No. 672,338.

Patented Apr. 16, 1901.

J. V. STOUT.

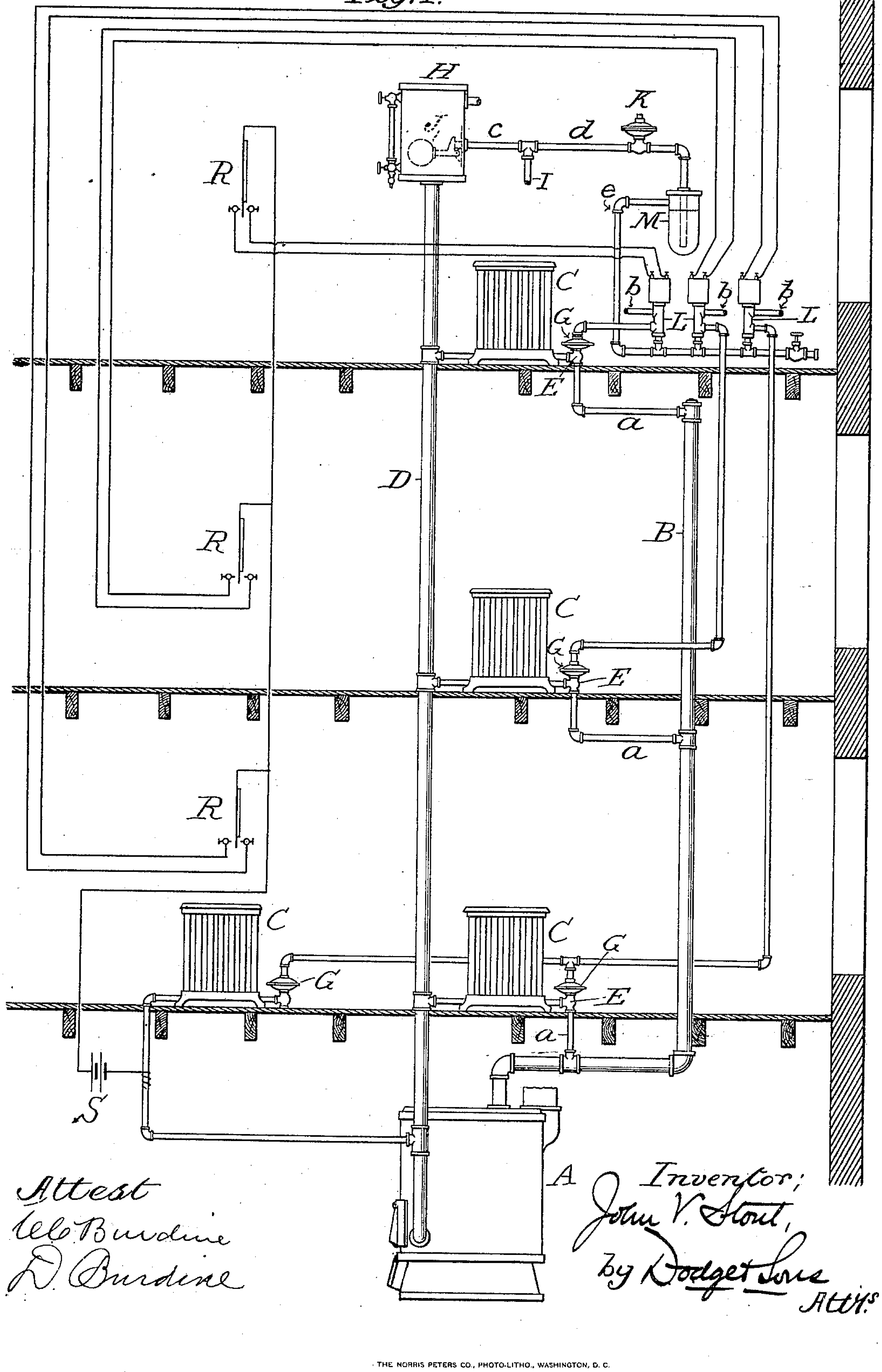
TEMPERATURE REGULATING APPARATUS.

(Application filed Aug. 17, 1896.)

(No Model.)

6 Sheets—Sheet 1.

Fig. 1.

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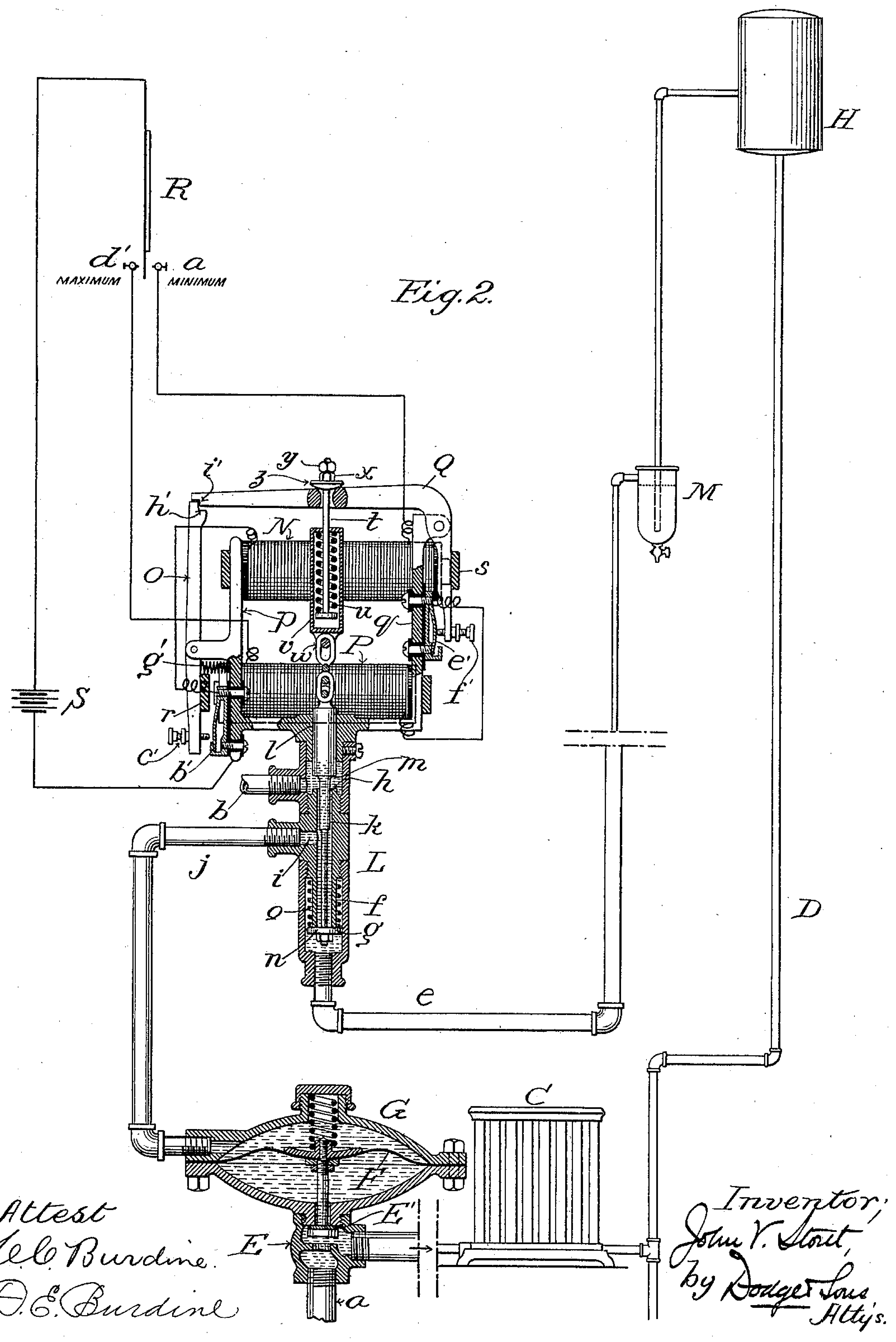


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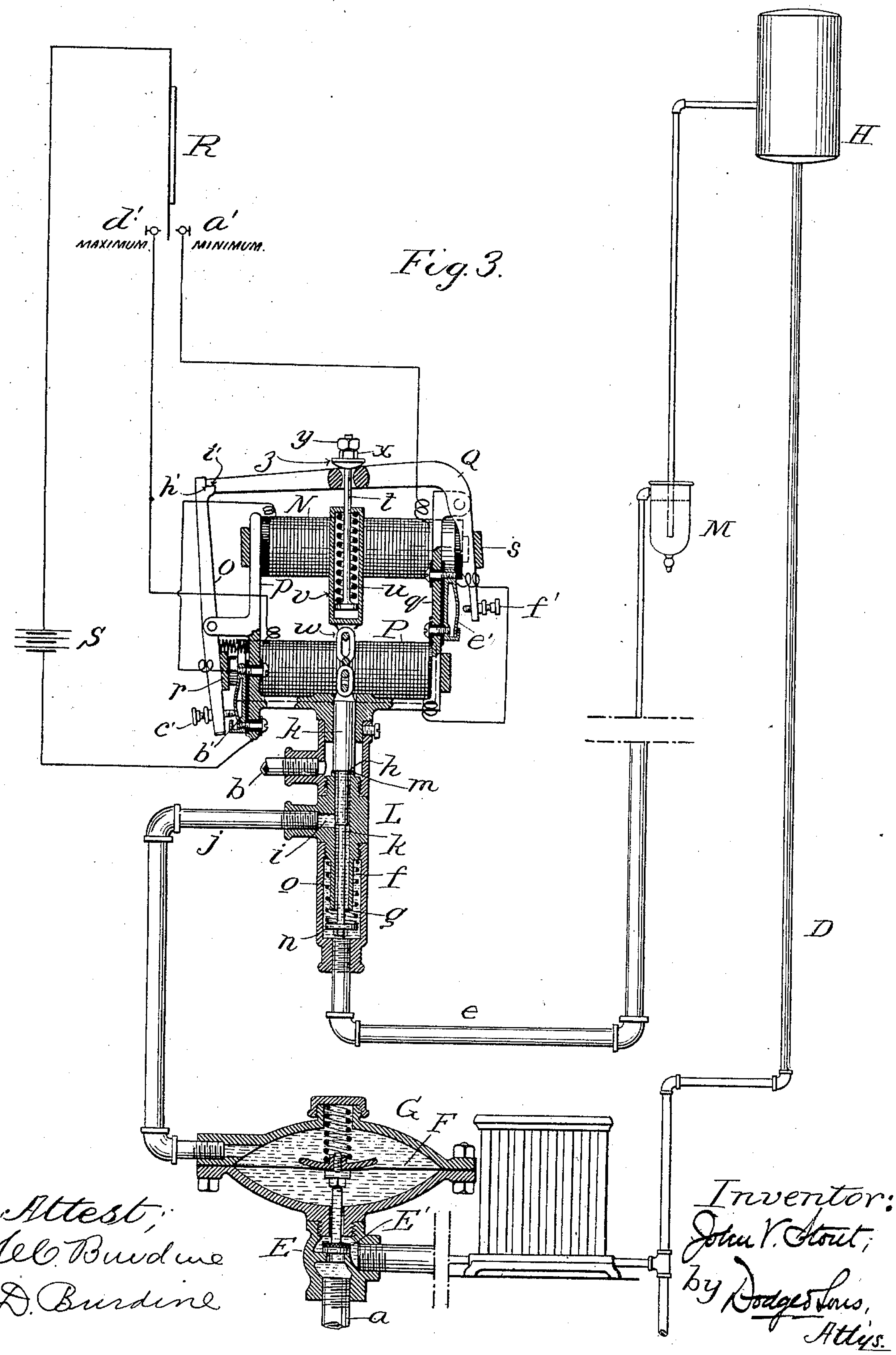
(No Model.) 6 Sheets—Sheet 3.

Fig. 3.

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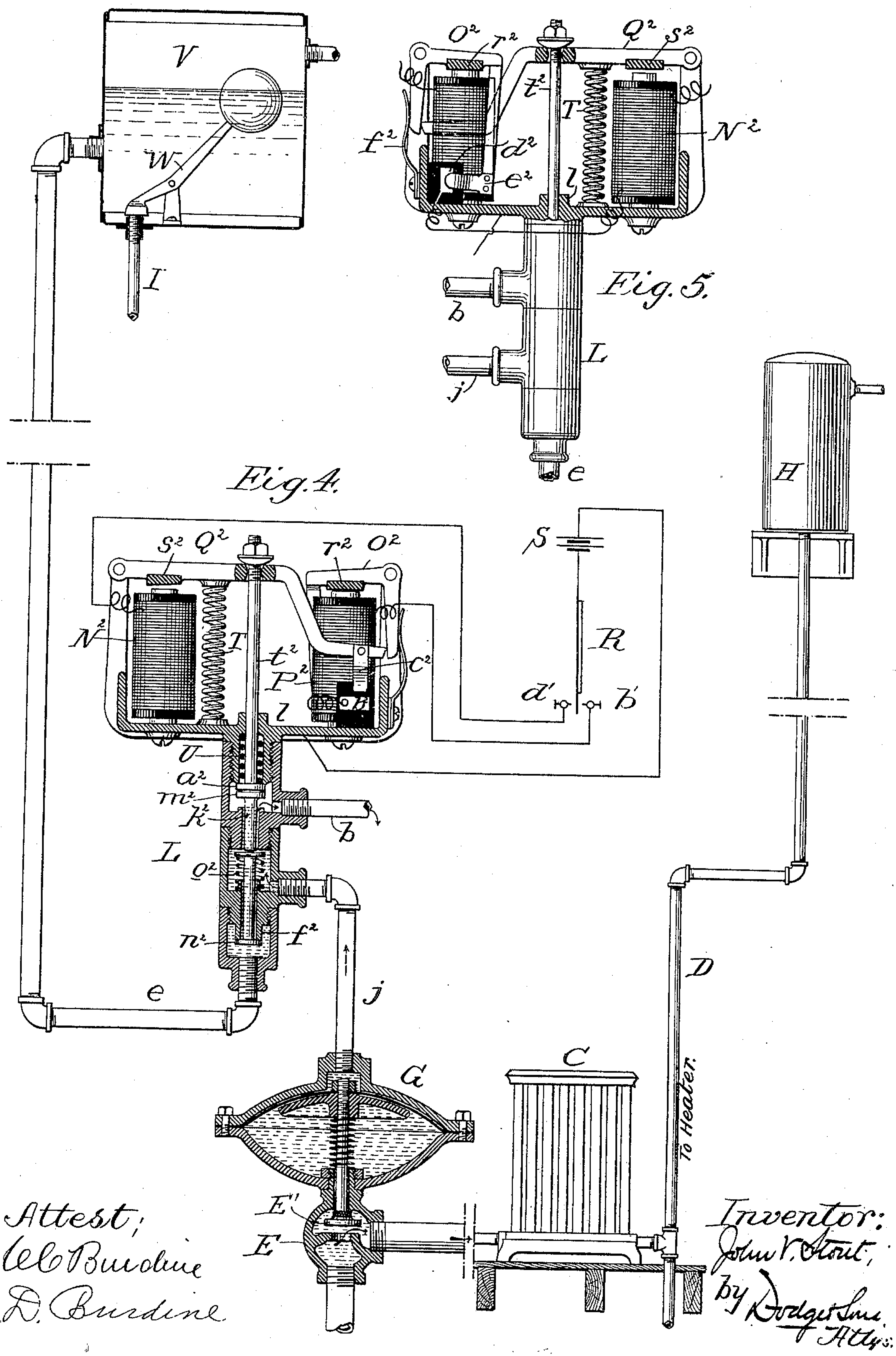
6 Sheets—Sheet 4.

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**TEMPERATURE REGULATING APPARATUS.**

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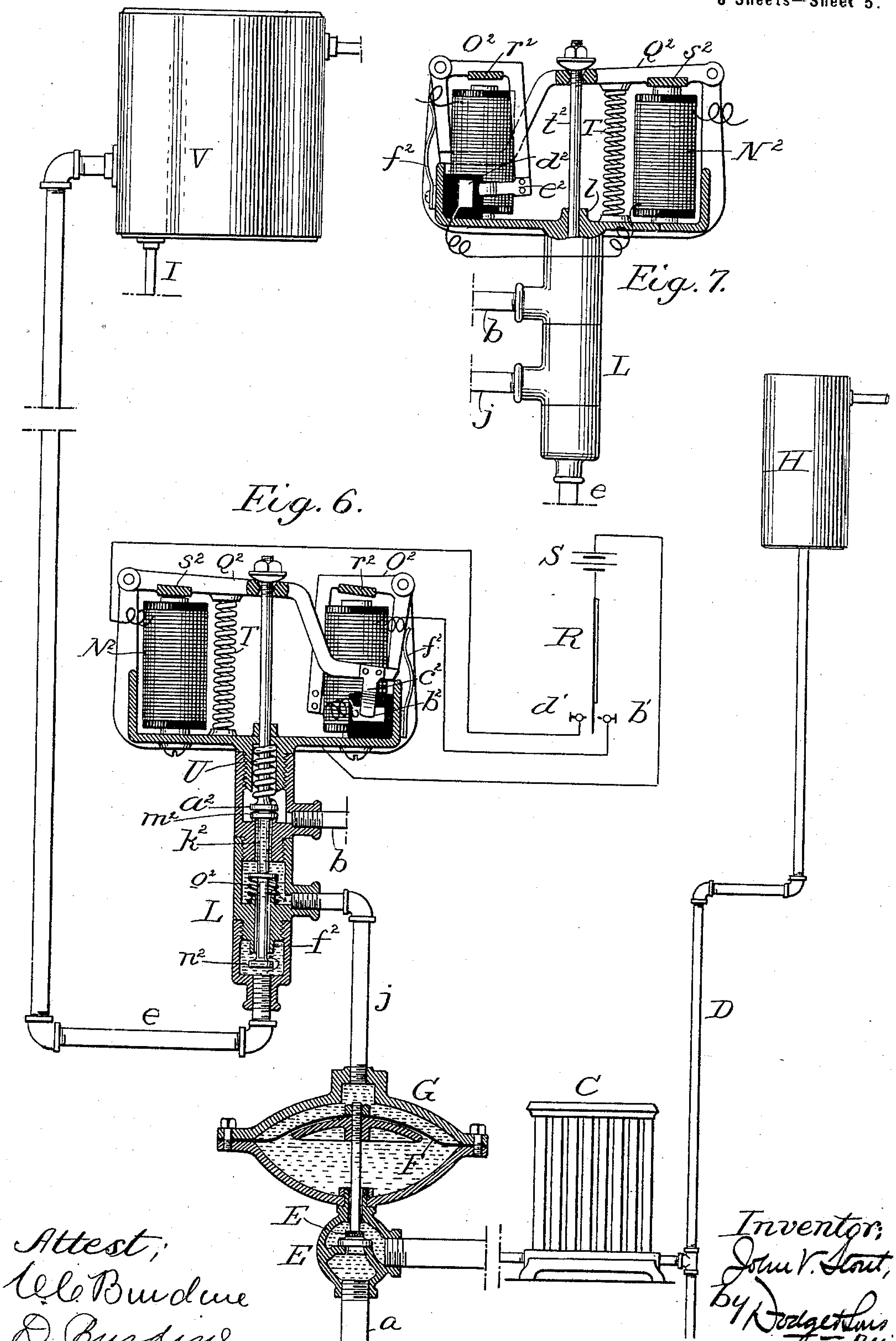
(No Model.) 6 Sheets—Sheet 5.

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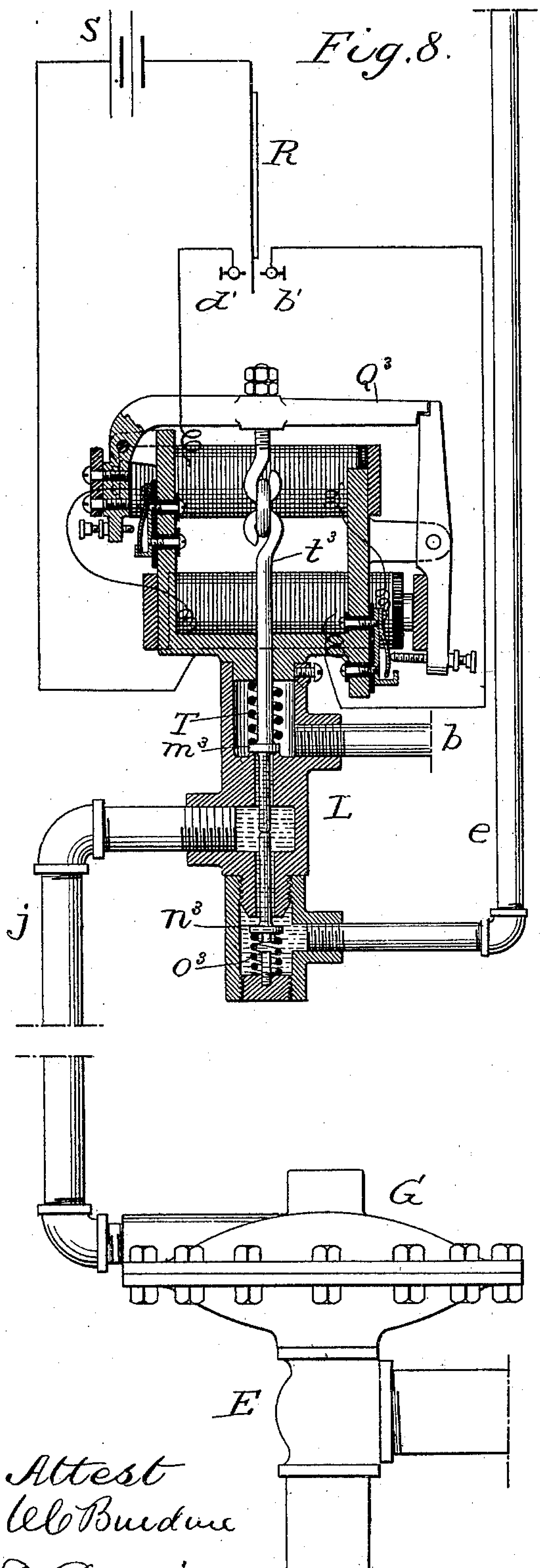
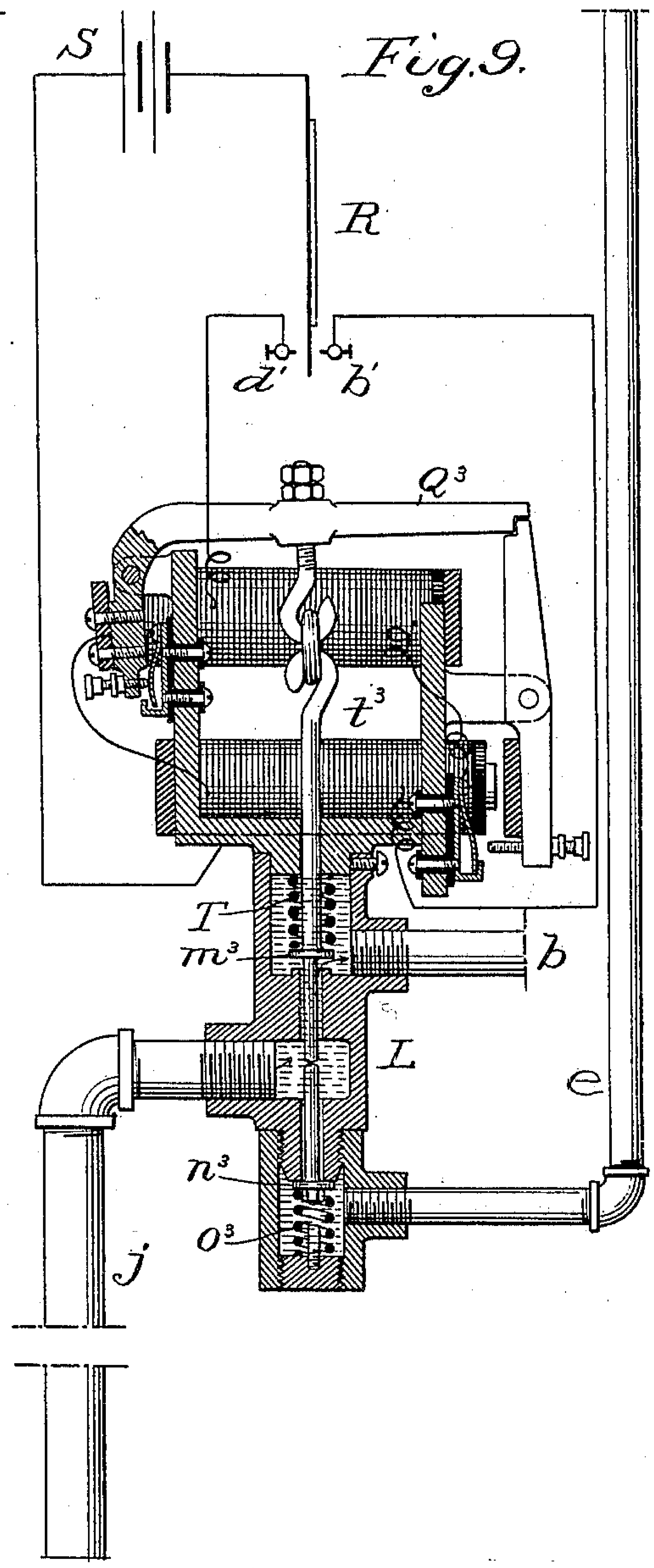
(No Model.) 6 Sheets—Sheet 6.

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# UNITED STATES PATENT OFFICE.

JOHN V. STOUT, OF EASTON, PENNSYLVANIA.

## TEMPERATURE-REGULATING APPARATUS.

SPECIFICATION forming part of Letters Patent No. 672,338, dated April 16, 1901.

Application filed August 17, 1896. Serial No. 602,969. (No model.)

*To all whom it may concern:*

Be it known that I, JOHN V. STOUT, a citizen of the United States, residing at Easton, in the county of Northampton and State of Pennsylvania, have invented certain new and useful Improvements in Temperature-Regulating Apparatus, of which the following is a specification.

My invention pertains to that system of heating in which hot water is employed as the medium of transmission and distribution; and it consists in a novel construction and arrangement of actuating and regulating or controlling devices for the radiator-valves, whereby I am enabled to employ valves devoid of packing, and consequently capable of actuation by the expenditure of very slight power.

The invention comprises various novel features, details, and combinations hereinafter set forth, all directed to the successful attainment of the result above mentioned.

In the drawings I have illustrated several modifications of the apparatus with a view to showing that it may be varied considerably in detail without departing from the spirit of my invention.

Figure 1 is a diagrammatic elevation of a building equipped with my apparatus; Figs. 2 and 3, sectional elevations of the thermostatic devices and one of the radiator-valves, on a larger scale, showing the parts in their two positions. Fig. 4 is a similar view of a modified form of the apparatus, showing the radiator-valve open; Fig. 5, an elevation of the electrical devices of Fig. 4 as seen from the opposite side; Fig. 6, a view similar to Fig. 5, but showing the radiator-valve closed; Fig. 7, a view of the opposite side of the electrical devices as they appear under this adjustment of parts; Figs. 8 and 9, sectional elevations showing another form of the mechanism under its two adjustments.

As is well known, a serious objection urged against automatic temperature-regulating apparatus for controlling the valves of hot-water systems of heating and one having more or less basis in fact, is the difficulty of maintaining perfectly tight joints about the stems of the radiator-valves owing to the frequent adjustment thereof. A like condition has been encountered in connection with the auxiliary valves used to control the action of the main-valve motor, with steam or water as the actuating fluid. In attempting to obviate this difficulty stuffing-glands are usually provided; but these involve so much friction upon the valve-stems as seriously to interfere with the actuation of the valves by automatic means, the power of which must necessarily be limited if the apparatus is to be kept within reasonable proportions and operated without undue expense. To enable me to dispense entirely with packing or stuffing glands, I inclose the main-valve stem within a fluid-pressure chamber completely closed to the atmosphere and containing a flexible diaphragm or a piston subject to variable or differential pressure on opposite faces, and by thus arranging the diaphragm between two opposing water columns I am enabled to obviate the danger of rupture incident to the application of pressure to one side of the diaphragm only.

The invention will be readily understood when explained in connection with the accompanying drawings.

Referring first to Figs. 1, 2, and 3, A indicates a water heater or boiler of any approved construction; B, its outflow-pipe; C, a radiator, of which there may be any desired number, each connected with the outflow or supply pipe by a branch *a*, and D a return-pipe in communication with several radiators and serving to carry the water back to the boiler A, as usual. Each radiator is furnished with a main valve E, the stem of which is preferably attached to or connected with a flexible diaphragm F within a shell or pressure-chamber G, as seen in Figs. 2 and 3, though a piston fitting within a cylinder may be employed.

At a suitable point in the system there is provided an expansion-tank H, shown in the drawings at the top of return-pipe D.

The radiator-valves E may be made to open or to close by the automatic mechanism about to be described, though I have represented them as arranged to be closed thereby. A spring or weight may be employed to move or to assist in moving the valve in one direction. Positive connection of the valve-stem and diaphragm will not be necessary when a spring is employed beneath the diaphragm.

The stem of the main valve has a disk E' to close the passage around its stem when the valve is lifted or opened. The object of this is mainly to prevent escape of water from the circulating system when it is found necessary to remove a diaphragm. The valve-stem is enough smaller than the opening through which it moves to permit water to flow around it, yet the fit is sufficiently close to insure proper guidance.

To seat the valves and hold them closed under the arrangements illustrated, I introduce water or fluid into the chamber G above the diaphragm under head or pressure sufficient to overcome the pressure of water beneath the diaphragm. This pressure may be obtained from the circulating body under the head or pressure due to the elevation of the expansion-tank, in which case I prefer to place a spring above the diaphragm, or it may be obtained from a tank at a higher elevation than the expansion-tank, or, lastly, water may be taken from the service-main directly, its pressure reduced or regulated, if need be, by a reducing-valve or equivalent means. In Fig. 1 I have illustrated the last-mentioned plan, which will now be explained. I indicates a water-pipe connected with the service-main, one branch *c* of which pipe connects with and supplies expansion-tank H under the regulation and control of a float-valve J. Another branch *d* of pipe I is furnished with a reducing or pressure-regulating valve K and communicates with a series of auxiliary valves L, each serving to admit water from pipe I to one of the pressure-chambers G or to cut off communication between the pipe and chamber and open a vent or outlet *b* for said chamber sufficiently below the level of the water in the expansion-tank to reduce the pressure above the diaphragm-chamber enough to cause the valve to be lifted by the excess of pressure beneath the motor diaphragm or piston. In the drawings I have shown a filter M interposed between the supply-pipe I and the auxiliary valves, a pipe *e* leading the water into said valves. The filter may be provided or omitted, as desired.

The construction of the auxiliary valve mechanism and of its electric actuating and thermostatic controlling devices is quite similar to that set forth in Letters Patent No. 560,763, granted to me on the 26th day of May, 1896, though modified somewhat for the particular application here in view. Referring to Figs. 2 and 3, the preferred construction of this mechanism will be explained. L indicates the auxiliary valve as a whole—that is to say, its casing, with inlets, outlets, stem, and disk, the casing being conveniently made up of several parts screwed together. Within the casing is a tube or thimble *f*, having a valve-seat *g* at its lower end, a similar seat *h* at its upper end, and an intermediate lateral outlet *i*, as seen in Figs. 2 and 3, said outlet communicating by a pipe *j* with the interior of pressure-chamber or shell G, above the diaphragm F therein. Extending vertically through the thimble *f* is a stem *k*, which is shown of three different diameters in different portions of its length. The upper section is largest and passes out through the head or cap *l* of the valve-casing, the section next below is smaller and occupies that portion of thimble *f* above the lateral outlet *i*, and the lowermost section is smallest and occupies that portion of thimble *f* below the lateral outlet. At the meeting-point of the upper and middle sections there is formed a shoulder *m*, which constitutes a valve or closure for the upper end of the thimble. The lower end of the stem *k* carries a disk *n*, which acts as a valve or closure for the lower end of thimble *f*, this disk being larger in diameter than the valve-seat *g* or lower end of thimble *f*. Encircling the lower portion of thimble *f* and bearing at its upper end against a shoulder thereof is a spiral spring *o*, the lower end of which bears upon disk *n* and tends constantly to hold said disk away from seat *g* and to draw shoulder *m* down upon seat *h*, the length of stem *k* between the disk and the shoulder being somewhat greater than that of the thimble, and consequently preventing the seating of both at once. The water for closing the radiator-valve E is introduced at the lower end of the casing or auxiliary valve L through a pipe *e*, disk *n* of said valve being held normally to its seat by a spring, as hereinafter explained, and closing communication with chamber G. The stem *k* is enough smaller than the bore of thimble *f* to permit the water to flow freely around its lower end to outlet *i* when disk *n* is off its seat or to escape gradually about its middle portion to the vent *b* when disk *n* is seated and the pressure-chamber is to be vented. The upper section of the stem *k* fits closely, yet freely, in the opening through cap *l*, but requires no packing, because the capacity of vent *b* is materially greater than that of the outlet around the middle section of stem *k*, and if the water should pass upward through the thimble with any considerable rapidity it would be thrown laterally by the shoulder *m*, and thus kept away from the cap *l*.

The electrical devices for actuating and thermostatic devices for controlling the auxiliary valve L are also illustrated in Figs. 2 and 3. As there shown, the cap *l* is formed with two uprights or standards *p* and *q*. Standard *p* carries at or near its upper end a horizontal electromagnet N, and pivoted in arms projecting from its side about midway of its height is a lever O, carrying an armature *r*, of soft iron. This armature faces the pole or core of a second electromagnet P, projecting horizontally from the standard *q* toward and past standard *p*. Q indicates an elbow-lever, pivoted at or near the junction of its arms in the upper end of standard *q* and carrying a soft-iron armature *s* opposite the pole or core of magnet N. From the horizontal arm of lever Q there is hung a rod or stem $t$, provided at its lower end with a head or disk and encircled by a spring $u$, the lower end of which rests upon the upper face of said disk. The spring $u$ is surrounded by a shell or casing $v$, the upper end of which rests upon the upper end of the spring, while from its lower end is suspended the stem $k$ of auxiliary valve L by a link or chain connection $w$. This connection, as also the suspension of the rod $t$ from a nut and lock-nut $x$ and $y$ above a washer $z$, resting upon the upper side of lever Q, permits the lever to descend without itself depressing stem $k$, and it also permits said stem $k$ to rise even though lever Q be depressed and held down. Spring $u$, which is stronger than spring $o$, will overcome the latter without being itself compressed until the valve $n$ is seated, and then only sufficiently to permit the locking of the lever. This arrangement insures perfect seating of valve $n$ and full movement of lever Q, both of which are essential to perfect operation of the apparatus. Magnet N has one end or terminal of its coil or helix electrically connected with a contact-screw $a'$ of a thermostatic circuit-closer R and its other end electrically connected with a contact-spring $b'$, carried by but insulated from standard $p$. Lever O carries at its lower end an adjustable contact point or screw $c'$, which when magnet P is energized and armature $r$ is attracted makes contact with contact-spring $b'$ and completes the circuit of magnet N at that point. The spring permits the contact to be made and maintained with certainty, while allowing proper play of lever O after contact is so made. In like manner one end or terminal of the coil or helix of magnet P is electrically connected with a contact screw or stud $d'$ of thermostatic circuit-closer R, while its other end or terminal is electrically connected with a contact-spring $e'$, carried by but insulated from standard $q$. When, therefore, the circuit of magnet N is completed and the magnet is energized, its armature $s$ is attracted and a contact point or screw $f'$, carried by the lever Q, is carried against contact-spring $e'$, thus completing the circuit of magnet P at that point. Levers O and Q being electrically connected with, or, in other words, not insulated from, standards $p$ $q$, and these being a part of cap $l$, which is in metallic contact with the entire pipe system, it follows that if the thermostatic bar of circuit-closer R be connected with one terminal of a battery or other source of electric energy S and the other terminal of said battery or source of electricity be electrically connected with the pipe system or any directly-connected metallic fitting one or the other of the magnets N P will be energized whenever contact is made with screw $a'$ or $d'$, since contact is always made either with spring $b'$ or with spring $e'$. Lever O is provided with a spring $g'$, which tends to throw its lower end outward and its upper end inward, thus carrying its armature away from magnet P and its head beneath the outer end of lever Q. As seen in Figs. 2 and 3, the upper end of lever O is provided with an offset or shoulder $h'$, which limits the descent of lever Q, and lever Q is provided with a shoulder $i'$, which limits the inward movement of the upper end of lever O, the outward movement of each being limited by the pole of its actuating-magnet.

The apparatus being thus constructed operates as follows: The lever Q being first raised and locked in its elevated position by lever O, as seen in Fig. 2, and radiator-valve E being open to permit a free flow of water into and through the radiator, owing to the supply of hot water the temperature of course rises in the apartment in which are located the radiator and thermostat, and this causes the deflection of the thermostatic bar toward the maximum-temperature contact $d'$, which will of course be set to any desired degree. This will cause a circuit to be completed from battery or supply-source S to and through the bar of thermostat R by contact $d'$ and the connected conductor to electromagnet P, through its coil or helix to contact-spring $e'$, thence by point or screw $f$ and lever Q to standard $q$, cap $l$, and the connected pipe system, and, finally, by wire or conductor back to battery or source S. This will cause magnet P to be energized and to attract armature $r$, thus withdrawing the upper end of latch-lever O from beneath the extremity of lever Q and permitting the latter to drop. In thus falling lever Q frees stem $k$ of auxiliary valve L and permits spring $o$ to unseat disk $n$, thereby allowing water to pass from pipe $e$ through thimble $f$ and outlet $i$ to chamber G, above the diaphragm F therein. At the same time the end of the lever Q engages the upper end of lever O and locks it in its outward position, thus insuring maintenance of electrical contact between spring $b'$ and screw $c'$ preparatory to the reverse action of the parts when the temperature falls to a predetermined limit. So, too, the descent of horizontal arm or lever Q causes its depending vertical arm to swing outward and to destroy electrical contact between spring $e'$ and screw $f'$, thus preventing waste of electric current. The parts will then occupy the positions indicated in Fig. 3. Water being thus admitted above diaphragm F and at a pressure sufficient to overcome that of the water beneath the motor diaphragm or piston, valve E is pressed and held to its seat, and thus the delivery of water to the radiator C is prevented. As the water in the radiator cools the temperature of the apartment falls and the thermostatic bar swings away from contact $d'$. If the temperature falls to the predetermined minimum for which contact-screw $a'$ is adjusted, the thermostatic bar will make contact with said screw, and a circuit will then be completed from battery or source S by the thermostat R, contact $a'$, and its connected wire or conductor to the coil or helix of magnet N. After traversing this coil the current passes by contact-spring $b'$ and screw $c'$, then in contact, as in Fig. 3, to standard $p$, and by cap $l$ and a suitable conductor back to battery or source S. In this way magnet N is energized and caused to attract armature $s$, thereby elevating the horizontal arm of lever Q, which is immediately locked in its elevated position by latch-lever O, thrown beneath it by spring $g'$. In thus rising lever Q causes contact to be made between spring $e'$ and screw $f'$ and also draws upward the stem $k$ of auxiliary valve L, seating valve-disk $n$ and unsealing the upper end of thimble $f$ or, in other words, restoring the parts to the first position, as represented in Fig. 2. Communication being thus cut off between shell or pressure-chamber G and pipe $e$ or its source of supply and opened between said chamber and vent-pipe $b$ at a level below that of expansion-tank H, valve E is lifted from its seat by the pressure of the water beneath the diaphragm F, while the water above it escapes through pipe $j$, thimble $f$, and vent or waste pipe $b$ to a sewer or receptacle. In moving inward at its upper end to lock lever Q in its elevated position lever O carries its contact-screw $c'$ away from spring $b'$, and thus at once interrupts the circuit of magnet N, avoiding waste of current after the parts are reset whether contact of the thermostat-bar be continued or broken.

The expansion-tank is represented as fitted with an automatic valve and with an overflow, the latter to pass to the outside of the building or to a sewer as a safeguard against failure of the float-valve. The float-valve is necessary for operation of the motor when the pressure upon the upper side of the diaphragm or piston is taken from the expansion-tank or other part of the heating system. Under other circumstances its use is optional.

In Figs. 2 and 3 a portion of the piping is shown on a reduced scale in order to bring the parts within the required size of drawing and yet show the auxiliary valve mechanism on a scale sufficiently large to permit it to be readily understood.

Referring now to Figs. 4, 5, 6, and 7, a modified form of the apparatus will be explained. The thermostatic devices of this embodiment of the invention quite closely resemble those of my prior patent above referred to, the contacts alone being varied slightly. The pressure is, however, obtained from an elevated water tank or reservoir, in this case independent of and higher than the expansion-tank. In this form of apparatus the lever $Q^2$ is normally lifted by a spring T and is drawn down against the pressure of said spring by a magnet $N^2$, acting upon its armature $s^2$, the stem $t^2$, suspended from said lever, being provided with a disk $a^2$, which seals the opening through which stem $t^2$ passes when said stem is elevated. Stem $t^2$ is disconnected from the valve-stem $k^2$, which latter is made in two sections in axial alinement with stem $t^2$, the three bearing against one another end to end, as shown. The lower section of stem $k^2$ carries a disk $n^2$, which seals the lower end of thimble $f^2$ when lever $Q^2$ is elevated, a spring $o^2$ serving to elevate said section of the stem and to seat said disk. A spring U, encircling the lower end of stem $t^2$, bearing at one end against cap $l$ and at the other against a disk on the lower end of stem $t^2$, serves to carry said stem downward when lever $Q^2$ is depressed and spring U is sufficiently strong to overcome spring $o^2$ and to unseat disk $n^2$. It will thus be seen that when lever $Q^2$ is depressed water may pass from pipe $e$ through the auxiliary valve L to chamber G, seating valve E, and when said lever is elevated communication between pipe $e$ and chamber G is cut off and communication is opened between said chamber and the waste $b$. Pipe $e$ in this case communicates with an elevated tank or reservoir V, the level of water in which is regulated by a float-valve W, applied to the supply-pipe I. The tank V being higher than expansion-tank H, the column of water in pipe $e$ will overcome the resistance or pressure of that in pipes B D and cause the closing of valve E. The lever $Q^2$ being arranged to rise under the action of spring T and to be depressed by the action of electromagnet $N^2$, the circuit connections must of course be changed accordingly with reference to those of Figs. 1, 2, and 3. These connections will be pointed out in connection with Figs. 4 and 5 and Figs. 6 and 7. S indicates the battery or source of electric energy, R the thermostat, and $b'$ $d'$, respectively, the contacts against which the thermostat-bar presses as the minimum or the maximum limit is reached. From one terminal of the battery or source S a conductor passes to the cap $l$ or to the connected pipe system. From contact $b'$ a wire or conductor passes to and connects with one end of the coil or helix of magnet $P^2$, the other end of said coil being electrically connected with a contact-plate $b^2$, carried by, but insulated from, cap $l$. Lever $Q^2$ is provided with a contact-finger $c^2$, which makes contact with plate $b^2$ when the lever is depressed, as in Fig. 6, so that current may then pass from battery S to and through the winding of magnet $P^2$, thence by contacts $b^2$ $c^2$ and lever $Q^2$ to the cap $l$ and back to battery, causing armature $r^2$ to be attracted and latch-lever $O^2$ to be withdrawn from locking engagement with lever $Q^2$, which will then rise under the influence of spring T, as illustrated in Fig. 4, assuming, of course, that contact be made between the bar of thermostat R and its contact $b'$. Contact will be broken between $b^2$ and $c^2$ by the rise of lever $Q^2$. From contact $d'$ a wire or conductor passes to and connects with one end of the coil or helix of magnet $N^2$, the other end of which is electrically connected with a contact-plate $d^2$, carried by but insulated from cap $l$. Lever $O^2$ carries a contact spring or finger $e^2$, which makes contact with plate $d^2$ when armature $r^2$ is attracted and lever $Q^2$ is released, as in Fig. 5. A spring $f^2$ tends to throw lever $O^2$ to locking position, acting in opposition to the attraction of magnet $P^2$, which is strong enough, however, to overcome said spring. When contact is made between the bar of the thermostat and its contact $d'$ and between contacts $d^2$ $e^2$, current will pass from battery S to the coil of magnet $N^2$, thence by contacts $d^2$ $e^2$ and lever $O^2$ to cap $l$ and back to battery, causing armature $s^2$ to be attracted and lever $Q^2$ to be depressed, whereupon spring $f^2$ will throw lever $O^2$ to locking position, breaking the contact between $d^2$ and $e^2$ in so doing.

Assuming that the parts be in the positions indicated in Fig. 4, the action will be as follows: Water being freely supplied to the radiators, the temperature will rise until the thermostatic bar swings to contact $d'$, whereupon current will pass from battery S by thermostatic bar R and contact $d'$ to magnet $N^2$, thence by contacts $d^2$ $e^2$, Fig. 5, to lever $O^2$, thence to cap $l$ and back to battery. Magnet $N^2$ being thus energized will attract armature $s^2$, depress lever $Q^2$, which will be at once locked by latch-lever $O^2$, and valve $n^2$ will be opened, valve or disk $m^2$ will be seated, and water will pass from pipe $e$ to chamber G, causing the closing of main valve E. In swinging to locking position under the influence of spring $f^2$ lever $O^2$ will carry contact-spring $e^2$ out of contact with plate $d^2$, and lever $Q^2$ in falling will carry finger $c^2$ into contact with plate $b^2$, thus preparing the circuit of magnet $P^2$ for completion by the contact of the thermostatic bar with screw $b'$, which will occur as soon as the temperature falls to the predetermined limit for which said screw is adjusted. When the circuit is thus completed, magnet $P^2$ will be energized and armature $r^2$ will be attracted, thus swinging lever $O^2$, releasing lever $Q^2$, and permitting spring T to elevate said lever, whereupon spring $o^2$ will lift valves $n^2$ and $m^2$, closing communication between pipe $e$ and chamber G and opening communication between said chamber and waste or outlet $b$. This outlet being at a lower level than expansion-tank H, the water below the diaphragm F will lift it and valve E and drive the water from chamber G.

Diaphragm F may be provided with a spring to aid it in opening or in closing, as may be found expedient under any special conditions, or the spring may be wholly omitted.

Figs. 8 and 9 show the thermostatic and electrical devices of essentially the same construction as in Figs. 1, 2, and 3, but the auxiliary valve made in two parts, in axial alinement. In this the valve $n^3$ is closed by a spring $o^3$, when the opening-spring T is compressed by elevation of lever Q. Valve or disk $m^3$ is in this case made upon or carried by stem $t^3$, the lower end of which stem bears upon and actuates the stem of disk $n^3$ when lever $Q^3$ is lowered. The action is the same as described in connection with Figs. 2 and 3.

There may be any number of radiators, each with its main and auxiliary valves, or one auxiliary valve may be arranged to control two or more radiator-valves.

The prominent feature of my invention is the employment in connection with a water heating system of main and auxiliary valves wholly inclosed and devoid of packing, yet free from liability of leakage, and this I mean to claim without restriction to specific mechanism.

It will be seen that the inclosed valves may be employed in connection with a manually-actuated auxiliary valve. In other words, the device would still be operative if the thermostat were omitted and a push-button or manual switch were substituted or any equivalent means were provided for actuating the auxiliary valve. It is, however, highly preferable to employ the automatic controlling devices, to which a thermostat of some character is essential.

In the foregoing description I have throughout referred to "differential water columns." In thus speaking of the two columns or bodies it is not meant to convey the idea that the actuating-pressure must of necessity be due to a water column on each side of the diaphragm, since, as a matter of fact, any fluid-pressure is available; but it is desirable to employ in all cases a liquid column acting upon the diaphragm in opposition to the head or pressure of the circulating body and of sufficient head, weight, or pressure to approximately counterbalance the pressure of the circulating body. This is for the purpose of preventing injury to or rupture of the diaphragms. A very slight addition of pressure to the cushioning-column causes it to overcome the pressure opposed to it, and thus to actuate the valve. By the employment of the two opposing columns with or without other fluid-pressure I am enabled to make use of rubber diaphragms with perfect safety, whereas their use is attended with considerable risk where pressure is from one side only. It will also be observed that owing to the fact that the relief-valves are located at a common level the diaphragms throughout the system are subjected to precisely the same differential pressure, since the relative height of the two pressure-columns is the same throughout.

I am aware that it is not broadly new to connect a motor and a valve without packing between them; but, so far as I am advised, this combination has never been successfully employed in connection with hot-water heating systems owing to the liability of rupture of the diaphragms incident to the application of the full water-pressure to one face only, while the other face has been without anything to sustain it during the opening of the exhaust-valve. As the valves are free from the friction which packing would occasion a slight excess of pressure is sufficient to move them in either direction, and there is consequently little or no strain on the diaphragms.

Having thus explained my invention, I claim—

1. In combination with a main valve, a fluid-pressure motor; a liquid column arranged to exert its pressure upon the motor to move the valve in one direction; a second liquid column arranged to exert its pressure to move the valve in the opposite direction; and an auxiliary valve adapted to vary the pressure in one of the columns when desired, the second liquid column serving to maintain a continuous pressure on one side of the motor and thereby prevent injury to the motor by the pressure on its opposite side.

2. In combination with the circulating system of a hot-water heating plant, a valve for controlling delivery of water to the radiating body; a fluid-pressure device connected with said valve; a circulating fluid column at one side of said pressure device and bearing thereon; a water column bearing upon the other side of said fluid-pressure device, and having a head or effective pressure greater than that of the circulating body on the opposite side thereof; and a valve for controlling admission of water to the fluid-pressure device and its escape therefrom, whereby one or the other column may be given the greater effect upon the main valve to maintain a continuous pressure upon the fluid-pressure device sufficient to prevent injury thereto by pressure on one side when the escape-valve is open.

3. In a hot-water heating system, the combination of a circulating system comprising a heater, radiator, and connecting-pipes; a valve arranged to close communication between the circulating-pipes and radiator; a fluid-pressure motor connected with said valve and serving to actuate it; a water-supply having a greater head or pressure than the circulating system; a pipe connecting said water-supply and the fluid-pressure motor; and an auxiliary valve adapted to open communication between the water-supply and the fluid-pressure motor and to seal the latter, or to close communication between them and vent the motor sufficiently to cause it to yield to the pressure on the valve side of it, the water column serving to maintain a fixed and permanent pressure on the motor to prevent injury to it by the opposing pressure when the exhaust-valve is open.

4. In a hot-water heating system, the combination of a circulating system comprising a heater, radiator, and connecting-pipes; a valve arranged to close communication between the radiator and the circulating water column; a fluid-pressure motor connected with said valve and serving to actuate it; a water-supply having a greater head or pressure than the circulating column; a pipe connecting said supply and the fluid-pressure motor; an auxiliary valve adapted to open communication between the water-supply and the fluid-pressure motor and to seal the latter, or to close communication between them and vent the motor located at such point in the pipe that the height or head of the water column shall counterbalance the circulating water column sufficiently to prevent excessive strain on the motor when the exhaust-valve is open; electric mechanism for actuating the auxiliary valve; a source of electric energy; and a thermostatic circuit-closer adapted to control the action of the electric mechanism, substantially as set forth.

5. In combination with a radiator-valve; a fluid-pressure motor therefor, a circulating water column arranged to exert its pressure upon the motor to move the valve in one direction; a second water column arranged to exert a greater pressure upon the motor to move the valve in the opposite direction; an auxiliary valve adapted to admit or exclude the second water column, and to relieve the motor of part of its pressure when desired, said second water column serving to maintain a continuous and sufficient pressure on the motor to support it against the circulating water column when the exhaust-valve is open.

6. In combination with the main valve and auxiliary valve of a temperature-regulating system, an electric motor for actuating the auxiliary valve, comprising frame or support *l*, *p*, *q*; electromagnets N and P; lever O provided with armature *r* and contact *c'*; insulated contact-spring *b'* connected with the helix of magnet N; lever Q provided with armature *s* and contact *f'*; insulated contact-spring *e'* connected with the helix of magnet P; battery or source of electric energy S in electrical connection with frame *l*, *p*, *q*; and a circuit-closer for completing the battery-circuit through either magnet, as required.

7. In a hot-water heating plant or system, the combination of a boiler; a circulating-pipe; a radiator; a packingless valve for admitting water to or excluding it from the radiator; a fluid-pressure device subject to the head or pressure of the circulating medium, on one side, tending to move the valve in one direction; means for producing water-pressure on the opposite side of said pressure device to move the valve in the other direction; means for relieving or reducing the pressure on one side of the pressure device; an auxiliary valve for controlling the relief located at such elevation above the motor that the head or pressure of the water column shall offset the opposing water column sufficiently to prevent excessive strain on the motor when the relief-valve is open; an electric motor for actuating the auxiliary valve; and a thermostat for controlling the action of the electric motor.

8. In a hot-water system, the combination of a heater; a circulating-pipe; a radiator; a valve for controlling delivery of water to the radiator; a fluid-pressure motor subject to the head or water-pressure of the circulating body and tending to move the valve in one

direction; a water-pipe connected with said motor and containing water under a predetermined and constant head or pressure normally less than that of the circulating body, but sufficient to protect the motor against injury by the pressure on the opposite side of it; means for increasing the pressure in said pipe sufficiently to overcome the pressure of the circulating body and to actuate the motor in opposition thereto; an auxiliary valve for controlling said pressure-increasing means; and an electric motor for actuating the auxiliary valve.

9. In a hot-water heating plant or system, the combination of a heater; a circulating-pipe; a radiator; a valve for controlling the delivery of water to the radiator; a fluid-pressure motor subject to the head or water-pressure of the circulating body and tending to move the valve in one direction; a water-pipe connected with the motor and containing a water column of normally less head or pressure than that of the circulating body; means for admitting to said pipe additional water sufficient to raise the pressure and move the motor and valve in opposition to the pressure of the circulating body; means for cutting off and relieving such additional pressure; an auxiliary valve for controlling the cut-off or relief; and an electric motor for actuating the auxiliary valve.

10. In a hot-water heating plant or system, the combination of a heater; a circulating-pipe; a radiator; a valve for controlling the delivery of water to the radiator; a fluid-pressure motor subject to the head or water-pressure of the circulating body and tending to move the valve in one direction; a pipe connected with the motor and containing liquid; means substantially as described for augmenting or reducing the pressure of said liquid to make its effect upon the motor greater or less than that of the circulating body; an auxiliary valve for controlling the variation or difference in pressure; said valve being located at such a height above the motor that the water column between it and the motor shall be of sufficient head or pressure to sustain the motor against its opposing pressure; an electric motor for actuating the auxiliary valve; and a thermostat for controlling the electric motor.

11. In a hot-water heating system, the combination of a heater, circulating-pipe and radiator; a valve for controlling admission of water to the radiator; a motor for actuating said valve, comprising a shell or chamber and a movable diaphragm; liquid-pressure columns communicating with the shell or chamber on opposite sides of the diaphragm and adapted to maintain at all times a sustaining-pressure upon opposite faces of said diaphragm; and means for varying the relative pressures of the columns upon the diaphragm, substantially as and for the purpose set forth.

12. In combination with the radiator of a hot-water heating system, a shell or chamber; a diaphragm within said shell or chamber; liquid-pressure columns communicating with the chamber on opposite sides of the diaphragm and serving each as a cushion for the other; means for varying the relation between the pressures upon the two sides of the diaphragm; and means for maintaining continuous the pressure of each liquid column, so that in operating the motor its diaphragm shall not be subjected to undue strain or pressure.

13. In a hot-water heating system, the combination of a radiator and its valve; a motor subject to the pressure or head of the circulating body; a permanent water column acting upon the motor in opposition to the pressure of the circulating body and of height or pressure sufficient to sustain the motor-diaphragm against injurious strain by the circulating body when the latter pressure predominates; an auxiliary valve for determining the relative pressure on opposite sides of the diaphragm; and a spring for supplementing the pressure upon one side of the diaphragm.

14. In combination with a hot-water radiator, a controlling-valve therefor; a fluid-pressure motor for actuating said valve, provided with a flexible diaphragm; a circulating water column arranged to bear upon one side of said diaphragm; a liquid-pressure column arranged to bear upon the opposite side of said diaphragm; an exhaust-valve for reducing the pressure of said liquid column, provided with a stem and disks, the head or pressure of said column serving to sustain the diaphragm against rupture; and a spring bearing upon the diaphragm and serving to assist in moving or sustaining the diaphragm against the water-pressure from the opposite side.

15. In a hot-water heating system, the combination of a heater, circulating-pipe, and radiator; a valve for controlling delivery of water to the radiator; a fluid-pressure motor for actuating said valve, provided with a diaphragm and in communication with the circulating system; a pipe communicating with the motor on the side of the diaphragm opposite that with which the circulating system communicates; and a water-tank located at a higher point than the level of water in the circulating system, and connected with said pipe; an auxiliary valve for varying the pressure on the motor, comprising an inlet-valve for admitting liquid to the motor, and an exhaust-valve for relieving the motor, said auxiliary valve being located at such distance below the tank that when the exhaust-valve is open the pressure of the circulating system shall move the diaphragm against the remaining pressure in said pipe, which remaining pressure forms a cushion for the diaphragm and sustains it against rupture by the opposing pressure; and an automatic feed for said pipe.

16. In a hot-water heating system, the com-

bination of a heater; a circulating-pipe; a radiator; a main valve for controlling delivery of water to the radiator; a fluid-pressure motor subject to the head or pressure of the circulating body for moving said valve in one direction; an electrically-actuated auxiliary valve for controlling the pressure on the motor, comprising an inlet-valve for admitting pressure to, and an exhaust-valve for relieving the motor; and means for retaining sufficient pressure on one side of the motor, when the exhaust-valve is open, to act as a cushion for the pressure of the circulating body or heating agent on the opposite side of said motor, for the purpose of preventing excessive strain upon the same.

In witness whereof I hereunto set my hand in the presence of two witnesses.

JOHN V. STOUT.

Witnesses:
CHAS. B. BRUNNER,
W. W. NEWTON.