No. 808,693. PATENTED JAN. 2, 1906.

L. SCHUTTE & E. KÜRTING.

CALORIMETER.

APPLICATION FILED JULY 7, 1904.

4 SHEETS—SHEET 1.

FIG. 1.

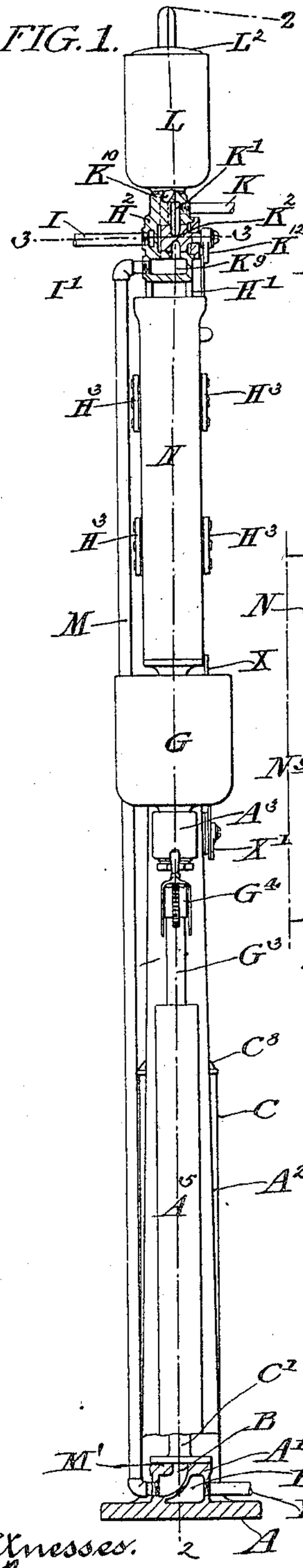

FIG. 2.

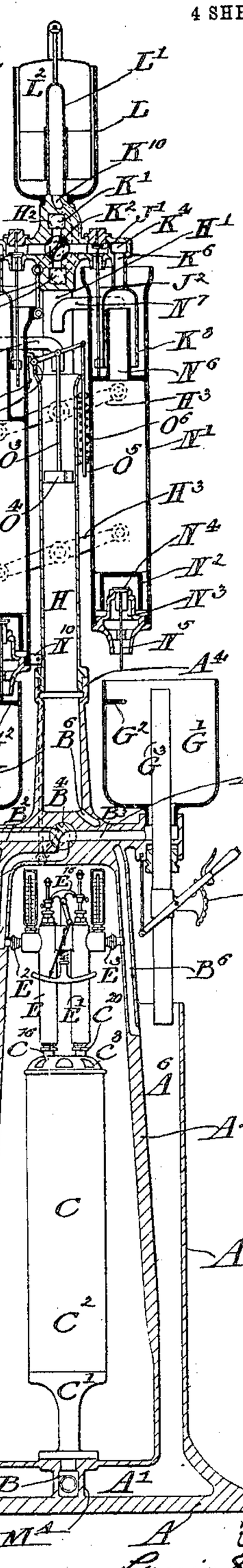

FIG. 3.

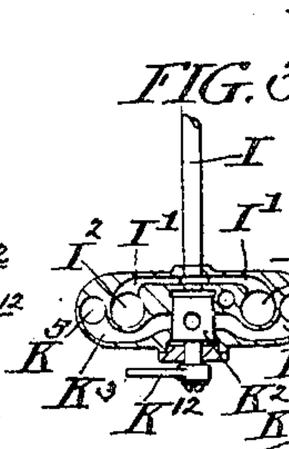

FIG. 4.

Witnesses.

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4 SHEETS—SHEET 2.

FIG. 6.

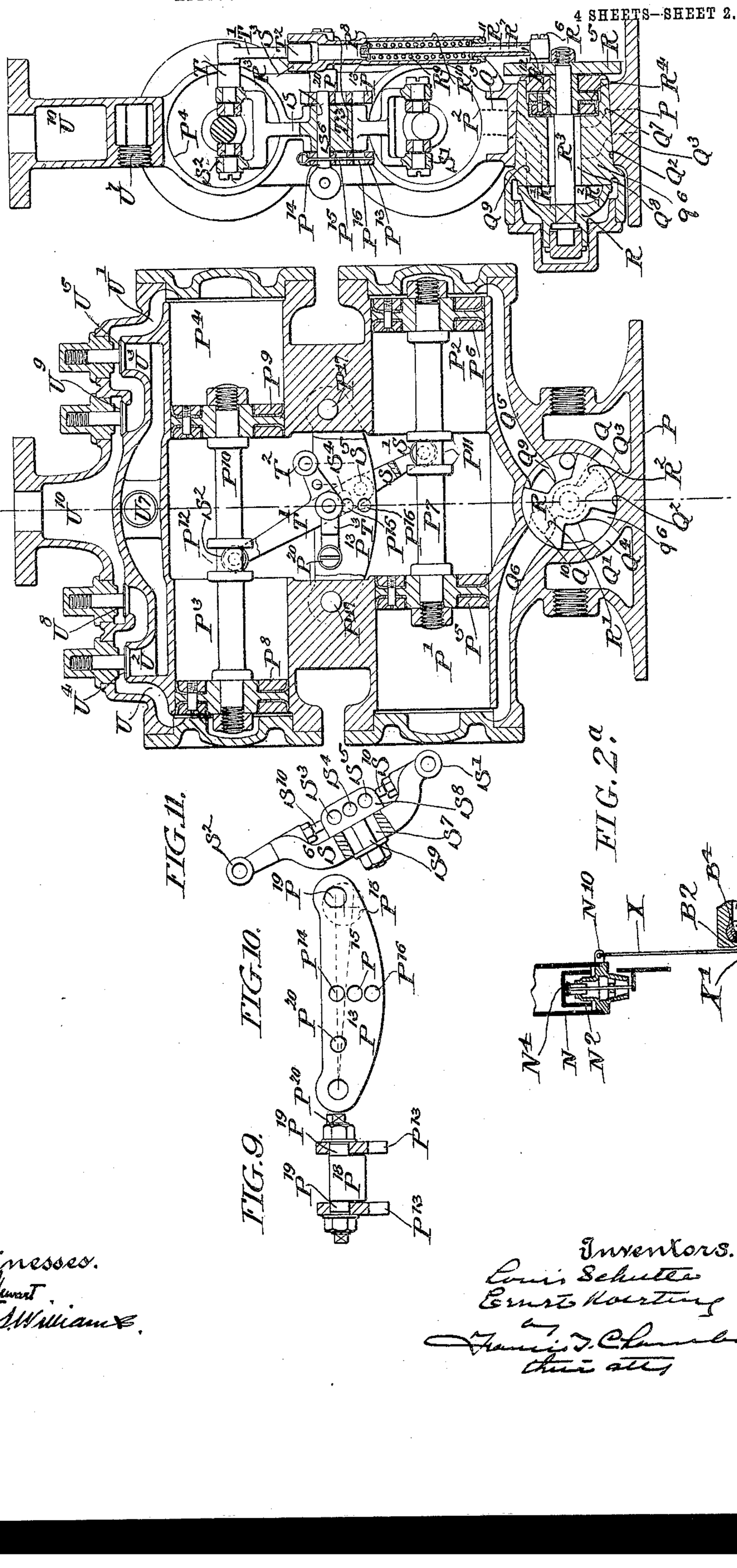

FIG. 7.

FIG. 11.

FIG. 10.

FIG. 9.

FIG. 2a.

Witnesses.
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4 SHEETS—SHEET 3.

FIG. 5.

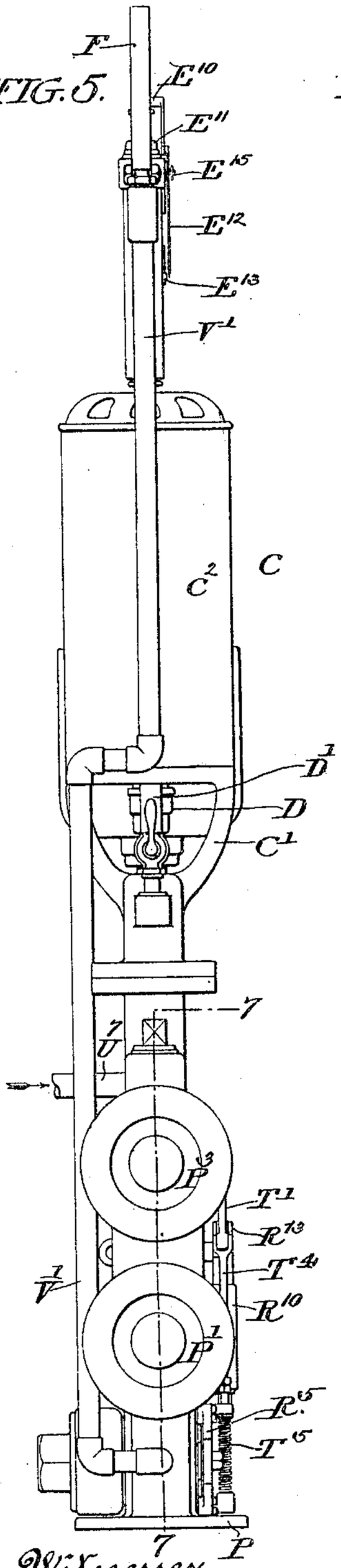
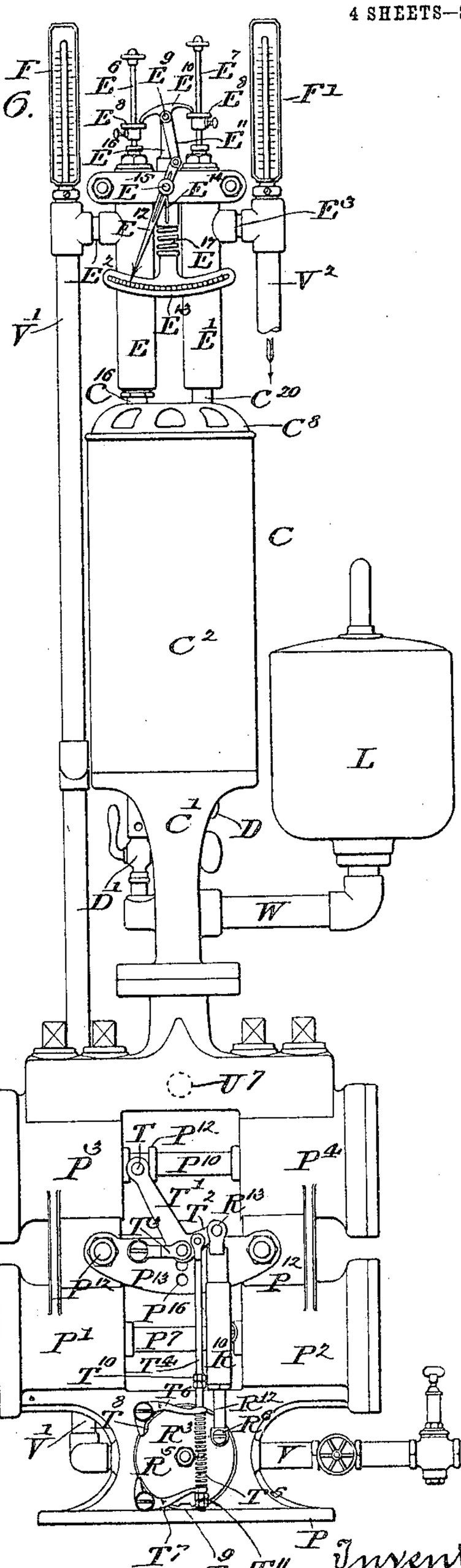


FIG. 6.



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4 SHEETS—SHEET 4.

FIG. 12.

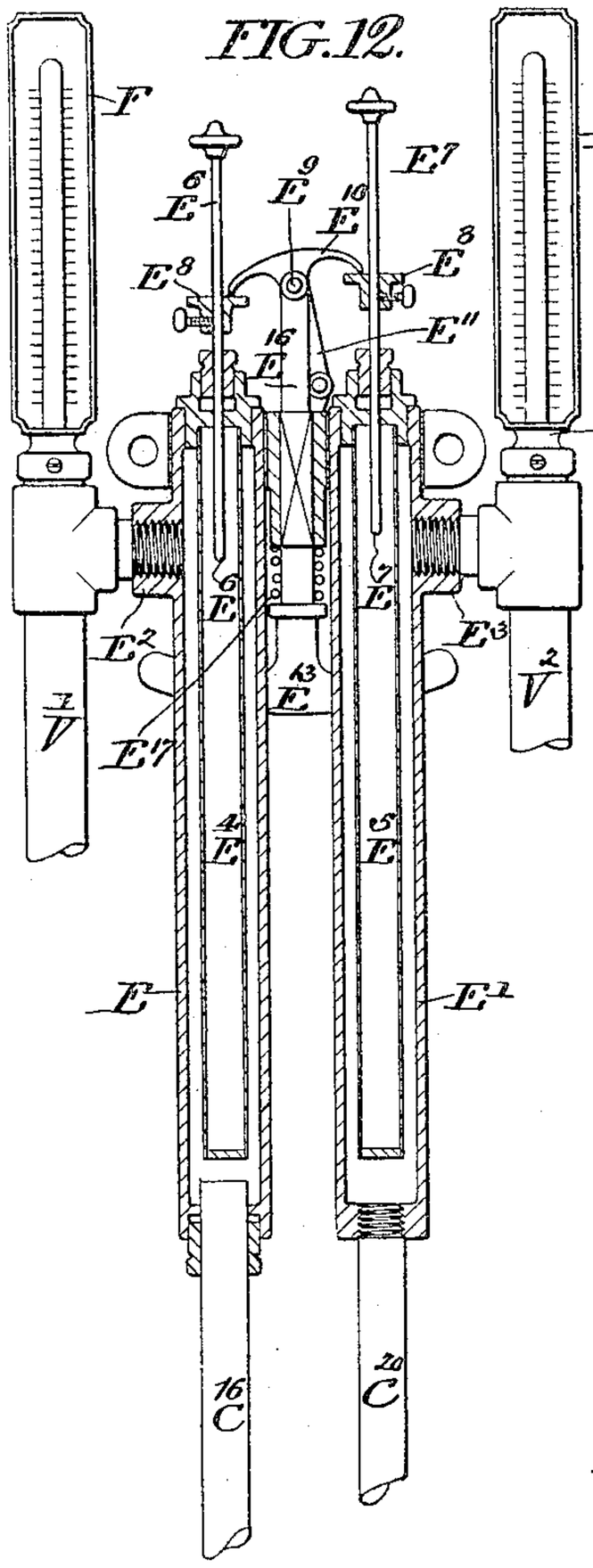


FIG. 13.

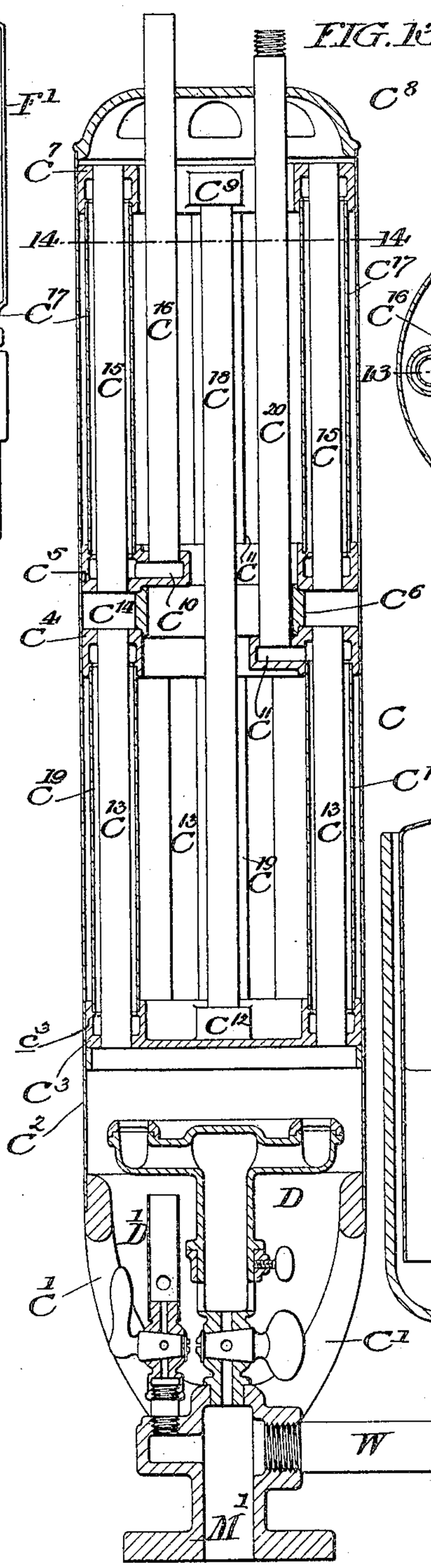
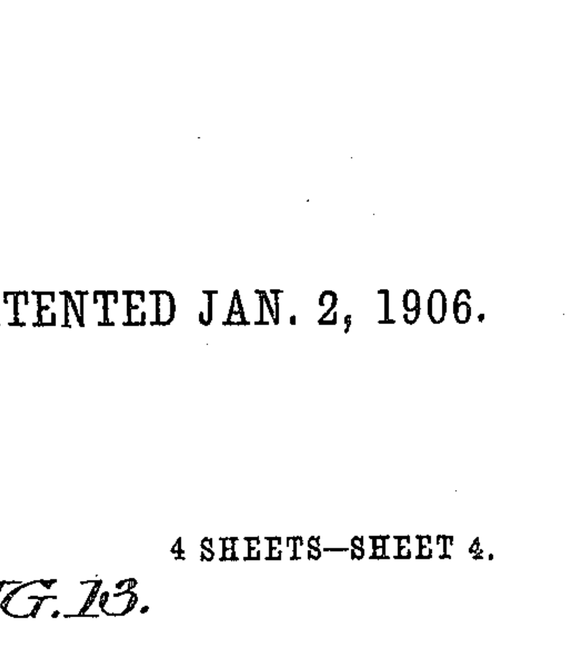
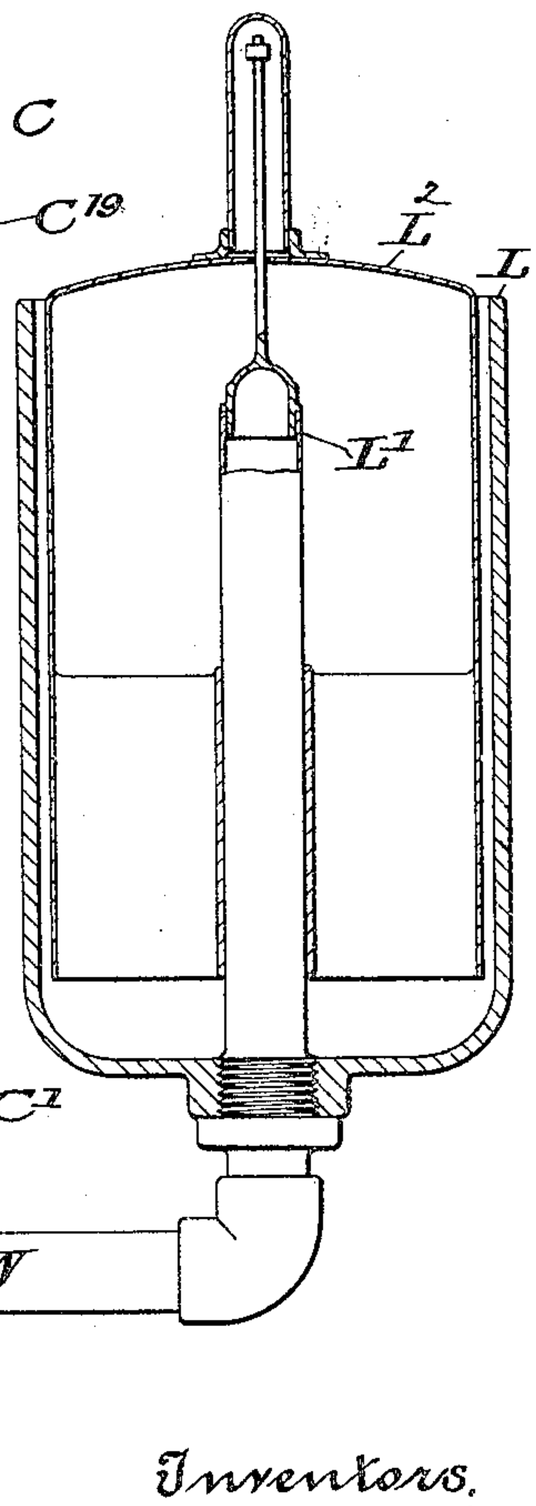


FIG. 14.





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UNITED STATES PATENT OFFICE.

LOUIS SCHUTTE, OF PHILADELPHIA, PENNSYLVANIA, AND ERNST KÖRTING, OF PEGLI, ITALY, ASSIGNORS TO SCHUTTE AND KOERTING COMPANY, OF PHILADELPHIA, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA.

CALORIMETER.

No. 808,693. Specification of Letters Patent. Patented Jan. 2, 1906.

Application filed July 7, 1904. Serial No. 215,596.

To all whom it may concern:

Be it known that we, LOUIS SCHUTTE, a citizen of the United States of America, residing in the city and county of Philadelphia, in the State of Pennsylvania, and ERNST KÖRTING, a subject of the German Emperor, residing in Pegli, county of Genoa, Province of Liguria, Kingdom of Italy, have invented a certain new and useful Improvement in Calorimeters for Measuring the Heating Value of Gases, of which the following is a true and exact description, reference being had to the accompanying drawings, which form a part thereof.

Our invention relates to the construction of calorimeters for measuring the heating value of gases, and has for its object to provide an accurate and efficient and practically automatic apparatus for this purpose.

Our apparatus, like others provided for the purpose, embodies the use of a heater for heating water or other fluid, said heater being heated by a gas-burner supplied with the gas whose heating properties it is desired to ascertain, and the heating value of the gas is determined by ascertaining the amount of heat imparted to the water passing through the heater; and, broadly speaking, the leading feature of our invention consists in supplying the water and gas to the heater through interconnected means by which both fluids are supplied in automatically-fixed proportion to each other.

Other features of our invention will be best understood as described in connection with the drawings in which our invention is illustrated, and in which—

Figure 1 is a side elevation of an apparatus embodying our improvements in what we believe to be their best form, the burner connections at bottom and the water and gas connections at top being shown in vertical section. Fig. 2 is a front view of the same apparatus on the section-line 2 2 of Fig. 1. Fig. 2^a is a detail imperfectly shown in Fig. 2. Fig. 3 is a cross-sectional view of the supply ports and valve, taken on the section-line 3 3 of Fig. 1, and Fig. 4 is an enlarged view of the latch shown in Fig. 2. Fig. 5 is a side elevation of a modified form of apparatus also embodying the leading features of our invention. Fig. 6 is a front view of this modified apparatus. Fig. 7 is an enlarged sectional view of the apparatus, taken on the section-line 7 7 of Fig. 5. Fig. 8 is a cross-section taken on an irregular section-line indicated at 8 8 in Fig. 7. Figs. 9, 10, and 11 indicate somewhat-modified details of the construction shown in Figs. 5 to 8. Fig. 12 is a sectional elevation of our thermostatic indicating apparatus for visually indicating the results obtained in the working of the apparatus. Fig. 13 is a section through our preferred form of heater, taken on the line 13 13 of Fig. 14; and Fig. 14 is a cross-secton on the line 14 14 of Fig. 13.

Referring first to the construction shown in Figs. 1 to 4, A indicates the base of the apparatus, from the center of which extends upwardly the boss A′, furnished with ports by which the gas passes to the burner and waste water is permitted to escape from the surrounding chamber formed by the upwardly-extending walls A^5. A^2 A^2 indicate upwardly-extending arms or walls which pass on opposite sides of the heater and are united by the part indicated at A^3, which has various ports formed in it, as will be described, and on which is supported the upper part of the apparatus. B is the gas-port formed in the boss A′ and connecting, as will be described, with the gas-supply pipe M, and B′ is the port formed in the lower end of the boss A′ and connecting with the waste-pipe indicated at Y in Fig. 1. The boss A′ supports the heater C through the arms C′ C′, and the section M′, in which they merge and through which is formed a port communicating directly with the burner indicated at D and also preferably with a pilot-burner, (indicated at D′.) An equalizing gas-reservoir (indicated at L) is also connected with the gas-port through a pipe W, as shown in Fig. 13, and a similar gas-equalizing reservoir is connected with the gas-supply, though not directly with the burner, in the construction shown in Figs. 1 and 2.

The construction of the heater C which we prefer to use in our apparatus is best shown in Figs. 13 and 14. It consists of an outer cylindrical casing C^2, across the lower portion of which and immediately above the burner is set the partition C^3, supporting at its edge the annular integral ring c^3 and

formed with perforations extending through this ring and through its bottom in an annular series, as shown. At an intermediate point in the cylinder C^2 are secured the annular rings indicated at C^4 and C^5, set quite close together, the space between them being formed into an annular chamber C^{14} by means of the ring C^6, which is secured to both the rings C^4 and C^5, as shown. At the top of the cylinder C^2 is secured the annular ring C^7, while at C^8 we have indicated a perforated top or cover for the cylinder. The ring C^3 is formed with an inwardly-projecting extension C^{12}, which corresponds in shape to and is situated directly beneath a corresponding inward projection C^9 of the ring C^7, while the rings C^4 and C^5 are formed with inwardly-projecting chambers, (indicated at C^{11} and C^{10}.) C^{13} C^{13} indicate an annular series of gas-tubes connecting the rings C^3 and C^4 and extending through the bottom of the first and the top of the second, as shown, and the rings are further connected by the series of tubes or conduits C^{19} C^{19}, &c., which connect the ring-chambers with each other and surround the conduits C^{13}, the rings and conduits described forming the lower of two sections into which each heater is divided. The upper section, comprehended between the rings C^5 and C^7 is similarly formed of gas-tubes C^{15} and water-tubes C^{17}, surrounding the gas-tubes, and the water-supply is received through the conduit C^{16}, which opens, as shown, directly into the chamber C^{10} of the rings C^5, while the upper ring C^7 is connected through its chamber C^9 and the vertical conduit C^{18} with the chamber C^{12} of the ring C^3 of the lower section of the heater, while the outlet-pipe of the composite heater is the conduit C^{20}, which connects, as shown, with a chamber C^{11} of the ring C^4. It will thus be seen that the water entering the heater through conduit C^{16} passes first to the ring C^5, thence through the conduit C^{17} to the ring C^7, thence through the conduit C^{18} to the ring C^3, thence through the conduit C^{19} to the ring C^4, and thence through the conduit C^{20}. In this way the colder water is to be found in the upper section of the heater and the warmer water in the lower section of the heater, so that as the gases arising through the tubes C^{13} and C^{15} impart their heat to the water they are met constantly by colder water in the upper regions of the heater and the more active and complete absorption of heat thus insured.

Referring next to Fig. 12 of the drawings, it will be seen that inlet C^{16} and outlet C^{20}, leading to and from the heater, are connected at their upper ends to the conduit-chambers E and E′, which at their upper ends connect at E^2 and E^3 with the inlet-pipe V′ and the outlet-pipe V^2. In each of the chambers E and E′ is situated a closed chamber, (indicated, respectively, at E^4 and E^5,) and into each of these chambers extends a plunger, (indicated at E^6 and E^7,) the plungers of course extending through the stuffing-boxes in the heads of the chambers E^4 and E^5. The upper or exposed ends of the plungers have secured to them the stops or collars indicated at E^8 E^8, against which rest the ends of a double-arm lever E^{10}, pivoted at E^9 to a vertically-guided slide E^{16}, which is drawn downward by the action of the spring E^{17} and supports at its lower end the segmentally-graduated index indicated at E^{13}. A downwardly-extending lever-arm E^{11} (best shown in Fig. 6) connects the lever E^{10} with an indicating-finger E^{12}, which is preferably formed slotted, as shown, and secured to a slotted support (indicated at E^{14}) through an adjustable pin E^{15}. F and F′ are thermometers connected with the inlet and outlet conduits and by which the automatic thermostatic indicator can be regulated and verified.

It will be best to describe the operation of the indicating mechanism before passing to other parts of the apparatus, and we will therefore point out that the chambers E^4 and E^5 and their connections constitute a thermostatic indicating device. The chambers E^4 and E^5 are filled with water or other liquid, and as this liquid is heated and expands in volume the plungers E^6 and E^7 are necessarily forced out to make room for the expanding liquid. Of course the heat of the two thermostatic devices corresponds to the extreme temperatures of the incoming or outgoing water or other liquid, and the relative position of the plungers will vary in accordance with this difference, and obviously the difference will be indicated on a properly-graduated scale by the indicating-finger actuated by the arm E^{10}, which rests upon the collars secured on the plungers. It will be seen that in the device indicated the ends of the arm E^{10} are always kept in contact with the collars and the plungers drawn downward by the action of the spring E^{17} and that as the graduated index is secured to the slide E^{16}, as is also the indicating-finger, the up-and-down motion of this slide will have no effect upon the position of the indicating-finger. The advantage of the adjusting device described in connection with the indicating-finger will be readily recognized, as it enables a nice adjustment of the scale to be made with the least possible trouble, and of course different scales can be secured to the slide at will.

Returning now to the construction illustrated in Fig. 2, it will be seen that the support A^3 is formed with ports, (indicated at B^2 and B^3,) which open into a plug-valve seat (indicated at B^4) and communicating through a port B^5 with the inlet E^2 of the chamber E and of the water-heater, this port B^5 corresponding with the pipe V′ of the special construction indicated in Fig. 12. It will also be seen that the upper part of the support A^3

is formed as a hollow cylinder, from the bottom of which leads a port B^6, opening into one of the chambers A^6, supported on the base A. At B^7 we have indicated a two-way cock fitting in the seat B^4 and by which the ports B^2 and B^3 are alternately connected with the port B^5. G and G′ are open-top receptacles the bottoms of which connect with the ends of the ports B^2 and B^3. As shown, they are each provided near their upper ends with shoulders, (indicated at G^2,) and each is shown as fitted with an overflow-pipe G^3, which extends downward through a stuffing-box and is vertically adjustable through adjusting devices (indicated at G^4 G^4). From the top of the cylindrical portion of the base A^3 extends a hollow supporting-cylinder H, which, through arms H′ at its top, supports the valve-casing indicated at H^2. The cylinder H also supports at its sides the pivot-arms indicated at H^3 H^3, to the ends of which are connected the movable vertical vessels indicated at N and N′; but before describing these vessels we will return to the valve-casing H^2 (shown in Figs. 1, 2, and 3) and explain that I indicates a water-supply pipe connecting with the diverging ports indicated at I′ I′, said ports terminating in valve-seated openings I^2 and I^3, the openings being directly above the open tops of the chambers N and N′. The pipe K is the gas-supply pipe which connects with the downwardly-extending port K′ and through it with the two-way cock K^2, which also connects with the ports K^3 and K^4, which in turn connect, through the downwardly-extending conduits K^5 and K^6, with the two bell-like extensions indicated at K^7 and K^8, which extend down into the tops of the vessels N and N′, as is shown in Figs. 1 and 2. The valve-casing is also, as shown in Figs. 1 and 2, provided with a gas-storing and pressure-equalizing device L L^2, being an inverted cylindrical vessel set in the upwardly-extending casing and in communication with the gas-space of the valve-casing H^2 through a perforated pipe L′ and a port K^{10}, communicating at bottom with a port K^9, from which also leads the gas-pipe M, by which the gas passes to the burner of the water-heater. J and J′ indicate puppet-valves, which are actuated by gravity to close the ports I^2 and I^3 and are provided with depending rods, (indicated at J^2 J^2,) which as the vessels N and N′ rise come in contact with partitions in said vessels and are raised, raising the valves and permitting the inflow of water to the vessel. It will also be seen that the plug-cock K^2 is provided with an actuating-lever K^{12}, which is connected by a link K^{13} (see Fig. 2) with the top of the vessel N, so that as this vessel rises and falls the plug-cock is shifted in position so as to shut off the gas-supply to the vessel N when it is in its raised position and connect the gas-supply to the vessel N′, then in its lower position, and to reverse the connections with the shift in the position of the two vessels.

The construction of the two vessels N and N′ is the same. They are both open-topped cylinders, each provided with bottom pieces N^3, formed with valve-seated openings normally closed by puppet-valves N^4 and each provided with a dependent cup-like device N^2, extending over the valve and acting as a water seal to prevent the escape of gas. Both of the vessels are also provided with annular partitions with upwardly-extending pipe-like projections, as indicated at N^6, the bells K^7 and K^8 extending down over these pipe-like projections and forming with them and the annular partitions water seals to prevent the escape of gas from the top of the vessels N and N′. On the side of one of the vessels N, as shown, is formed a latch-engaging bar, as indicated at N^9, Fig. 2, and on a larger scale in Fig. 4.

O is a fixed pivot on which is pivoted the latch-lever O′, having the outwardly-extending arm O^2, to an intermediate point of which is connected the vertically-depending rod O^3, supporting a loosely-fitting piston O^4, seated in the cylindrical support H. To the outer end of the lever O^2 is secured the depending rod O^5, drawn downward by the action of the spring O^6.

At N^{10}, Fig. 2, we have shown a lug extending out from the bottom of the vessel N and connecting through a rod X with a lever X′, which in turn is connected to the plug-cock working in the seat B^4.

To explain the operation of the devices above described, it will be seen that, the parts being in the position shown in Fig. 2, the vessels are latched by the engagement of the latch-lever O′ with the detent-bar N^9. In this position the valve J′ is opened, and the water coming through the supply-pipe I therefore flows down through the open port I^3 into the top of the vessel N′ and through the water seal and pipe-like extension N^6 and bell K^8 into vessel N′. The displaced gas in vessel N′ flows upward through the port K^4 and thence through the plug-cock K^2 to the chamber K^9, where it is at once in communication with the reservoir L and through the conduit M with the burner of the heating device. In coming to its lowermost position the vessel N brings the valve-rod N^5 of its outlet-valve N^4 into contact with the shoulder G^2, which, lifting the valve, permits the water previously contained in it to run out into the receptacle G. While the water runs out the gas from the gas-conduit K passes through the plug-cock K^2 and port K^5 to the bell K^7 and through it and the pipe extension K^6 into the body of the vessel N, taking the place of the water as the water exhausts therefrom. It will be seen that each of the vessels N and N′ is provided with an outlet

pipe N^7, leading from a point near its outer end and opening immediately above the cylindrical port H. As soon, therefore, as the water flowing into one of these vessels reaches the height of the outlet-pipe N^7 it will flow into the cylindrical port H and upon the piston O^4, gradually leading this piston to a point which will counteract the spring O^6 and will draw down the lever-arm O^2 and release the catch-lever O′ from the detent N^9. As soon as this occurs the loaded vessel will at once fall to its lowermost position and the vessel from which the water has escaped rise to its uppermost position. This motion cuts off the supply of water to the full vessel, and the leaky piston O^4 soon permits it to escape, whereupon the action of the spring O^6 returns the catch-lever to operative position, which will be either above or below the detent N^9. It will be seen that the plug-cock K^2 will be reversed by the shifting of the vessels through the described connection of the link K^{13} and lever K^{12}, and of course all the other valve positions already described will be reversed, as the apparatus is in duplicate on both sides.

We have already described how the water delivered into the receptacles G and G′ is in turn delivered from these receptacles to the water-heater and will here only note that the rising and falling of the vessel N through the rod X and valve-lever X′ reverses the position of the valve in the seat B^4, permitting the water to be drawn alternately from the receptacles G and G′, in which the volume of the water is regulated by the adjustable outflow pipes G^3, as already described.

Passing now to the modified construction illustrated in Figs. 5 to 8, the construction of the heater and of the thermostatic indicating mechanism is all virtually the same as that already described. In place of the reciprocating vessels N and N′ we prefer to use we show in this modified apparatus a pump construction in which the water is used in two pump-cylinders to actuate the pistons in two gas-cylinders, the water being exhausted from the pump-cylinders to the heater and the gas being driven from the gas-cylinders to the burner—an action which, it is obvious, is strictly analogous to that which takes place in the reciprocating receptacles N and N′ of our preferred construction, in which we utilize the water directly as the piston for drawing in and expelling the gas. Referring to the construction illustrated, P indicates the cylinder-casing; P′ and P^2, the water-cylinders; P^3 and P^4, the gas-cylinders. The water-pistons are shown at P^5 and P^6 and are rigidly connected by the piston-rod P^7, having at its center the collars indicated at P^{11}. The gas-pistons are shown at P^8 and P^9 and are connected by the rod P^{10}, having the collar construction indicated at P^{12}. On each side of the casting and between the upper and lower cylinders are secured, in the construction shown, the longitudinally-supporting bars P^{13} P^{13}, formed with three sets of pin-holes, (indicated at P^{14}, P^{15}, and P^{16}.) In the construction illustrated in Fig. 7 the cross-bars P^{13} are secured in place by bolts P^{17}, and in the modification of Fig. 9 a shaft P^{18} is indicated as adapted to extend through the casting and having eccentrically set pins P^{19} P^{19}, to which the ends of the cross-bars P^{13} are secured, so that by turning the shaft P^{18} the cross-bars can be raised or lowered. At P^{20} we have shown an outwardly-extending boss secured to one of the cross-bars for purposes which will be described. Referring now to the valve and port system of the pump, Q indicates an inlet-chamber, and Q′ an outlet-chamber for water. Q^2 is a chamber which connects through ports Q^3 and Q^4 with the inlet and outlet chambers, and which chamber also communicates, through lateral ports Q^5 and Q^6, with the pump-cylinders P′ and P^2. This chamber Q^2 is filled by a plug q^6, having a central longitudinal chamber Q^8, which communicates, through a port Q^7, with the inlet-port Q^3, while ports indicated at Q^9 and Q^{10} extend from the outer end of the plug and communicate with the ports Q^5 and Q^6. This plug, it is well to mention, is not a valve or plug-cock and is simply a convenient way of constructing the device, remaining entirely stationary and without motion, so that it might just as well be a part of the solid casting if it were convenient to make it. The valve proper is indicated at R and has the form indicated in Figs. 7 and 8, an internal chamber extending from side to side, as indicated at R′ and R^2, though the extension R^2 is simply for balancing pressure, the function of the valve being performed by the alternate connection of its chamber R′ to the ports Q^9 and Q^{10}, and the connection of said ports in alternation around and over the valve with the outlet-port Q^4. The valve is actuated through a stem R^3, extending through the central cavity of the plug q^6 and having, preferably, the enlarged cup-leather packing indicated at R^4, by which the pressure of the water tends to hold the valve to its seat, as the cup-leather packing is given a larger area than that of the valve. The end of the actuating-shaft R^3 has secured to it the disk R^5, to one point of which is attached the crank-pin R^6, (see Figs. 6 and 8,) a connecting-rod R^7 being coupled to this crank-pin and having surrounding it a spring R^9, the upper end of which is held in position by a washer, (indicated at R^8.) Around the spring, which is indicated at R^9, extends the cylindrical casing R^{10}, having a shoulder R^{11} at its bottom, on which the spring rests, and preferably a tubular extension R^{12}, which surrounds the rod R^7. As shown, the upper part of the cylinder R^{10} is connected by arms R^{13} with a le-

ver-arm T^2, to be described. Returning now to the connections made directly with the piston-rods, S is a lever which is pivoted by a pin S^6 to the cross-bars P^{13} and has forked extensions S′ and S^2, which are engaged by the collars P^{11} and P^{12} on the piston-rods, so that the pivot-lever S will be moved back and forward on its pivot as the actuating pump-pistons are moved back and forward, and with the effect of giving to the gas-pistons a corresponding, though reversed, movement. The provision of the three pivot pin-holes (indicated at P^{14}, P^{15}, and P^{16}) is to enable the point of pivoting the lever S to be varied, with a corresponding variation in the stroke of the water-piston, the arrangement being such that the gas-pistons move through their full strokes in every adjustment. A similar adjustment is made by the eccentric device indicated and described in Fig. 9 of the drawings, though we have indicated this device not so much to make the full shifts desirable as to provide for intermediate shifts between those indicated by the positions of the pin-holes. In Fig. 11 we have illustrated a necessary modification to be used in connection with the mechanism for shifting the vertical position of the cross-bars P^{13}—such, for instance, as that shown in Fig. 9. It is obvious that as the supporting-bars are shifted a corresponding change should be made in the pivot-holes of the lever S or its equivalent, and in Fig. 11 we have shown a bent lever S^6 as taking the place of the lever S, having a slot S^7 formed in it and an adjustable bar adjustably secured in this slot by a bolt S^9 and provided with pin perforations S^3, S^4, and S^5. Set-screws S^{10} S^{10} are also provided for securely holding this adjustable bar in position and for making nice adjustments in its position.

It will be seen (see Figs. 7 and 8) that from the upper end S^2 of the lever S we have provided an extension-boss T, supporting a pin, to the end of which is pivotally connected a lever-arm T′, said lever-arm being pivoted at the end of a link T^3, connected with the cross-bar P^{13}, through its boss P^{20}, and the lever having also the arm T^2, to which arm is connected the cylinder R^{10}, already described, and through it connection made with the valve-disk R^5, while another connection from the arm T^2 is made by the rod T^4 and the spring T^5, secured on its end with levers T^6 and T^7, (best shown in Fig. 6,) the ends of which engage with detents T^8 and T^9, formed in the periphery of the disk R^5, the disengagement of these levers with the detents being effected by the contact with them of the nuts indicated at T^{10} and T^{11}.

Returning to Figs. 7 and 8, it will be seen that ports U and U′ lead from the ends of the gas-cylinders connected through valve-ported openings with the gas-outlet passage U^{10}, which in turn connects directly with the burner-passage indicated at M′. (Shown in Fig. 13.) The valves controlling the ports are indicated at U^8 and U^9, and into these ports lead also inlet-ports U^2 and U^3, controlled by valves U^4 and U^5, the inlet-port for gas being indicated at U^7.

The operation of the above-described modification of our apparatus will be readily followed. The water from the inlet-chamber Q, which connects through a pipe V, Fig. 6, with a source of air-supply, passes through the ports Q^3 and Q^7 to the inlet-passage Q^8 and thence through the chamber of the valve R to either the ports Q^5 or Q^6. On entering, for instance, the chamber P′ the water will push the piston P^5 to the right, while the water in front of the piston P^6 is forced out of the cylinder, through the port Q^5 and round the valve R, to the outlet-passage Q′ and thence to the water-heater. It is of course obvious how the motion of the pistons P^5 and P^6 communicates motion through the lever S to the gas-pistons P^8 and P^9, the gas being brought in, for instance, through the valve U^5 to the chamber P^4 and expelled from the chamber P^3 through valve U^8 and chamber U^{10}, through which it passes to the burner. It will be obvious that the shifting of the rod P^{10}, acting through the lever-arms T and T^2 and through the spring R^9, and its connections will tend to rotate the disk R^5, and the valve connected with it, alternately in different directions. The immediate transmission of this motion is, however, prevented by the latching-levers T^6 and T^7, one of which is normally engaged with the disk through one of the disk-notches and holds it stationary until one of the nuts T^{10} or T^{11} comes in contact with the engaged latch-lever and forces it out of the latch, whereupon the action of the spring R^9 will at once turn the valve to its reversed position. We have already described sufficiently the adjustments which are made in the devices by which the total movements of the water-pistons with reference to the movements of the gas-pistons are regulated.

Having now described our invention, what we claim as new, and desire to secure by Letters Patent, is—

1. A calorimeter for measuring the heating value of gases having in combination a heater for water or other liquid and a gas-burner for heating the same, means for measuring the heat imparted to the liquid in the heater, means for feeding liquid through the heater, and means for forcing gas to the gas-burner, said means controlling the liquid and gas supply being so interconnected that the volumes of liquid and gas are delivered to the heater and burner in automatically-fixed proportion to each other.

2. A calorimeter for measuring the heating value of gases having in combination a heater for water or other liquid and a gas-burner for heating the same, means for meas-

uring the heat imparted to the liquid in the heater, means for feeding liquid through the heater, means for forcing gas to the gas-burner, said means controlling the liquid and gas supply being so interconnected that the volumes of liquid and gas are delivered to the heater and burner in automatically-fixed proportion to each other, and means for adjusting the interconnected mechanism for supplying liquid and gas to vary the proportional relationship of the liquid and gas.

3. A calorimeter for measuring the heating value of gases having in combination a heater for water or other liquid and a gas-burner for heating the same, means for measuring the heat imparted to the liquid in the heater, means for feeding liquid through the heater, means for forcing gas to the gas-burner, said means controlling the liquid and gas supply being interconnected so that the volumes of liquid and gas are delivered to the heater and burner in automatically-fixed proportion to each other, and means for adjusting the interconnected mechanism for supplying liquid and gas to vary the proportionate supply of water without affecting the actual volume of gas supplied to the burner.

4. A calorimeter for measuring the heating value of gases having in combination a heater for water or other liquid, said heater having inlet and outlet ports and a gas-burner for heating the same, means for feeding liquid through the heater, means for forcing gas to the burner, said means controlling the liquid and gas supply being so interconnected that the volume of liquid and gas are delivered in automatically-fixed proportion to each other, two thermostats, one connected to the inlet-port and the other to the outlet-port of the heater, and an indicator actuated by the relative movements of said thermostats for indicating the heat imparted to the liquid.

5. A calorimeter for measuring the heating value of gases having in combination a heater for water or other liquid, said heater having inlet and outlet ports and a gas-burner for heating the same, means for feeding liquid through the heater, means for forcing gas to the burner, said means controlling the liquid and gas supply being so interconnected that the volumes of liquid and gas are delivered in automatically-fixed proportion to each other, two thermostats, one connected to the inlet-port and the other to the outlet-port of the heater, an indicator actuated by the relative movements of said thermostats for indicating the heat imparted to the liquid, and two thermometers, one connected to the inlet and the other to the outlet of the heater for setting and verifying the thermostatic indicator.

6. A calorimeter for measuring the heating value of gases having in combination a heater for water or other liquid, said heater having inlet and outlet ports, and a gas-burner for heating the same, means for feeding liquid through the heater, means for forcing gas to the burner, said means controlling the liquid and gas supply being so interconnected that the volumes of liquid and gas are delivered in automatically-fixed proportion to each other, two thermostats, one connected to the inlet-port and the other to the outlet-port of the heater, a rocking arm E^{10} actuated by the thermostats as described and an indicator actuated by the rocking arm E^{10}, and having an adjustable pivot.

7. In a calorimeter for measuring the heating value of gases, a heater C, having two sets of gas and water conduits the one set placed above the other and the gas-conduits in both sets connected in series, a water-inlet conduit leading to the bottom of the upper set, a conduit leading from the top of the upper to the bottom of the lower set and an outlet-conduit leading from the top of the lower set, a gas-burner situated below the lower set of conduits, means for feeding water through the heater and forcing gas to the burner in automatically-regulated proportionate volumes, and means connected with the inlet and outlet conduits of the heater for measuring the heat imparted to the water.

8. In a calorimeter for ascertaining the heating value of gases, and having a heater for water or other liquid, a gas-burner for heating the same and means for measuring the heat imparted to the water, the combination of the vessels N, N′, and means for supporting said vessels so that one moves up as the other moves down, a latch for securing said vessels in their extreme up-and-down positions valves in the bottoms of vessels N, and N′, for permitting the outflow of water therefrom into receptacles connected with the heater, means for automatically opening said valves when the vessel is in its lower position, water and gas supply conduits leading into each vessel, means whereby water is supplied therethrough to the vessels when in their upper positions, and means actuated by the filling of the vessels with water for releasing the latch holding the vessels in fixed position and permitting their positions to shift by gravity.

9. In a calorimeter for ascertaining the heating value of gases, and having a heater for water or other liquid, a gas-burner for heating the same and means for measuring the heat imparted to the water, the combination of the vessels N, N′, and means for supporting said vessels so that one moves up as the other moves down, a latch for securing said vessels in their extreme up-and-down positions, valves in the bottoms of vessels N, and N′, for permitting the outflow of water therefrom, into receptacles connected with the heater, means for automatically opening said valves when the vessel is in its lower po-

sition, water and gas supply conduits leading into each vessel, means whereby water is supplied therethrough to the vessels when in their upper positions, means whereby gas is supplied to the vessels in their lower positions and exhausted therefrom to the burner in their upper positions, means actuated by the filling of the vessels with water for releasing the latch holding the vessels in fixed position and permitting their positions to shift by gravity, receptacles arranged to receive the water from vessels N, N′, said receptacles being connected to the heater, means whereby said receptacles are alternately connected to supply the heater and adjustable waste-conduits leading from each said receptacles whereby the volume of water supplied to the heater can be reduced in any desired proportion.

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