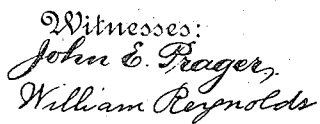


APPLICATION FILED APR. 19, 1909.

Patented Apr. 29, 1913.

3 SHEETS—SHEET 1.



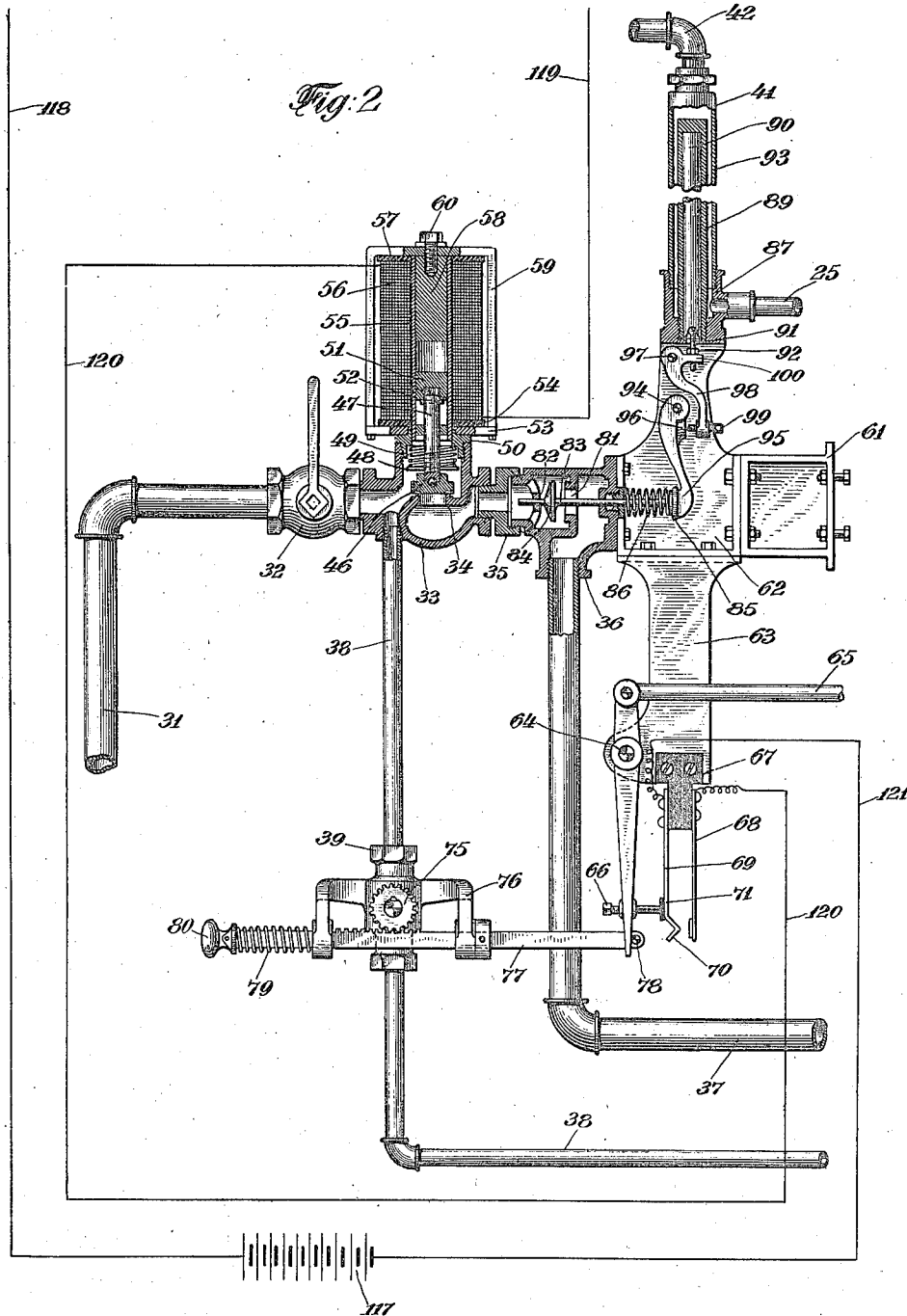
Inventors
George P. Carroll
Frank N. Rockovich

G. P. CARROLL & F. N. ROEHRICH.
SAFETY INSTANTANEOUS WATER HEATER.
APPLICATION FILED APR. 19, 1909.

1,059,977.

Patented Apr. 29, 1913.

3 SHEETS—SHEET 2.



Witnesses:
John E. Prager,
William Reynolds

Inventors
George P. Carroll
Frank N. Roehrich

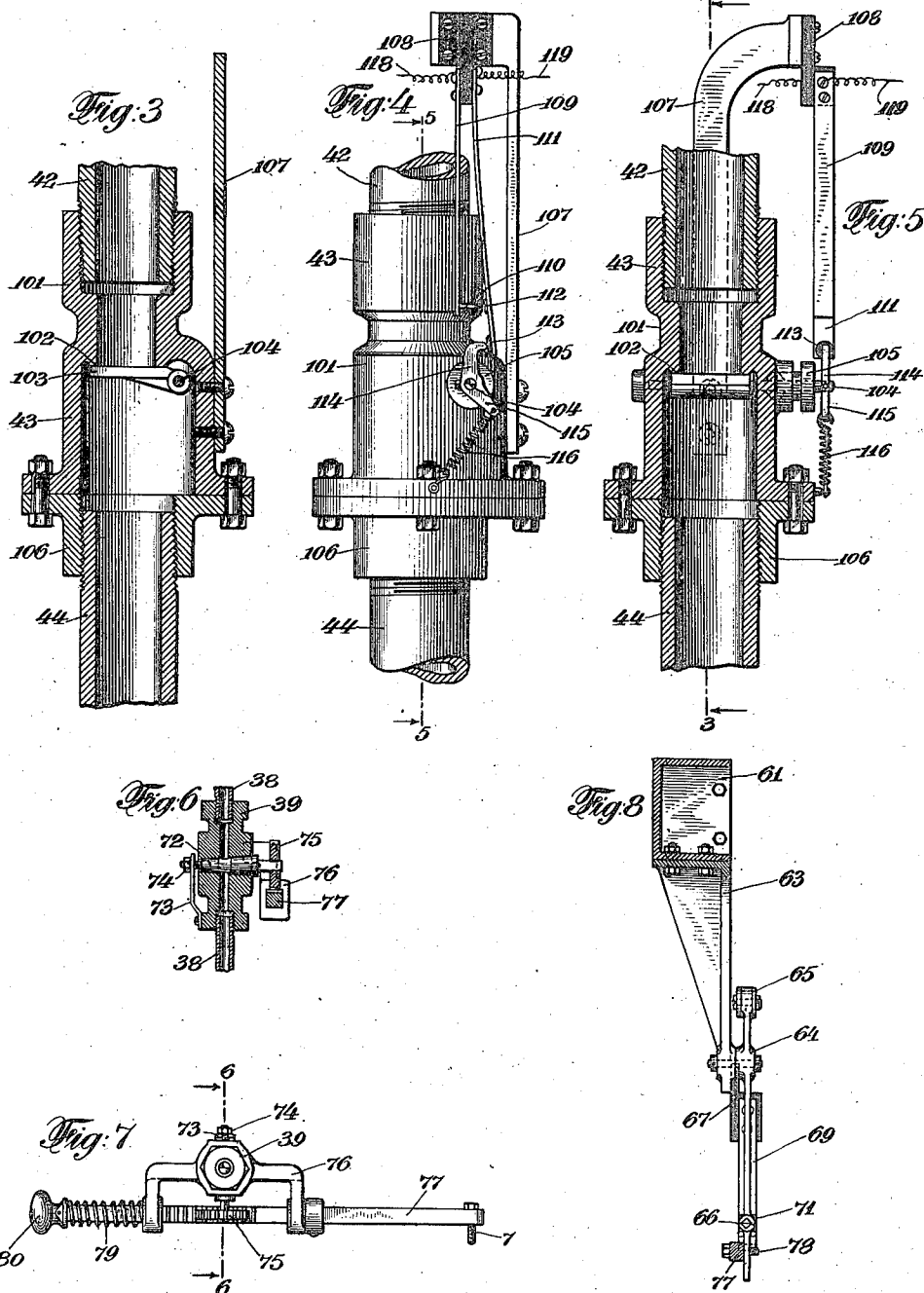
G. P. CARROLL & F. N. ROEHRICH.
SAFETY INSTANTANEOUS WATER HEATER.

APPLICATION FILED APR. 19, 1909.

1,059,977.

Patented Apr. 29, 1913.

3 SHEETS—SHEET 3.



Witnesses:
John E. Prager,
William Reynolds

Inventors
George P. Carroll
Frank N. Roehrich

UNITED STATES PATENT OFFICE.

GEORGE P. CARROLL, OF BRIDGEPORT, CONNECTICUT, AND FRANK N. ROEHRICH, OF NEW YORK, N. Y.; SAID ROEHRICH ASSIGNOR TO SAID CARROLL.

SAFETY INSTANTANEOUS WATER-HEATER.

1,059,977.

Specification of Letters Patent.

Patented Apr. 29, 1913.

Application filed April 19, 1909. Serial No. 490,793.

To all whom it may concern:

Be it known that we, GEORGE P. CARROLL and FRANK N. ROEHRICH, respectively a citizen of and an applicant for citizenship in the United States, residing, respectively, at the city of Bridgeport, county of Fairfield, and State of Connecticut, and in the city, county, and State of New York, have jointly invented a new and useful Safety Instantaneous Water-Heater, of which the following is a specification.

Our invention relates to improvements in water heaters which are automatically and instantaneously heated upon the opening of a faucet to draw off the water from the heating coil.

It consists of means whereby the flow of water from a faucet automatically causes the closing of an electric circuit, if a pilot flame is burning, so as to open a valve for admitting fuel to the main heating burners in proximity to the pilot flame, whereby the cessation of such flow breaks the circuit and causes the valve to close, and whereby any chance extinguishment of the pilot flame quickly and automatically prevents the opening of the valve and causes it to close if open and also shuts off the supply of fuel to the pilot flame until human agency intervenes to again start the automatic operation of the heater.

While in the description the liquid to be heated is referred to as "water", it is to be understood that this word typifies any liquid which it is desired to have heated only while being drawn off; and while the fluid fuel is described as "gas", this word also is to be understood as being typical of any fluid fuel.

In the drawings Figure 1 is a partial elevation and a partial vertical section of our invention with diagrammatic connections. Fig. 2 is a detail of a part of the same structure, partially in elevation and partially in vertical section. Fig. 3 is a partial front elevation of a water controlled switch and a partial vertical section of the same through the line 3—3 of Fig. 5 looking toward the left. Fig. 4 is a front elevation of the same structure. Fig. 5 is a partial left side elevation of the same structure and a partial vertical section of the same through the line 5—5 of Fig. 4 looking toward the right. Fig. 6 is a partial elevation and a partial vertical section through the line 6—6 of next

figure, looking toward the right, of a pilot flame valve. Fig. 7 is a plan view of the same valve and its actuating device. Fig. 8 is a left end elevation of a thermostatic switch and a partial elevation and a partial vertical section of the adjacent structure.

A tripodal base 15, having a central vertical opening for the upward passage of air, supports an annular gas distributing chamber 16, surrounding the opening. A convenient number, say ten of Bunsen, burners 17, have their lower ends removably fitting into the upper side of the chamber 16, only the rear half, however, of these burners being shown in Fig. 1. Around the outer edge of the top of the base 15 is supported a lower cylindrical casing 18, having openings 19 near its lower edge for the inward passage of air. An outwardly flanged ring 20 rests within and above the casing 18. An upper outer cylindrical casing 21 rests on the flange of the ring 20 and closes in at the top so as to leave a comparatively small vent 22 at the center of its top. A smaller cylindrical casing 23 is also supported by the ring 20 so as to leave an annular air space between the casings 21 and 23 and is open at its top for almost its entire diameter.

Leading from a water inlet pipe 24, connected with a source of water supply not shown, is a liquid chamber 25 in the form of a series of pipe coils constructed as follows: As the liquid chamber leads from the inlet pipe 24 through the side of the casing 21 near its top, it forms a large upper coil occupying the top of the casing 23; thence the coil narrows downward hour glass fashion and then enlarges, still continuing its downward course, into the large coil 25^b; thence the coil narrows and again enlarges, continuing downward into the large coil 25^c; thence the coil drops down by the vertical pipe 26 so as to form the large coil 25^d, immediately over the top of the burners 17; thence the coil proceeds upward, first narrowing and then enlarging; and finally the liquid chamber passes to the outside through the walls of the casings 23 and 21 about one-third of the distance above the ring 20.

Above and extending laterally over the vent 22 is a lower hood 27, having an opening 28 at its top. Above and extending laterally over the opening 28 is an upper hood 29, within which is supported a deflector 30.

This deflector is in the form of two opposed shallow cones with their adjacent bases in a horizontal plane; and it has the apex of its lower cone projecting just within the opening 28. The upper end of the hood 29 is to be understood as leading to a chimney flue, not shown. The parts are also so constructed and positioned that the bottom of the hood 27 is a little below the vent 22, leaving passages to and from the spaces outside of the casing 21; that the bottom of the hood 29 is somewhat below the opening 28, leaving passages to and from the spaces outside of the hood 27; and that free upward passages exist through the opening 28 between the hood 27 and the deflector 30 and between the hood 29 and the deflector 30.

Secured to the inlet end of a gas supply pipe 31 is a gas supply valve 32 that is to be kept open all the time during which it is desired that the heater be automatically operative. Secured to the chamber of the valve 32 in horizontal alinement therewith is an electric valve chamber 33 preferably of brass and having a flat horizontal valve seat 34. A threaded union 35 connects the free end of the chamber 33 and a throttling valve chamber 36. From the under side of the chamber 36 a main pipe 37 leads to the distributing chamber 16. From the chamber 33, between its inlet end and the valve seat 34, a small pipe 38 leads into a pilot flame valve chamber 39; and from thence the pipe 38 leads to a pilot flame burner 40, having its mouth in proximity to the mouths of the main burners 17. It will be noted that any valve adapted for seating on the seat 34 controls the chambers, essentially constituting a fuel supply pipe, leading from the seat to the main burners 17, and that the pilot burner 40 has a supply inlet separate from the pipe controlled by such valve.

The liquid chamber 25 leads into the lower part of an upright tube 41. From the tube 41 a hot water pipe 42 leads into a disk valve chamber 43; and from thence a pipe 44 leads to any desired places. Any desired number of faucets 45, leading from the pipe 44, when opened singly or collectively, have an operative effect to be described.

While any kind of electric valve, adapted to keep the valve seat 34 open during the passage of an electric current and to permit of its being automatically closed upon the cessation of such current, might be used as a part of our apparatus; we prefer to employ the kind of electric valve now to be described, inasmuch as it obviates the necessity of a stuffing box.

A disk valve 46 has somewhat flexibly secured to the center of its top an iron stem 47. Just above the valve 46 the stem is threaded for the support of an internally threaded brass disk 48. A coiled spring 49 surrounds the stem and abuts at its lower

end against the disk 48. An externally and internally threaded brass nut 50, having a flange above its outside thread, is screwed into the internally threaded top of the chamber 33 outside of the spring 49 so that its flange covers the top of the chamber. The nut just below its internal thread has a shoulder against which the upper end of the spring abuts. The spring 49, acting through the disk 48 and the stem 47, thus constantly tends and normally is effective to seat the valve 46 upon the seat 34. The strength of the spring 49 can be varied by a proper adjustment of the disk 48 and always can be made such as to prevent the disk from hitting against the shoulder of the nut 50 on an upward movement of the disk. An iron core 51 has a hollow bore, extending from its lower end up to near its top, and, in its lower part, has opposed slots extending from within the bore to the outside of the core. The upper part of the stem 47 loosely fits in the bore of the core and is transversely pierced near its top by a pin 52 extending at each end into an adjacent slot. When the core is unmagnetized the pin is in the top of the slots and supports the core as shown in Fig. 2. An iron plate 53 fits over a hub on top of the nut 50 and supports an insulating disk 54. A thin brass tube 55 is externally threaded at its lower end and is screwed into the plate 53, correspondingly threaded, and into the internal thread of the nut 50. Surrounding the tube 55 and supported by the disk 54 is a solenoid coil 56 of insulated copper wire. Another insulating disk 57 surrounds the tube at its top and covers the coil. An iron plug 58 fits closely into the upper half of the tube 55. An iron yoke 59 fits over the disk 57, the tube 55 and the plug 58 and is bolted at its lower ends to the plate 53. A bolt 60 passes through the top of the yoke 59 into the plug 58 so as to hold it at the top of the tube 55. This electric valve is more fully described in the so entitled application of Louis M. Schmidt already filed or about to be filed.

Bolted to the casing 21 just above the ring 20 is a distance piece 61. Bolted on one side to the outside of the piece 61 and on its opposite side to the outer end of the chamber 36 is a center piece 62, having a switch bracket 63 bolted to its under side. The construction of the lower part of the piece 62 is such that it has a vertical back plate, then at right angles to the back plate a vertical plate bolted to the piece 61, then also at right angles to the back plate a vertical plate bolted to the chamber 36, and finally at right angles to all three plates a bottom horizontal plate bolted to the bracket 63, so as to leave a hollowed boxlike space above the horizontal plate. A two arm lever 64 is pivoted near its top, so as to make a short

upper arm and a long lower arm, on the outer lower part of the bracket 63. A thermostatic rod 65 is firmly secured at one end to and against the inner side of the casing 18, beneath the ring 20, so that it cannot expand in that direction; and at its other end it is pivoted to the outer end of the short arm of the lever 64. The rod is so positioned that when the pilot burner 40 is burning the rod will be in the flame and will be subjected to the maximum of its heating effect without receiving any more heat than is unavoidable from the burners 17 if they are also burning. To this end it is advisable to have the rear half of the burners 17 as shown in Fig. 1 spaced a little distance away from the unshown front half of the burners so as to leave a pathway for the rod between them. The rod, or that part of it constantly exposed to the flame from the burner 40, is preferably made of nickel. Passing through the larger arm of the lever 64 near its lower end is an adjusting screw 66. Screwed to the lower extremity of the bracket 63 is an insulating piece 67, to the right of which and toward the casing 18 is bolted the upper end of a somewhat rigid copper contact piece 68, having preferably a silvered contact at its outer lower end. Bolted to the left of the piece 67 is the upper end of a more flexible copper contact piece 69, having on its inside at its extreme lower end a preferably silvered angle contact 70 adapted to make contact, and so doing under normal operative conditions, with the corresponding silver contact of the piece 68. On the outside of the piece 69 just above the contact 70 is a small insulated plate 71 against which the inner end of the screw 66 abuts. When the rod 65 is subjected to only atmospheric temperature, and in fact to any temperature short of that caused by a flame from the burner 40, both pieces 68 and 69 are in a vertical position as shown in Fig. 2 and the contact 70 is out of contact with the piece 68. But when the rod 65 is subjected to heat from a flame from the burner 40, or to greater heat, the rod in expanding longitudinally forces the upper arm of the lever 64 outward and its lower arm inward so that the inner end of the screw 66, pressing against the plate 71, forces the piece 69 inward and the contact 70 against the piece 68 so as to establish an electrical connection as shown in Fig. 1. In case of very much heating of the rod 65 both pieces 68 and 69 are sufficiently flexible so as to be carried without injury so far to the right as is necessary; and a proper adjustment can be readily secured by means of the screw 66 so as to provide for minimum and maximum conditions of contact.

Within the chamber 39 is a small conical rotary valve 72 having its small end to the left as shown in Fig. 6. A flat spring 73 is

screwed at its lower end to the outer lower end of the chamber 39 and tends to spring outward at its top, where it encircles the small exposed end of the valve. A nut 74 is screwed on to the extreme outside end of the valve, there threaded for that purpose, outside of the spring 73. By this construction the spring presses against the nut 74 and keeps the valve 72 well seated. To the stem proceeding from the exposed larger end of the valve 72 is secured a small pinion 75. Cast integral with the chamber 39 is a two arm bracket 76, having openings in the extremities of the arms through which horizontally reciprocates an untoothed part of a ratchet 77. Secured to the inner extremity of the ratchet is a pin 78 adapted for engagement with the inside of the extreme end of the lower arm of the lever 64 below the screw bracket 76 is a coiled spring 79, which abuts at one end against the bracket and at its other end against a push button 80, secured to the extreme outer end of the ratchet. The parts are so constructed and positioned that, starting with the positions shown in Fig. 2, when the button 80 is pushed inward by hand the spring 79 is compressed, the ratchet 77 rotates the pinion 75 so as to open the valve 72, and the pin 78 is moved out of engagement with the lever 64. By reason of the departing place of the pipe 38 ahead of the valve seat 34, gas will now pass through the pipe 38 to the burner 40 even although the valve 46 may be closing its seat. On lighting the burner 40 and after waiting a minute, the rod 65 by its expansion will actuate the lever 64 so as, not merely to bring the contact 70 into contact with the piece 68, but also to bring the lever 64 at its lower extremity in contact with the pin 78 in such manner as to keep open the valve 72 and to permit of the hand being removed from the button 80. The parts are now in the position shown in Fig. 1. But upon an extinguishment of the flame from the burner 40, the rod 65 by its contraction, will actuate the lever 64 so as to break the contact between the contact 70 and the piece 68 and to permit of the pin 78 being moved to the left. Consequently the spring 79, acting on the button 80, is now forcing the ratchet 77 outward so as to close the valve 72 by means of the pinion 75. Gas, therefore, can no longer escape from the burner 40 and the parts resume the position shown in Fig. 2.

The throttling valve chamber 36 has a flat vertical valve seat 81; and between this seat and the inlet from the union 35 it has a valve stem guide 82 centrally perforated for the passage of a valve stem 83 and also perforated next to the walls of the chamber for the free passage of gas from below the seat 34 and through the union 35. Secured on the stem 83, between the guide 82 and the seat 81, is a throttling valve 84 adapted to

open or to close the seat according to the movement of the stem and valve to the left or right. To the right of the valve 84 the stem 83 passes through the seat 81, leaving an annular passageway between itself and the seat; it then passes through the wall of the chamber 36 where the latter is bolted to the center piece 62, being there provided with a stuffing box; and it finally terminates, in the hollowed box-like space in the piece 62, in a flat vertical head 85. A coiled spring 86, surrounding the stem 83 and abutting at one end against the head 85 and at its other end against the surface of the piece 62 that is bolted to the chamber 36, tends to force the head 85 and the stem 83 inward so as to seat the valve 84 on its seat 81. The communication from the chamber 36 into the pipe 37 is from the space between the seat 81 and the wall adjacent to the piece 62. The tube 41 consists of two parts: The lower part 87 is cup shaped, is internally threaded at its opening at the top and is cast integral with the top of the back plate of the piece 62; and it also has in front a depending lug 88 parallel with the back plate. The liquid chamber 25 leads into the side of the part 87. The part 87 also has at the bottom a small central vertical opening and above the opening a threaded recess into which the correspondingly threaded open lower end of a copper tube 89 has been screwed. On the inside of the tube 89 and with its top abutting against the closed top of the tube, is a porcelain rod 90, fitting somewhat closely in the tube but not so closely as to interfere with the expansion and contraction of the tube. Fitting into a recess in the bottom of the rod 90 is the head of a bolt 91 which passes downward through the opening in the part 87 and on its threaded lower end is provided with an adjusting nut 92. The upper part 93 of the tube 41 consists of a tube at its lower end screwed into the top of the part 87 and leading at its top into the pipe 42. The dimensions of the parts 87 and 93 are such that there is always a free annular passage through them from the chamber 25 to the pipe 42, however great may be the expansion of the tube 89. Pivoted at 94 in the back plate of the piece 62 and in the lower end of the lug 88, and depending between them, is a lower lever 95 having an inner engagement plate 96 near its pivot and having its depending outer lower end bearing against the head 85. Pivoted at 97 in and between said back plate and the lug 88 above the pivot 94 is a bell crank lever, having a curved lower arm 98 through the threaded lower extremity of which passes an adjusting screw 99 with its point bearing against the plate 96, and having a horizontal arm 100 through the perforated extremity of which passes the lower end of the bolt 91 below the nut 92.

In assembling the parts the two levers are first pivoted into position; then the tube 89, containing the rod 90 and the bolt 91, is screwed into the lower part 87, causing the lower end of the bolt to pass through the arm 100; and then the upper part 93 is screwed into the lower part.

Suppose it is desired to have the water passing through the tube 41 heated to a temperature of say 150°, the tube 89 expands longitudinally upward, but the rod 90 does not expand. The spring 86, however, acting on the head 85, is now effective to force the lever 95 inward, and this in turn through the screw 99 forces the arm 98 inward and the arm 100 upward. Consequently the arm 100, bearing against the nut 92, forces the rod upward just as far and as rapidly as the expansion of the tube 89 will permit. The result is that the head 85 gradually moves the stem 83 and the valve 84 so as to partially check the flow of gas through the seat 81 to the burners 17. With less fuel for the burners, the temperature in the tube 41 tends to fall below 150°. But a fall of temperature causes the tube 89 to contract somewhat, resulting in the rod 90, the bolt 91, the nut 92 and the arm 100 being carried downward, so as to force outward the arm 98, the screw 99, the lever 95 and the head 85, thus compressing the spring 86 and more fully opening the valve 84. With a larger inflow of gas the heat in the tube again tends to increase. These two opposing tendencies establish an approximate equilibrium and maintain a temperature within a few degrees of the assumed temperature. By properly adjusting the nut 92 and the screw 99, the temperature to be maintained can be varied as desired.

The disk valve chamber 43 consists of two parts: The upper part 101 has just below its top, into which the threaded end of the pipe 42 is screwed, a narrow passage and just below that passage the main part of the chamber of considerably greater diameter so that a flat valve seat 102 is formed. The part 101 is also flanged at the bottom. A disk valve 103 is adapted to close from beneath the seat 102, but may be rotated from its horizontal closing position by the withdrawal of water from the part of the chamber underneath it. The valve is firmly secured at one side and below the seat 102 to a shaft 104, which is journaled in the part 101 and is provided near one end where it emerges from the chamber with a stuffing box and gland 105. After the valve has been secured to the shaft, a lower part 106 is bolted on to the flange of the upper part 101 and subsequently has screwed into it the first part of the pipe 44. A bracket support 107 is screwed at its lower end to the part 101 near its flange and has screwed to its top an insulating bracket 108. Screwed

to the bracket 108 is a somewhat rigid depending copper strip 109, having a horizontal and preferably silvered contact knob 110 at its lower end. Also screwed to the bracket 108 is a somewhat more flexible and longer copper strip 111, having near its lower end a preferably silvered contact 112, adapted to make contact with the knob 110 but normally kept away therefrom as will appear, and also having on the same side at its lower end a small insulating plate 113. Firmly secured to the extreme outside end of the shaft 104 is a bell crank lever having an upper arm 114 normally vertical and a lower arm 115 making an angle of 135° with the upper arm. The arm 114, slightly curved at its top, normally bears against the plate 113 in such manner as to keep the contact 112 out of contact with the knob 110. A tension spring 116 is secured at one end to the flange of the part 101 and at its other end to the outer extremity of the arm 115. The parts are so constructed and positioned that the spring 116 is normally operative to keep the arm 114 vertical and the contact 112 out of contact with the knob 110, and also, acting through the shaft 104, to keep the valve 103 closing the seat 102, as shown in Fig. 3. But upon opening any faucet 45, water is drawn from beneath the valve 103, tending to create a vacuum underneath, there also being water pressure above it, and the valve and the shaft 104 are consequently turned through an angle. Consequently the arm 115 is rotated and the spring 116 is stretched; and the arm 114 is also rotated away from the plate 113 so that the resiliency of the strip 111 brings the contact 112 into contact with the knob 110. This condition of contact continues until the flow of water from the pipe 44 ceases, allowing the spring 116 to bring all parts back to their normal positions as before described.

From any source of electrical supply such as a battery 117 a wire 118 leads to the strip 109. From the strip 111 a wire 119 leads to the coil 56. From the coil 56 a wire 120 leads to the piece 68. From the piece 68 a wire 121 returns to the battery 117.

Having already described the modes of operation of the several subordinate combinations, it remains necessary to describe only the general mode of operation of the heater as a whole. It is assumed that the button 80 has been pushed in, that the pilot burner 40 has been lighted, and that the rod 65 has expanded sufficiently to keep in contact the contact 70 and the piece 68. Hot water is now desired. Obviously the flame from the burner 40 has no perceptible heating effect. Any faucet such as 45 is opened. The outflow of water closes the contact between the knob 110 and the contact 112. Thereupon a current flows from the battery 117, through the wire 118, the strip 109, the

knob 110, the contact 112, the strip 111, the wire 119, the solenoid coil 56, the wire 120, the piece 68, the contact 70, the piece 69 and the wire 121 back to the battery 117. The consequent energization of the solenoid coil lifts the core 51 and delivers a hammer blow on the pin 52 so as to suddenly lift the stem 47 and the valve 46 in opposition to the spring 49. The resulting rush of gas through the valve seat 34 emerges from the openings in the tops of the burners 17. This gas is ignited from the pilot flame. The great heat then instantaneously heats the water flowing through the liquid chamber 25, whence it passes through the connected passages and the open faucet. This condition normally continues so long as the faucet remains open. The throttling valve 84 maintains an approximate constant temperature in the manner previously described. The products of combustion normally pass through the vent 22, the opening 28 and the upper hood 29 into the chimney. But in case of a back draft, these products temporarily pass out into the room through the openings at the bases of the hoods 29 and 27. The closing of all the faucets 45 breaks the electric circuit by breaking contact between the knob 110 and the contact 112. Consequently the solenoid coil 56 is de-energized and the valve 46 closes the seat 34. The flame from the main burners 17 goes out and the heating of the water ceases. But suppose, prior to the turning on of a faucet, the pilot flame has gone out. This results in the contact between the contact 70 and the piece 68 being broken. Consequently the turning on of any faucet cannot close a circuit to energize the solenoid coil 56. It thus is impossible to flood a room with gas in case the pilot flame is not burning.

We claim:

1. In combination a liquid chamber, a burner for heating said chamber, two pieces normally in constant contact with each other and when in contact permitting the operation of said burner, an igniting device when in normal condition operative for lighting said burner but when in abnormal condition operating to break such contact of said pieces, and means operating in case said pieces are in such contact and when liquid is drawn from said chamber to supply fuel to said burner and when such drawing ceases to shut off such supply.

2. In combination a liquid chamber, a main burner for heating said chamber, two pieces normally in constant contact with each other and when in contact permitting the operation of said burner, a pilot burner device when burning operative for lighting said main burner but when extinguished operating to break such contact of said pieces, and means operating in case such

pieces are in such contact and when liquid is drawn off from said chamber to supply fuel to said main burner and when such drawing ceases to shut off such supply.

5 3. In combination a liquid chamber, a burner for heating said chamber, two pieces normally in constant electric contact with each other, an igniting device when in normal condition operative for lighting said
10 burner but when in abnormal condition operating to break such contact of said pieces, and electrically operated means in series with said pieces when in such contact
15 and then operating when liquid is drawn from said chamber to supply fuel to said burner and when such drawing ceases to shut off such supply.

4. In combination a liquid chamber, a main burner for heating said chamber, two
20 pieces normally in constant electric contact with each other, a pilot burner device when burning operative for lighting said main burner but when extinguished operating to break such contact of said pieces, and electrically operated means in series with said
25 pieces when in such contact and then operating when liquid is drawn from said chamber to supply fuel to said main burner and when such drawing ceases to shut off such
30 supply.

5. In combination a liquid chamber, a burner for heating said chamber, conductors to and from a source of electric power, two
35 switches in said conductors, the first being normally constantly closed and the second being initially open, an igniting device when in normal condition operative for lighting said burner but when in abnormal condition
40 operating to open said first switch, an electrically operated device in series with said conductors and operating while energized to supply fuel to said burner, and means operating when liquid is drawn from said chamber to close said second switch and when
45 such drawing ceases to open said second switch.

6. In combination a liquid chamber, a main burner for heating said chamber, conductors to and from a source of electric
50 power, two switches in said conductors, the first being normally constantly closed and the second being initially open, a pilot burner device when burning operative for lighting said main burner but when extinguished operating to open said first switch,
55 an electrically operated device in series with said conductors and operating while energized to supply fuel to said burner, and means operating when liquid is drawn from said chamber to close said second switch and when such drawing ceases to open said second
60 switch.

7. In combination a liquid chamber, a burner operating when burning to heat said
65 chamber, a valve for admitting or excluding

a fuel supply to said burner and initially closed, conductors to and from a source of electric power, two switches in said conductors, the first being closed while the elements are in operative condition and the
70 second being initially open, a device operating during a flow of current in said conductors to open and to keep open said valve, means operating in case both switches are closed to cause said burner to burn, means
75 operating, in case said first switch is closed, when liquid is drawn from said chamber to close said second switch and when such drawing ceases to open said second switch, and means operating to open said first switch
80 in case some of the elements are in abnormal condition.

8. In combination a liquid chamber, a burner operating when burning to heat said chamber, a valve for admitting or excluding
85 a fuel supply to said burner and initially closed, conductors to and from a source of electric power, two switches in said conductors, the first being closed while the elements are in operative condition and the
90 second being initially open, a device operating during a flow of current in said conductors to open and to keep open said valve, means operating in case both switches are closed to cause said burner to burn, means
95 actuated, in case said first switch is closed, by the flow of liquid from said chamber to close said second switch and operating upon the cessation of the flow of such liquid to open said second switch, and means operating
100 to open said first switch in case some of the elements are in abnormal condition.

9. In combination a liquid chamber, a pipe in series with said chamber, a burner operating when burning to heat said chamber, a
105 valve for admitting or excluding a fuel supply to said burner and initially closed, conductors to and from a source of electric power, two switches in said conductors, the first being closed while the elements are in
110 operative condition, and the second being initially open, a device operating during a flow of current in said conductors to open and to keep open said valve, means operating in case both switches are closed to cause
115 said burner to burn, a device in said pipe actuated, in case said first switch is closed, by a flow of liquid in said pipe to close said second switch and to keep it closed during the continuance of such flow, and means
120 operating to open said first switch in case some of the elements are in abnormal condition.

10. In combination a liquid chamber, a pipe in series with said chamber, a burner
125 operating when burning to heat said chamber, a valve for admitting or excluding a fuel supply to said burner and initially closed, conductors to and from a source of electric power, two switches in said con-
130

ductors, the first being closed while the elements are in operative condition and the second being initially open, a device operating during a flow of current in said conductors to open and to keep open said valve, means operating in case both switches are closed to cause said burner to burn, a water valve initially closing said pipe but operating, in case said first switch is closed, by being opened by a withdrawal of liquid to close said second switch and to keep it closed during the continuance of such withdrawal, and means operating to open said first switch in case some of the elements are in abnormal condition.

11. In combination a liquid chamber, a main burner for heating said chamber, a pilot burner having its outlet near the outlet of said main burner, two pieces normally in contact with each other, means operating in case of such contact of said pieces when liquid is drawn off from said chamber to supply fuel to said main burner and when liquid ceases to be drawn from said chamber to shut off such supply, and means operating in case such contact of said pieces is broken to prevent a supply of fuel to said pilot burner and upon a lighting of said pilot burner operating to permit such supply.

12. In combination a liquid chamber, a main burner for heating said chamber, a pilot burner having its outlet near the outlet of said main burner, two pieces normally in contact with each other, means operating in case of such contact of said pieces when liquid is drawn from said chamber to supply fuel to said main burner and when liquid ceases to be drawn from said chamber to shut off such supply, and means operating in case such contact of said pieces is broken to prevent a supply of fuel to both burners and upon a lighting of said pilot burner operating to permit such supply.

13. In combination a liquid chamber, a main burner for heating said chamber, a valve for admitting or excluding a fuel supply to said burner, a pilot burner having its outlet near the outlet of said main burner, two pieces normally in contact with each other, means operating in case of such contact of said pieces when liquid is drawn from said chamber to cause said valve to open and when liquid ceases to be drawn from said chamber to result in the closing of said valve, and means operating in case such contact of said pieces is broken to prevent a supply of fuel to said pilot burner and upon a lighting of said pilot burner operating to permit such supply.

14. In combination a liquid chamber, a main burner for heating said chamber, a valve for admitting or excluding a fuel supply to said burner, a pilot burner having its outlet near the outlet of said main burner,

two pieces normally in contact with each other, means operating in case of such contact of said pieces when liquid is drawn from said chamber to cause said valve to open and when liquid ceases to be drawn from said chamber to result in the closing of said valve, and a thermostat actuated by heat from said pilot burner to maintain such contact but operating if said pilot burner is extinguished to break such contact and to prevent a supply of fuel to said pilot burner and upon a lighting of said pilot burner operating to permit such supply.

15. In combination a liquid chamber, a main burner for heating said chamber, a valve for admitting or excluding a fuel supply to said burner, a pilot burner having its outlet near the outlet of said main burner, two pieces normally in contact with each other, means operating in case of such contact of said pieces when liquid is drawn from said chamber to cause said valve to open and when liquid ceases to be drawn from said chamber to result in the closing of said valve, and a thermostat actuated by heat from said pilot burner to maintain such contact but operating if said pilot burner is extinguished to break such contact and to prevent a supply of fuel to both burners and upon a lighting of said pilot burner operating to permit such supply.

16. In combination a liquid chamber, a main burner for heating said chamber, a pilot burner having its outlet near the outlet of said main burner, two pieces adapted to make or break an electric contact, means actuated in case of such contact of said pieces by the flow of liquid from said chamber to supply fuel to said main burner and operating upon the cessation of such flow to shut off such supply, and means operating in case such contact is broken to prevent a supply of fuel to both burners.

17. In combination a liquid chamber, a main burner for heating said chamber, a valve for admitting or excluding a fuel supply to said burner, a pilot burner having its outlet near the outlet of said main burner, two pieces normally in contact with each other, means actuated in case of such contact of said pieces by the flow of liquid from said chamber to cause said valve to open and operating upon the cessation of such flow to result in the closing of said valve, and means operating in case such contact is broken to prevent a supply of fuel to said pilot burner and upon a lighting of said pilot burner operating to permit such supply.

18. In combination a liquid chamber, a main burner for heating said chamber, a valve for admitting or excluding a fuel supply to said burner, a pilot burner having its outlet near the outlet of said main burner, two pieces normally in contact with each other, means actuated in case of such con-

tact of said pieces by the flow of liquid from said chamber to cause said valve to open and operating upon the cessation of such flow to result in the closing of said valve, and a
 5 thermostat actuated by heat from said pilot burner to maintain such contact but operating if said pilot burner is extinguished to break such contact and to prevent a supply of fuel to said pilot burner and upon a lighting of said pilot burner operating to permit
 10 such supply.

19. In combination a liquid chamber, a main burner operating when burning to heat said chamber, a pilot burner having
 15 its outlet near the outlet of said main burner, conductors to and from a source of electric power, two switches in said conductors, the first being normally closed and the second initially open, means operating in case both
 20 switches are closed to supply fuel to said main burner, means operating in case said first switch is closed when liquid is drawn from said chamber to close said second switch and when such closing ceases to open
 25 said second switch, and means operating in case said first switch is open to prevent a supply of fuel to both burners.

20. In combination a liquid chamber, a main burner operating when burning to heat said chamber, a valve for admitting or
 30 excluding a fuel supply to said burner, a pilot burner having its outlet near the outlet of said main burner, conductors to and from a source of electric power, two switches in said conductors, the first being normally
 35 closed and the second initially open, means operating in case both switches are closed to cause said valve to open, means operating in case said first switch is closed when liquid is drawn from said chamber to close said
 40 second switch and when such drawing ceases to open said second switch, and means operating in case said first switch is open to prevent a supply of fuel to said pilot burner.

21. In combination a liquid chamber, a main burner operating when burning to heat said chamber, a valve for admitting or
 45 excluding a fuel supply to said burner, a pilot burner having its outlet near the outlet of said main burner, conductors to and from a source of electric power, two switches in said
 50 conductors, the first being normally closed and the second initially open, means operating in case both switches are closed to cause said valve to open, means operating in case said first switch is closed when liquid is drawn from said chamber to close said
 55 second switch and when such drawing ceases to open said second switch, and a thermostat actuated by heat from said pilot burner to keep said first switch closed but operating to open it if said pilot burner is
 60 extinguished.

22. In combination a liquid chamber, a
 65 main burner operating when burning to heat

said chamber, a pilot burner having its outlet near the outlet of said main burner, conductors to and from a source of electric power, two switches in said conductors, the first being normally closed and the second
 70 initially open, means operating in case both switches are closed to supply fuel to said main burner, means actuated in case said first switch is closed by the flow of liquid from said chamber to close said switch and operating
 75 upon the cessation of such flow to open said second switch, and means operating in case said first switch is open to prevent a supply of fuel to both burners.

23. In combination a liquid chamber, a main burner operating when burning to heat
 80 said chamber, a valve for admitting or excluding a fuel supply to said burner, a pilot burner having its outlet near the outlet of said main burner, conductors to and from a source of electric power, two switches in
 85 said conductor, the first being normally closed and the second initially open, means operating in case both switches are closed to cause said valve to open, means actuated in case said first switch is closed by the flow of liquid from said chamber to close said
 90 second switch and operating upon the cessation of such flow to open said second switch, and means operating in case said first switch is open to prevent a supply of fuel to said
 95 pilot burner.

24. In combination a liquid chamber, a main burner operating when burning to heat said chamber, a valve for admitting or
 100 excluding a fuel supply to said burner, a pilot burner having its outlet near the outlet of said main burner, conductors to and from a source of electric power, two switches in said conductors, the first being
 105 normally closed and the second initially open, means operating in case both switches are closed to cause said valve to open, means actuated in case said first switch is closed by the flow of liquid from said chamber to close said second switch and operating upon
 110 the cessation of such flow to open said second switch, and a thermostat actuated by heat from said pilot burner to keep said first switch closed but operating to open it if said pilot burner is extinguished.
 115

25. In combination a liquid chamber, a pipe in series with said chamber, a main burner operating when burning to heat said
 120 chamber, a pilot burner having its outlet near the outlet of said main burner, conductors to and from a source of electric power, two switches in said conductors, the first being normally closed and the second initially open, means operating in case both
 125 switches are closed to supply fuel to said main burner, a device in said pipe actuated in case said first switch is closed by a flow of liquid in said pipe to close said second switch and to keep it closed during the con-
 130

tinuance of such flow, and means operating in case said first switch is open to prevent a supply of fuel to both burners.

26. In combination a liquid chamber, a pipe in series with said chamber, a main burner operating when burning to heat said chamber, a valve for admitting or excluding a fuel supply to said burner, a pilot burner having its outlet near the outlet of said main burner, conductors to and from a source of electric power, two switches in said conductors, the first being normally closed and the second initially open, means operating in case both switches are closed to cause said valve to open, a device in said pipe actuated in case said first switch is closed by a flow of liquid in said pipe to close said second switch and to keep it closed during the continuance of such flow, and means operating in case said first switch is open to prevent a supply of fuel to said pilot burner.

27. In combination a liquid chamber, a pipe in series with said chamber, a main burner operating when burning to heat said chamber, a valve for admitting or excluding a fuel supply to said burner, a pilot burner having its outlet near the outlet of said main burner, conductors to and from a source of electric power, two switches in said conductors, the first being normally closed and the second initially open, means operating in case both switches are closed to cause said valve to open, a device in said pipe actuated in case said first switch is closed by a flow of liquid in said pipe to close said second switch and to keep it closed during the continuance of such flow, and a thermostat actuated by heat from said pilot burner to keep said first switch closed but operating to open it if said pilot burner is extinguished.

28. In combination a liquid chamber, a pipe in series with said chamber, a main burner operating when burning to heat said chamber, a pilot burner having its outlet near the outlet of said main burner, conductors to and from a source of electric power, two switches in said conductors, the first being normally closed and the second initially open, means operating in case both switches are closed to supply fuel to said main burner, a water valve initially closing said pipe but operating in case said first switch is closed by being opened by a withdrawal of liquid to close said second switch and to keep it closed during the continuance of such withdrawal, and means operating in case said first switch is open to prevent a supply of fuel to both burners.

29. In combination a liquid chamber, a pipe in series with said chamber, a main burner operating when burning to heat said chamber, a valve for admitting or excluding a fuel supply to said burner, a pilot

burner having its outlet near the outlet of said main burner, conductors to and from a source of electric power, two switches in said conductors, the first being normally closed and the second initially open, means operating in case both switches are closed to cause said valve to open, a water valve normally closing said pipe but operating in case said first switch is closed by being opened by a withdrawal of liquid to close said second switch and to keep it closed during the continuance of such withdrawal, and means operating in case said first switch is open to prevent a supply of fuel to said pilot burner.

30. In combination a liquid chamber, a pipe in series with said chamber, a main burner operating when burning to heat said chamber, a valve for admitting or excluding a fuel supply to said burner, a pilot burner having its outlet near the outlet of said main burner, conductors to and from a source of electric power, two switches in said conductors, the first being normally closed and the second initially open, means operating in case both switches are closed to cause said valve to open, a water valve normally closing said pipe but operating in case said first switch is closed by being opened by a withdrawal of liquid to close said second switch and to keep it closed during the continuance of such withdrawal, and a thermostat actuated by heat from said pilot burner to keep said first switch closed but operating to open it if said pilot burner is extinguished.

31. In combination a liquid chamber, a main burner for heating said chamber, a fuel supply pipe leading to said burner, a pilot burner having its outlet near the outlet of said main burner and having a supply inlet separate from said pipe, a valve for admitting or excluding a fuel supply through said pipe, a switch normally constantly closed and operating when closed to permit of said valve being opened, and means whereby the drawing of liquid from said chamber causes said valve to open if said switch is closed and the cessation of such drawing causes said valve to close.

32. In combination a liquid chamber, a casing containing said chamber, a main burner for heating said chamber, a fuel supply pipe leading to said burner, a pilot burner having its outlet near the outlet of said main burner and having a supply inlet separate from said pipe, a valve for admitting or excluding a fuel supply through said pipe, a switch normally constantly closed and operating when closed to permit of said valve being opened, means whereby the drawing of liquid from said chamber causes said valve to open if said switch is closed and the cessation of such drawing causes said valve to close, an outlet pipe from said

chamber exterior to said casing, and a thermostat in said outlet pipe operative to prevent the heat of the liquid so drawn from exceeding a predetermined limit.

- 5 33. In combination a liquid chamber, a main burner for heating said chamber, a pilot burner having its outlet near the outlet of said main burner, a pipe leading to said pilot burner, a rotary valve controlling
10 said pipe and having a stem extending outside of the pipe, a pinion secured to the outer end of said stem, a rack member tending to act on said pinion so as to close said valve, means for temporarily overcoming the tendency of said member so as to open said valve,
15 a thermostatic device when said pilot burner

is burning operatively positioned so as to hold said member in the position caused by operating said means and when said pilot burner is extinguished releasing said member, and means operating when said device is so operatively positioned and when liquid is drawn from said chamber to permit a supply of fuel to said main burner and when liquid ceases to be drawn from said chamber to shut off such supply. 20 25

GEORGE P. CARROLL.
FRANK N. ROEHRICH.

Witnesses:

WILLIAM REYNOLDS,
JOHN E. PRAGER.