipe 187, cock 190, to pipes 97, 27 and 155 and to chamber 150.

Although it has been implied that all the apparatus shown is on the cold water side 25 of the heater, it should be understood that it may be placed on the hot water side so that the hot water from the coil of the heater will enter the illustrated device and flow from it direct to the hot water faucets. This 30 will in no wise change the parts shown. The apparatus may also be divided and the heating coil interposed between the illustrated parts, and the parts rearranged. This last arrangement is advantageous because the 35 friction of the water passing through the heating coil assists in the operation of some of the parts. This is also true of the modified forms described further on.

Closing cocks 11 and 106; turning cocks 40 95 and 103 to close all ports; turning cock 127 to close outlet 128 and open pipe 129 to chamber 126; turning cock 173 to close outlet 175 and open pipe 174 to chamber 172; turning cock 190 to close tube 187 and open 45 pipe 97 to tube 189; opening valve 26; opening valve 156 on pipe 155; disconnecting valve stem 54 from yoke 55, and leaving gas valve 48 open; the heater will now operate as a thermostatic water regulating system 50 see Fig. B. Opening any hot water faucet will reduce the water pressure in the hot water pipes and in WO, 97, 27, 3 and chamber 2. The motor piston 7 will be moved up by the water at inlet pressure coming in 55 through pipe WI, 170, port 169, pipe 163, 13 and chamber 12 below the motor piston. This movement of the motor piston will open the gas valve 37, start the burners and heat the water in the heating coil, not shown. 60 When the thermostat 75 reaches the temperature for which it is set, its end lever 70 will be lowered far enough to permit the spring 137 to open the water port 131. Water will now flow from the inlet WI through pipe 65 170, port 169, pipe 163, 132, port 131, pipe

138, to the outlet WO. As the temperature rises and falls the valve 130, on which the water pressure is balanced through pipe 134, 129, cock 127 and chamber 126, will be moved up and down by the thermostat opening and 70 closing the port 131. If the thermostat gets much above normal temperature the valve 130 will be opened so far that the water pressure on the two sides of motor piston 7 will be equalized through chamber 12, pipes 13, 75 132, port 131, pipes 138, 97, 27, 3 and chamber 2. This equalization of pressures will permit springs 36 or 6 to move the motor piston 7 down and close the gas valve 37. The temperature of the water will thus be 80 regulated within reasonable limits as long as the difference in pressure between the hot and cold water pipes does not vary over too large a range. I have found that when the difference of pressure is large the hot water 85 will be cooler and when the difference of pressure is small the hot water will be hotter than normal. This is due to the fact that for each degree of temperature at the thermostat there is a definite area of water way 90 at the port 131. But the quantity of water that passes is not dependent solely on the area of water way but is dependent also on the difference of pressure on the two sides of the port. If the difference of pressure 95 varies much it is necessary to provide an additional regulating means to insure uniformity of hot water temperature.

One such regulating means is the loose fitting piston 136 which partly obstructs the 100 flow of water from the chamber 133. There is a tendency for this obstruction to be carried along with the water and a consequent pull on the valve 130 proportional to some function of the quantity of water flowing past. The effect is easily adjusted by 105 spring 137 when the thermostat is not connected and the water flow can then be kept constant regardless of the difference of pressure. But for the particular mode of operation now being explained, the thermostat 110 must needs be attached and its elasticity must be taken into account. There is no doubt that these parts can be properly proportioned so they will operate as intended 115 without additional adjusting means, but too long a series of experiments would be necessary for each design. The spring 80 of adjustable length is, therefore, introduced to facilitate the adjustment. 120

At 165 is an obstruction to the water flow, similar to that at 136. There is also a piston valve 171 on which the water pressure is equalized through pipe 167, 174, cock 173 125 and chamber 172. If diaphragm 158 is removed or by-pass cock 156' opened, the remaining parts can be adjusted to regulate the water passing through the heater to a uniform flow which is more particularly desired when the thermostat regulates the gas 130

valve as described later on, instead of regulating the water as now being described.

The diaphragm 158 and the attached piston valve 171 are adapted to maintain a uniform difference of water pressure on the two sides of the port 131 no matter how much the pressures in the hot and cold water pipes vary. It will be observed that the chamber 150 above the diaphragm 158 is in communication through cock 155' with the chamber 133 on the outlet side of the thermostatically operated valve 130. The chamber 162 below the diaphragm 158 is in communication with the inlet side of the port 131 of the same valve 130 by way of pipes 163 and 132. Any change in the difference of pressure on the two sides of the port 131 will cause the diaphragm to move and regulate the piston valve 171. Any increase in the difference of pressure at the thermostat valve 130, above that for which the governor spring 154 is adjusted, will cause the diaphragm 158 to close the piston valve 171 and nearly restore the normal difference of pressure. The uniformity of difference of pressure thus obtained at the port 131 enables the thermostat 75 to regulate the temperature of the water with only a moderate movement of the valve 130 and there is therefore only a small change in temperature even with the greatest changes of total difference of pressure between the hot and cold water pipes. The amount of the difference of pressure at the port 131 is adjusted by the governor springs 154 and 176, and should be enough to keep the motor piston 7 up and the gas valve 37 open.

It will be seen that diaphragm 158 and its piston valve 171 limit the maximum difference of pressure on motor piston 7 whether or not piston valve 130 is in use and so accomplishes the same purpose as safety valve 22, but in a different way.

A different general mode of operation of the heater, well known in the art, results if the cock 11 is opened, but my invention can still be applied in the same way. The opening of any hot water faucet causes motor piston 7 to move up and gas valve 37 to open as before. But when the port 9' in the motor piston 7 comes opposite the port 9 in the cylinder, a flow of water is established from WI through pipe 170, port 169, pipe 163, 13, chamber 12, port 9', 9, pipe 10 to WO. At the same time a flow of gas is established from GI through pipe 35, port 39, pipe 42, open valve 46 and pipe 50 to the burners. When thermostat 75 gets hot enough it permits spring 137 to open valve 130 and increase the flow of water through the heater by the amount that can flow from WI through pipe 170, port 169, pipe 163, 132, port 131, pipe 138 to WO. If the thermostat gets much above normal temperature the valve 130 will be opened so wide that the

difference of pressure on the motor piston 7 will be reduced and the gas valve 37 closed.

The pipes 163, 13, port 9, pipe 10, etc., will cause enough friction to produce a difference of pressure on the two sides of the diaphragm 158. The spring 154 is adjusted to keep port 169 open in spite of this and allow the rated amount of water to flow through the heater. When the thermostat 75 gets above normal temperature the port 131 will be opened, the pressure will be partly equalized on the two sides of the diaphragm 158, the piston valve 171 will be opened farther, and more water will pass through the heater. This regulation by the thermostat would be more effective if communication from chamber 139 to pipe WO were closed at cock 138' and this chamber 139 connected to chamber 150 by opening cock 155'. The ports 189 and 97 of cock 190 then could be partly closed so that if the thermostat got too hot the pressure on the two sides of the motor piston 7 would be equalized through pipe 13, port 131, cocks 155' and 156, graduated valve 26, and the gas valve 37 would be closed. Without this modification the effect is obtained to a sufficient degree for the purpose.

Thus far it has been assumed that spring 36 or some other simple spring operates the motor piston 7 and that stop 20 limits the upward movement to just what is necessary to open gas valve 37 and port 9 if the latter is in use. A moderate difference of pressure on motor piston 7 moves it as far as it will go and holds it there. If the safety valve 22 is held shut and the spiral helical spring 6 is brought down into action by the screw 4, then the regulation will be different. Owing to the form of spring 6 its deflection is large when a small force is applied but the deflection does not increase very much when the force becomes larger. By winding this spring to the proper contour it can be made to give the desired gas valve opening at 37 for every difference of water pressure, it being remembered that the flow of water through a given orifice is approximately proportional to the square root of the difference of pressure. A long series of experiments will be necessary for any given heater if the spring is to function correctly over a wide range of difference of pressure. The two springs 6 and 36 however, can be readily adjusted to suit a limited range of difference of pressure, by using the adjustments 4 and 33 to shift the load from one spring to the other to obtain any desired rate of deflection per pound of load without changing the total load. The flow of gas through the valve 37 may be thus proportioned to the flow of water through the heater. It is preferable that the parts be adjusted to over regulate slightly so that the water will be hotter than normal when the flow is large

and cooler than normal when the flow is small.

If the screw stop 20 is backed off far enough to permit the motor piston 7 to move up so far that the ring 7' will partly close the port 9 after the gas valve is fully open, then the flow of water through the heater can be regulated by the difference of water pressure. The spring 6 should be so made that for all differences of water pressure on the piston 7, the port opening at 9 for the passage of water will be proportional to the reciprocal of the square root of the difference of water pressure ($A = C \div \sqrt{p_1 - p_0}$). Then the flow of water through the heater will be nearly constant. Such a spring is easily compressed by a small load and a small difference of pressure on the piston will fully open the port 9. A moderate difference of pressure moves the piston a little farther up and causes the ring 7' to partly close the port 9. With greater difference of pressure the resistance of the spring, on account of its form, increases very rapidly and no reasonable pressure upward will close the port entirely. The limit screw 20 is also set for this purpose. With such a spring the water flow will be nearly constant no matter how much the pressures vary, and the thermostat will have but little to do. It is preferable, however, that the quantity of water that flows through the heater when the difference of water pressure is small be somewhat more than the quantity of water that flows when the difference of pressure is large. To make a spring 6 that will perfectly meet the conditions for a given heater will require many experimental windings. Mathematical treatment is too complicated and only approximate. I prefer, therefore, to use two springs 6 and 36 jointly operating the piston. With a few trial windings, satisfactory results can be obtained over a moderate range of difference of water pressure, by shifting the load partly from one spring to the other, thus changing the deflection rate without changing the load.

Turning cock 95 to connect pipe 95' with 97 and turning cock 103 to connect pipe 102 with 104, the chamber 101 above the diaphragm 100 will be in communication with the inlet water pipe WI, and the chamber 94 below the diaphragm will be in communication with the outlet water pipe WO. The diaphragm will be subjected to the difference of pressure between these two pipes. Movement of the diaphragm will be transmitted by lever 61 to piston valve 130, and the water flow will be regulated by the difference of pressure if the springs are made as previously explained. The thermostat 75 will also join in the regulation of the piston valve 130.

By connecting stem 54 to yoke 55, screwing point 60 up free from lever 61 and ad-

justing the screw 64 into contact with the end of lever 61, as shown in Fig. A, the diaphragm 100 will operate gas valve 46 and regulate the flow of gas in accordance with the flow of water, if the springs are properly made as explained in connection with spring 6. The thermostat will at the same time regulate the flow of water at 131 independently.

Another general mode of operation of this heater results if the auxiliary gas valve 46 is connected by parts 55 and 60 to lever 61 so that thermostat 75 will regulate the gas supply and piston valve 130 will remain closed. This general mode of operation is well known in the art, although its equivalent is perhaps better known in which the thermostat 75 and the piston 7 are connected by suitable means to operate a single gas valve. My invention is applicable as before. The difference of water pressure on diaphragm 100 and the thermostat 75 will act jointly to regulate the flow of gas at 46.

Although previously explained, attention is again invited at this time to the piston valve 171 which, when operated by the diaphragm 158, will keep a uniform difference of pressure on the port 9 or on the hand adjusting water valve 13' commonly used on this kind of heater, and will thus insure a uniform flow of water at the rated capacity of the heater, say 4 gallons per minute, no matter how the conditions vary. With this uniform flow of water the thermostat, even though not very sensitive, will easily keep the temperature of the water within narrow limits by regulating the flow of gas at 46. With the hand operated water regulating valves heretofore used, more than 4 gallons of water a minute was delivered in the basement and less than 4 in the upper stories. This caused a corresponding variation in the temperature of the water which the thermostat could not entirely correct, and it also caused a reduction in the capacity of the heater during much of the time it was in use. My governor valve remedies these defects. Any change in the quantity of water flowing through the restriction at 9 will now change the difference of pressure on the diaphragm 158 and move the piston valve 171 until the flow is made normal again. The regulation to 4 gallons of water per minute can also be accomplished without the diaphragm 158, the friction and suction of the water passing piston 165 regulating the piston valve 171. In Fig. 7 is shown a very simple form of governor valve which can be substituted for parts 150 to 177.

When it is desired that the hot water for the upper stories be not so hot as that for the basement and lower stories the three-way cock 173 is turned to establish communication from chamber 172 to the atmosphere at 175. The piston valve 171 now will be un-

balanced. The back pressure from the hot water pipes tends to open port 169 but spring 176 is brought into action to balance this effect until the piston valve 171 operates as before, with the difference however, that every change in back pressure changes the adjustment. The greater the back pressure the more opening at port 169; hence very hot water on the lower floors and progressively cooler water for floors above. The thermostat may regulate the flow of water at 131 or the flow of gas at 46, but it should not be too sensitive because it tends to keep the water at uniform temperature, and overcomes, to a great extent, the altitude adjustment.

With the parts adjusted so that the thermostat 75 regulates the gas supply at 46 and the left end of the three point lever 61 supported on the frame 1 by the stop 88, see Fig. C, the piston valve 130 is free to regulate the flow of water through the by-pass 132, 131, 138. Turning the three-way cock 127 to establish communication from the chamber 126 to the air at 128 or loosening the stuffing box 124, this piston valve 130 will respond to the back pressure in the hot water pipes as described for piston valve 171. Considerable water will be permitted to go through the by-pass when water is drawn on an upper floor and little or none when water is drawn in the basement. It is preferable that pipe 138 be closed by cock 138' from pipe 10 and connected to the hot water pipe on the opposite side of the heater so that the small amount of water that goes through the by-pass will not go through the thermostat. This by-pass water will then dilute and cool the hot water and the thermostat will not neutralize the effect of the altitude adjustment.

If preferred the governor valve may be eliminated, chamber 126 still being exposed to the air and the piston valve 130 being unbalanced. With thermostatic water regulation, if hot water is now drawn on a lower floor the effect of the back pressure from the hot water pipes is reduced much more than if the water is drawn on an upper floor.

The extent to which the port 131 is closed is determined by the back pressure in the hot water pipes and the spring adjustment. The temperature at which the thermostat will permit the port 131 to be reopened is also determined by the altitude at which the water is drawn. The amount of the back pressure effect is adjusted by spring 137 and screw 86 at spring 80. This will be understood by observing that when no hot water is being drawn the pressure in chamber 133 and throughout the hot water piping of the house will be equal to the pressure in the cold water pipes. There is no water in chamber 126, and the force of spring 137 plus the water pressure in chamber 133 is

sufficient to push piston valve 130 down against the action of springs 125 and 80, thus holding port 131 open. When, however, hot water is drawn, the pressure in chamber 133 and the adjacent hot water pipes falls to approximately the pressure due to the mere weight of the superincumbent water in the hot water pipes above the heater up to the open faucet. The reduction in pressure will permit springs 125 and 80 to close port 131 against the spring 137 and the remaining water pressure in chamber 133. Now as the thermostat is heated, its levers move so that the upward pressure of spring 80 is gradually reduced, and spring 137 and the water pressure push the piston down until the port 131 is opened. The temperature at which the port opens is dependent partly on the back pressure in chamber 133 and therefore on the elevation at which the hot water is drawn.

For gas regulation, the piston 130 is adjusted so port 131 remains covered or pipe 132 is closed, and with gas valve 46 connected to lever 61 the back pressure on piston 130 acts jointly with the thermostat 75 to regulate the gas supply at 46 in accordance with the altitude and temperature.

Instead of applying the back pressure effect to piston valve 130, cock 95 may be turned to open pipe 95' to 97, cock 103 turned to close all ports, and cock 106 opened to the air. The chamber 101 above diaphragm 100 is now in communication with the air and chamber 94 below the diaphragm is in communication with the hot water pipes 97 and WO. The diaphragm being large, a great movement is produced for a small change in back pressure. The total movement is limited by stops 62 and 63. By properly adjusting the springs 108, etc., a sudden change in the water temperature is effected at any desired altitude. For example the water for the basement and first floor may be 160° F. and that for all floors above these may be 140° F. The parts may be connected so that either the water at 131 or the gas at 46 is adjusted by the altitude effect.

The large stem 18 of the piston 7 is exposed to the unbalanced pressure from the hot water pipes and either gas valve 37 or water valve 7' may be changed by the altitude at which the hot water is drawn.

If the three-way cock 95 is turned to establish communication between pipe 97 and chamber 94, and the three-way cock 103 is turned to establish communication between pipe 105 and chamber 101, then excessive flow of water past 186 in pipe WO will move diaphragm 100 down and partly close port 131 of the thermostatic piston valve, thus regulating the flow of water through the heater. The flow of gas at 46 may be regulated by the same means.

A similar regulation of the gas at 46 or the water at 131, in proportion to the velocity of the water passing at WI is obtained by turning cock 95 to open pipe 96 to 95', and turning cock 103 to open pipe 102 to tube 104.

When the governor water valve 150 to 178 is in operation, it should be noted that the chamber 150 above the diaphragm is in communication with the outlet pipe WO through the tube 188. Hence the pressure on the diaphragm is reduced by the velocity head and it will be seen that excessive flow of water will close slightly the port 169 and reduce the flow, thus assisting in the regulation of the temperature. When the three-way cock 190 is turned clockwise 90° the communication will be through the suction tube 186, instead of through tube 188, and the effect at piston valve 171 will be similar but greater.

The chamber 2 above the motor piston 7 is also in communication with the outlet pipe WO through either tube 186 or 188 and the gas valve 37 will be held fully open as long as the flow of water through the heater is normal. If, however, the flow is small for any reason while the temperature is high, the difference of pressure between chambers 2 and 12 will be reduced and the gas valve 37 will close. For this the motor piston and gas valve are preferably operated by spring 36 rather than by the graduated spring 6.

Referring to the modified form of heater shown diagrammatically in Fig. 5, a combination water motor, water valve and gas valve is shown at 201, which numeral designates particularly the inlet chamber of the water motor communicating with the inlet pipe 202. Carefully fitted in the chamber is a piston 206 adapted to close the port 203 which communicates with the pipe 204 and through a cock 205 with 335 and 362. Through the piston is a passage 207 fitted with a safety valve 208 adapted to be closed against the water pressure by a spring 210. The other end of this spring rests on the collar 211 adjustably threaded on the valve stem 220. This spring 210 is adjusted so that the valve will open when the difference of pressure between the chambers 201 and 214 exceeds that necessary to overcome the main spring 213 and the friction. It thus limits the force that opens the gas valve 236. The spring 213 bears against the piston 206 and a screw head 217, and the force is adjusted by turning the head. Chamber 214 communicates with pipe 215 and through the nearly closed valve 216 with pipe 385. The safety valve 208 is guided to its seat 207 by a stem 209, and the collar 211 is guided by the stud 212. The valve stem 220 is attached to the piston 206 by a rotatable connection 219 so that the stem may be turned to ad-

just the safety valve spring 210. The valve stem 220 passes through a stuffing box 218 and is screwed into a boss 221 carrying an arm 222 adapted to come in contact with stop screws 223 and 224 in brackets 225 and 226 on the frame. These stops can be adjusted so port 203 will be uncovered or not, as desired.

Into boss 221 is also screwed a gas valve stem 230 which passes through a stuffing box 231 and is adjustably connected to a gas valve 236. A head 232 closes the end of the gas outlet chamber 233 communicating with the pipe 234. Turning the screw head 232 adjusts the pressure of the spring 235. The valve is adapted to close on its seat 237. The inlet chamber 239 communicates with the gas inlet pipe 240. The screw head 241 that closes the lower end of chamber 239 also adjusts the spring 238 and carries a valve limit stop 242.

An auxiliary gas valve is shown at 243 which numeral designates more particularly the inlet gas chamber communicating with the pipe 234. The end of this chamber is closed by a screw head 244 which also serves to adjust the force of a spring 246. It carries a screw 245 to limit the movement of the gas valve 247. An outlet gas chamber 250 communicates with a pipe 251 conducting gas to the burners. A spring 249 adjusted by the screw head 252 urges the valve 247 from its seat 248. Adjustably connected to the gas valve is a stem 254 passing through a stuffing box 253 and detachably connected to a yoke 255. On the yoke is a knife edge 256 in contact with the three point lever 261. A thermostat 275, Fig. 5^A, operates compound levers. The end 270 of the last compound lever exerts force downward against the three point lever 261 when the thermostat is cooling and yields when it is getting warmer. One of the levers may be elastic and may have means for changing elastic rate. The three point lever is also in contact with the valve stem at 256 and with the diaphragm stem at 260. The contact of 270 is not necessarily midway between the two stems nor intermediate between them. It may be beyond either of them and is determined in each case by the relative sizes and motions of the thermostat, valves and motor. The knife edge 260 is threaded on the diaphragm stem 290 and its arm is adapted to come in contact with adjustable stops 262 and 263 threaded in brackets 266 and 267 attached to the frame.

The main parts 290 to 311 of the diaphragm motor are like the parts 90 to 111 in Fig. 2, the last two characters of the numerals being the same in both drawings. The water connections, however, are different. The upper diaphragm chamber 301 is in communication with pipes 302 and 391, and through cock 383 it can be put in com-

munication with the inlet pipe WI at 382 or through cock 390 it can be put in communication with the outlet pipe WO at 388.

The lower diaphragm chamber 294 is in communication with pipe 295, and through cock 297 it can be put in communication with the atmosphere, or through cock 296 it can be put in communication with pipes 355 and 381, and at 380 with the inlet pipe WI.

The upper end 321 of yoke 255 is detachably connected to the water valve stem 320. This stem passes through a stuffing box 324 and is adjustably connected to the valve boss 327. A proportioning spring 326 presses on the boss 327 and its pressure can be adjusted by screwing the head 323 more or less into the chamber 325. The boss 327 is attached to the valve 330 by a shank 329 which is open to allow the water to pass through the center opening 334. The valve 330—331 is double and nearly balanced; the lower valve 330 closing on its seat 332 against the water pressure, and the upper valve 331 closing on its seat 333 with the water pressure.

There is a central passage 334 through the two valves to establish communication between the lower chamber 325 and the inlet chamber 336. The passage 334 is proportioned to the capacity of the heater so there will be an appreciable drop in pressure between chamber 336 and chamber 325, and a consequent increase in tendency to close the valve with increase of quantity of water flowing through the heater. The area of the passage 334 is preferably made adjustable in any convenient manner. The area of the water way between valve seat 333 and the shell that connects 330 with 331 must also be proportioned to suit the capacity of the heater. The spring 339 is adjusted by the screw plug 340 and the lift of the valve is limited by the screw stop 341. The central chamber 335 communicates with pipe 363 and through cock 205 communicates with pipe 204. The upper chamber 336 communicates through cock 337 with the cold water supply pipes WI and 202, and through cock 338 with pipes 355 and 381.

A water motor operated governor valve is shown at 350 which indicates more particularly the upper chamber. Its upper end is closed by a screw head 351 carrying a screw 352 adapted to limit the movement of the piston 359. Turning the head adjusts the pressure on the graduating spring 354. A pipe 355 communicates with the chamber 350 and with the water inlet WI at 380. The chamber 362 below the piston communicates with the pipe 363 and through 384 with pipe 385 and through cock 205 with pipe 204. There is a cup leather 358 between the piston 359 and the head 357 held by a screw 356. To the lower side of the piston is fastened a valve 371 adapted to close the port 369. The valve is preferably of smaller area than

the piston, as shown. Through the valve is a passage 366 and one or more holes 365 of small enough size to cause an appreciable loss of pressure between chamber 362 and chamber 368 when the water is flowing through at the full capacity of the heater. The port 369 communicates with the pipe 370 and pipe WO leading to the upper end of the heating coil. In the lower chamber 368 there is a spring 376 tending to open the valve. A screw plug 378 closes this chamber and also serves to adjust the compression of the spring 376. There is also a screw 377 to limit the movement of the valve.

At 387 there is a restriction in the outlet pipe 370—WO adapted to cause the water to flow at a high velocity across the end of the small tube 388 and cause a reduction of pressure in the tube 389. The restriction is so shaped as to cause as little friction as possible, as in the well known Venturi meter. The pipe 389—391 is provided with a cock 390 through which the pressure is transmitted to the diaphragm 300.

At 384 in the intermediate pipe 363 a suction effect is produced in another manner well known in other arts. It will be understood that the forms 388 and 384 are equivalent means and one may be substituted for the other. The tube 384 connects with pipe 385 and through cock 216 with motor chamber 214. The suction effect assists in keeping the gas valve 236 open when water is flowing through the heater rapidly but permits it to close if the flow is slow.

At 380 is a small tube the end of which faces the flow of water and produces a pressure in the pipe 381 higher than the static pressure in the main pipe WI. This is well known in other arts as a Pitot tube. The tube 380 connects with the larger pipe 381 which in turn connects with pipe 355 and through cock 338 with chamber 336 and through cock 296 with chamber 294.

Where the tube 380 restricts the flow of water pipe in WI, there is a Venturi tube 382 communicating through cock 383 with pipe 302.

Operation of Fig. 5, by thermostatic control of the flow of water, when cocks 205, 296, 297, 338, 383 and 390 are closed, the remaining cocks 337 and 216 are open, the latter only part way, and the auxiliary gas valve 247 disconnected at 255 and left open. Now when a hot water faucet is opened some cold water will flow from the inlet WI through pipe 202 to chamber 201. At the same time a corresponding amount of water will flow out of chamber 214, through pipe 215, partly open cock 216, pipe 385, pipe 363, chamber 362, passage 366, port 369, outlet pipe WO, and hence through the heater coil and out at the open faucet. The resulting movement of the piston 206 opens the gas valve 236. The difference of pressure on the

two sides of the governor piston 359 will move it against the spring 376 and nearly close the port 369. Complete closure is prevented by screw 377. As the thermostat gets hot, valve 330—331 will be opened, diaphragm 300 being immovable at this time. As valve 330—331 opens, the pressure in chamber 362 will increase and the spring 376 will open port 369 more or less. The valve 371 and piston 358 must move easily so as to respond readily to slight changes of pressure, and maintain a nearly uniform difference of pressure between chambers 350 and 362, and therefore between chambers 336 and 335. This uniform difference of pressure enables the thermostat to accurately regulate the flow of water in proportion to the heat supplied by the burners and deliver hot water at uniform temperature regardless of variations in back pressure in the hot water outlet pipe and variations of direct pressure in the cold water inlet pipe. A uniform pressure is also kept on the motor 206 and the safety valve 208 can be dispensed with. It should also be noted that the inlet water pressure tends to close water valve 330—331 by the unbalanced pressure on its stem 320.

A very rapid flow of water through the passage 366 tends to close the port 369. It also tends to close the valve 330—331 due to the friction and loss of pressure through passage 334, and the elasticity of the thermostat or interposed spring.

The Pitot tube at 380 also increases the pressure slightly in chamber 350 and tends to close port 369. It will be understood that any one of these velocity means is sufficient for the purpose and they are intended as alternative ways of regulating. There is also an increased suction effect from 384 tending to open gas valve 236 which can be made to regulate the gas supply if a graduating spring is used.

If it is desired that the hot water on the upper floors of the house be not quite so hot as on the first floor and basement then cocks 297 and 390 are opened and stops 262 and 263 are set to limit the effect. The large back pressure remaining on when the water is being drawn on an upper floor will be communicated to chamber 301 while chamber 294 is in communication with the air. The resulting movement of the diaphragm 300 will be transmitted by the lever 261 to the water valve 330—331 and more water will pass, resulting in somewhat cooler water notwithstanding the fact that the thermostat is trying to keep the temperature uniform.

If cock 296 is opened instead of 297, all parts perform the functions just described except diaphragm 300. There is now inlet water pressure in chamber 294. Variations in the difference of pressure between the inlet WI and the outlet WO will move the

lever 261 and adjust the water valve 330—331, thus assisting the thermostat. With piston 358 and its valve 371 assisting, there is no difficulty in adjusting the device. But if screw 377 is turned home to put valve 371 out of commission, then springs 308 and 326 must be graduated to give the proper deflection for each pound of force to make the device regulate over a large range.

If cocks 383 and 296 are opened instead of 297 and 390, all parts will act as before except the diaphragm 300. A rapid flow of water through the heater will now cause Pitot tube 380 to increase the pressure in chamber 294 and the Venturi tube 382 will cause a decrease in pressure in chamber 301. The diaphragm 300 will move the lever 261 and water valve 330—331 in a direction to restrict the flow of water at 332 and 333 to normal, and assist the thermostat in its efforts to keep the temperature normal. The piston 358 and its valve 371 also assist the regulation but if they are eliminated the other parts can still be adjusted to give good regulation.

Operation of the heater by indirect thermostatic regulation of the water flow will take place with cocks 296, 297, 337, 390 and 383 closed, and cocks 205, 216, 338, etc., open. Now when a hot water faucet is opened cold water flows from the inlet WI, through pipe 202 into chamber 201. A like amount of water will flow out of chamber 214, through cock 216, pipe 363, chamber 362, passage 366, port 369, pipe WO, hence through the heater to the open faucet. This flow moves piston 206 down and opens the gas valve 236 and also uncovers port 203. The water now flows from inlet WI through pipe 202, chamber 201, port 203, pipe 204, cock 205, pipe 363, chamber 362, passage 366, port 369, pipe WO, heater coil, not shown, and out at the open faucet. The flow of water is limited to the capacity of the heater by two means. Too large a flow through 366 will close port 369 more or less and limit the flow. Too large a flow at Pitot tube 380 will increase the pressure in chamber 350 and close port 369 more or less. When the thermostat is hot, valve 330—331 will be opened, equalizing the pressures in chambers 350 and 362, and allowing port 369 to be uncovered more with consequent increase of water flow. Diaphragm 300 can be also put in operation as previously described.

Operation of the heater by indirect thermostatic regulation of the gas supply will take place if cocks 338, 383, 296, 297 and 390 are closed, and cocks 205, 216 and 337 are opened. The water valve 330—331 now will act as a by-pass when the thermostat gets hot enough. It will increase the flow of water through the heater, thus keeping the temperature down, and when fully open it

will equalize the pressures on the two sides of the piston 206 and so close the gas valve 236.

In all the above cases the auxiliary gas valve 246 may be connected as a safety device. Screw stop 341 will be backed off so that if the thermostat 275 gets overheated the gas will be shut off at 247.

Operation of the heater shown in Fig. 5 will be by thermostatic regulation of the gas, if cocks 337, 338, 296, 297, 383 and 390 are closed, cocks 205, 216, etc., open, water valve 330—331 disconnected from 321, and auxiliary gas valve 247 in operative adjustment with the point of 256 in contact with lever 261 as shown in Fig. 5^B. It will then operate as an ordinary heater with the novel features, however, of the governor valve 371 and its piston 358, which regulate the water flow accurately to the capacity of the heater, regardless of difference of water pressures. The valve 371 regulates the water flow in the three different ways already pointed out. Any one of these is sufficient and the other parts may be omitted. It also has the novel feature that the thermostat may be assisted in regulating the gas supply by the diaphragm 300 operated by the velocity of the water or by the pressure as already pointed out, and the other novel features are still operative.

In Fig. 6 is shown another modified form of a part of my invention, in which the governor valve and thermostat valve are put in the same chamber to simplify the structure. The gas valve and motor are not shown but are of well known construction or like those shown in connection with the previously described forms.

A well known kind of thermostat is shown, 400 being the outer tube, 401 the inner copper tube, 402 the hot water outlet, and 403 a porcelain rod. This rod bears on the adjusting screw 404 in lever 406. The lever fulcrums at 405, and the end 407 of its arm bears on lever 410. This second lever fulcrums on the point of the adjusting screw 408 tapped through a part of the frame 409. The arm of lever 410 is pressed by the end of valve stem 411. The stem passes through stuffing box 412, through chamber 413, and is adjustably connected to piston valve 415 and stop nuts 421 and 422. The inlet water enters from pipe 414 to the chambers 417 and 426. The valve 415 is adapted to close port 418 which communicates by pipe 419 with chamber 428. The spring 420 opens valve 415 and keeps a strain on the thermostat. The relative motion of valves 415 and 434 is limited by the adjustable nuts 421 and 422 coming in contact with socket 423. A soft packed piston is shown at 427 which is joined by the shank 430 to the loosely fitted piston 431, and to

the valve 434 having holes 433 to admit water. The upper edge of valve 434 is adapted to close port 439 communicating with the outlet water pipe 440. The spring 441 opens both valves. It is adjusted by screw plug 442. There is a motion limit at 437 in cap 436.

When a hot water faucet is opened the unbalanced pressure on piston 427 will close port 439. When the water motor, not shown, opens the gas valve and the thermostat gets hot the spring 420 will open port 418 and increase the pressure in chamber 428. The reduced difference of pressure on piston 425 will permit spring 441 to open port 439 just enough to keep a uniform difference of pressure between chambers 417 and 428 enabling the thermostat to accurately regulate the flow of water regardless of the total difference of pressure between 414 and 440. Changes in either valve assist the regulation of the other through the pressure of the spring 420, and extreme movement of either will move the other by the limit nut 421 or 422.

Rapid flow of water assists the regulation by the friction, etc., at 416 and 431.

I claim:

1. In an automatic water heater, the combination of a means for automatically establishing a flow of fuel to the burner upon the opening of a hot water faucet, a thermostatic means for regulating the temperature of the hot water, and a water motor actuated means for regulating the temperature of the hot water.

2. In a water heater, the combination of a thermostatically operated water valve, and a water pressure actuated water valve adapted to regulate the pressure of the water and automatically maintain a nearly uniform difference of water pressure on the thermostatically operated water valve.

3. In an automatic water heater, the combination of a valve adapted to regulate the temperature of the hot water, a thermostat operatively connected therewith, a water motor actuated by difference of water pressure, and means actuated by the water motor adapted to restrict the flow of water through the heater as the difference of water pressure increases.

4. In an automatic water heater, the combination of a piston actuated by the difference between the pressure in the cold water pipe and the pressure in the hot water pipe, a means actuated by the piston for establishing a flow of water through the heater, a means actuated by the piston for establishing a flow of gas to the burner, a thermostat responding to the temperature of the hot water, means actuated by the thermostat for varying the flow of gas to regulate the temperature of the hot water,

and a second means for regulating the temperature of the hot water, said second means being actuated by water pressure.

5. In an automatic water heater, the combination of a pipe conducting water through the heater, two valves on said pipe with the water passing consecutively through both, a thermostat adapted to operate one of the valves, a water motor adapted to operate the other valve, communication from one side of the water motor to the outlet of the thermostatically operated valve.

6. In an automatic water heater, the combination of a thermostat responding to the temperature of the hot water, means operated thereby for regulating the temperature of the hot water, a water motor responding to the pressure in the hot water pipe independently of the inlet pressure, and means operated thereby for changing the temperature at which the thermostat operates.

7. In an automatic water heater, the combination of a thermostat, a valve operated thereby, a water motor one side of which is exposed to the air and the other side of which is connected with the hot water outlet pipe, means for limiting the effect of the water motor, and means operated by the water motor for changing the adjustment of the thermostat so that its valve will be closed at a different temperature if the hot water is being drawn from above a predetermined altitude than if the water is being drawn from a point below that altitude.

8. In an automatic water heater, the combination of a cylinder, a piston fitted within the cylinder, a port adapted to be fully open to permit free flow of water through the heater only when the piston is in an intermediate position, a graduated spring operating the piston, and a gas valve operated by the piston.

9. In an automatic valve mechanism a spring having the form of a spiral helix, one part of the spring being very flexible but of small total movement and the rest of the spring of progressively less flexibility, in combination with a helical spring, and a valve operated jointly by the two springs.

10. In an automatic water heater, a water valve, an actuating means for said water valve, a spring, one end of which is operatively connected to the water valve and the other end of which is operatively connected to the actuating means, and an adjustable support for said spring adapted to vary the effective length of said spring.

11. In an automatic water heater, the combination of a thermostat, a water valve operated thereby, a water motor actuated by the difference of water pressure, and a spring connecting the water motor with the

thermostatically operated water valve to enable the water motor to assist the thermostat to regulate the flow of water through the heater.

12. In an automatic water heater, a water regulating device consisting of a cylinder, a valve therein to control the flow of water, a member attached to the valve the member being adapted to partly obstruct the flow of water and cause the flowing water to exert a closing force on the valve, a spring exerting an opening force on the valve and a thermostat adapted to automatically vary the adjustment of said water regulating device.

13. In an automatic water heater, the combination of a pipe conducting water through the heater, a valve, a water motor adapted to operate the valve, two water passages establishing communication independently of each other between the pipe and the two sides of the water motor, the end of one of the passages connecting with a tube projecting into the pipe and having the plane of its opening within the pipe perpendicular to the flow of water in the pipe so that the pressure of the water within said passage will vary according to the velocity of the water in the pipe.

14. In an automatic water heater, the combination of a pipe conducting water through the heater, a restricted passage in said pipe adapted to cause the water to flow at increased velocity, a small lateral water passage across the end of which the water flows at high velocity, a water motor one side of which communicates with this passage, a communication from the other side of the water motor to an adjacent part of the pipe where the velocity of the water is less, and a water valve in said pipe operated by the motor.

15. In an automatic water heater, the combination of a thermostatic means for regulating the temperature of the hot water, a water motor actuated means for regulating the temperature of the hot water, and means independent of said water motor for automatically establishing a flow of fuel to the burner upon the opening of a hot water faucet.

16. In an automatic water heater, the combination of a cold water inlet, a hot water outlet, a water motor responding to the pressure at the outlet independently of the pressure at the inlet, and means actuated by the motor adapted to vary the temperature of the hot water in accordance with the elevation at which it is drawn.

17. In a water heater, a water actuated water valve adapted to automatically compensate for variations in water pressure and maintain a substantially uniform flow of

water, and a thermostatic mechanism adapted to automatically change the adjustment of said water valve.

5 18. In an automatic water heater, the combination of a water motor actuated by difference of water pressure, a water valve actuated thereby, and means actuated by the kinetic energy of flowing water for varying the pressure on the water motor in proportion to the velocity of the water.

10 19. In an automatic water heater, the combination of a water motor, means for establishing a difference of pressure on the two sides thereof, means actuated by the water
15 motor for putting the heater in operation, and means actuated by the kinetic energy of flowing water to regulate the temperature of the water.

20. In an automatic water heater, the combination of an inlet, an outlet, means actuated by the difference in water pressure between the inlet and outlet for putting the heater in operation, and means actuated by the water pressure in the outlet for regulating the temperature of the water.

25 21. In an automatic water heater, an inlet, an outlet, means actuated by the difference in water pressure between the inlet and outlet for putting the heater in operation, and means actuated by the water pressure
30 in the outlet for regulating the heat supply.

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Witnesses:

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