No. 725,341. PATENTED APR. 14, 1903.

A. J. HOPKINS.

HEAT REGULATOR.

APPLICATION FILED NOV. 4, 1901.

NO MODEL. 3 SHEETS—SHEET 1.

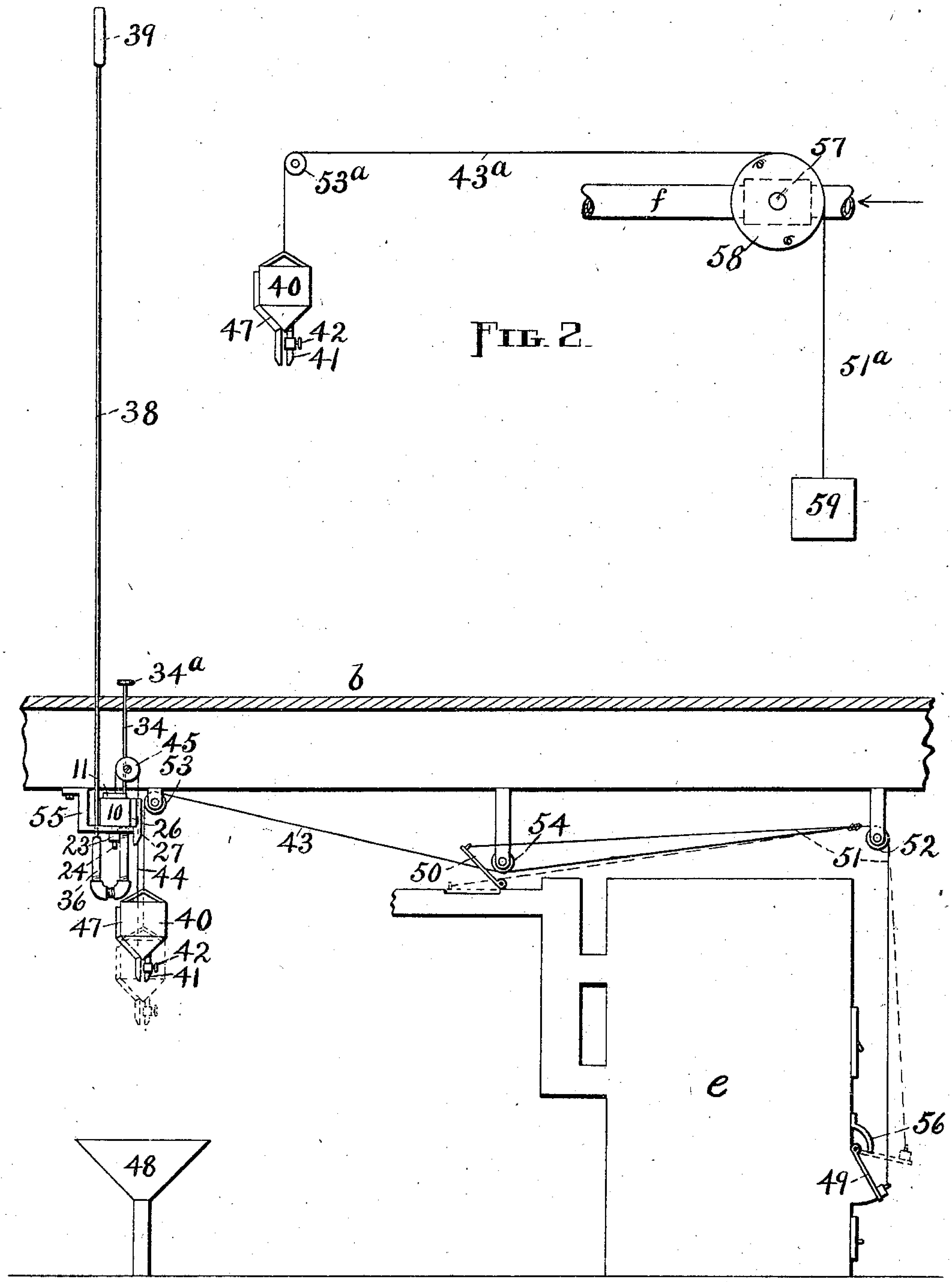

FIG. 2.

FIG. 1.

Witnesses

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3 SHEETS—SHEET 2.

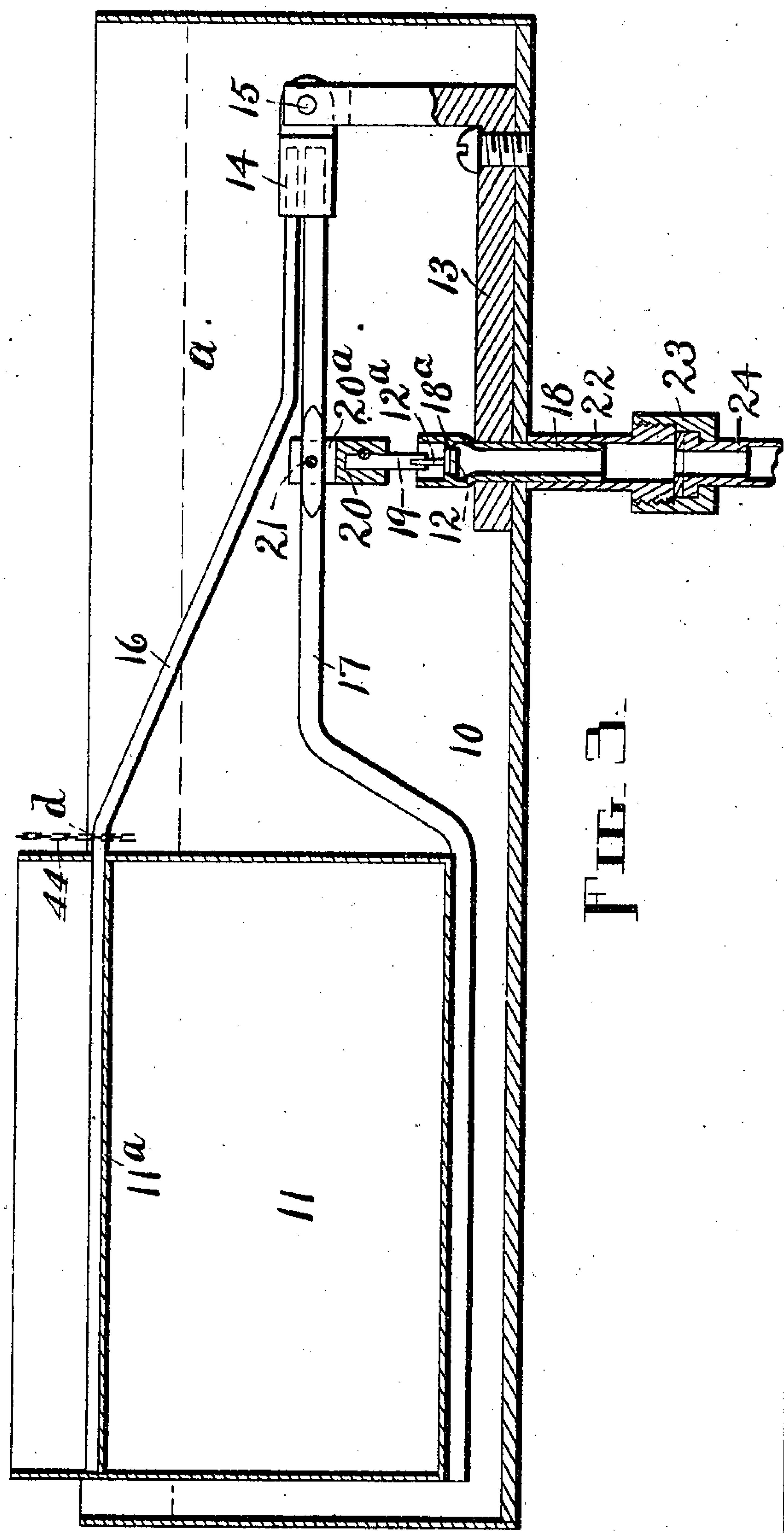

Fig. 3.

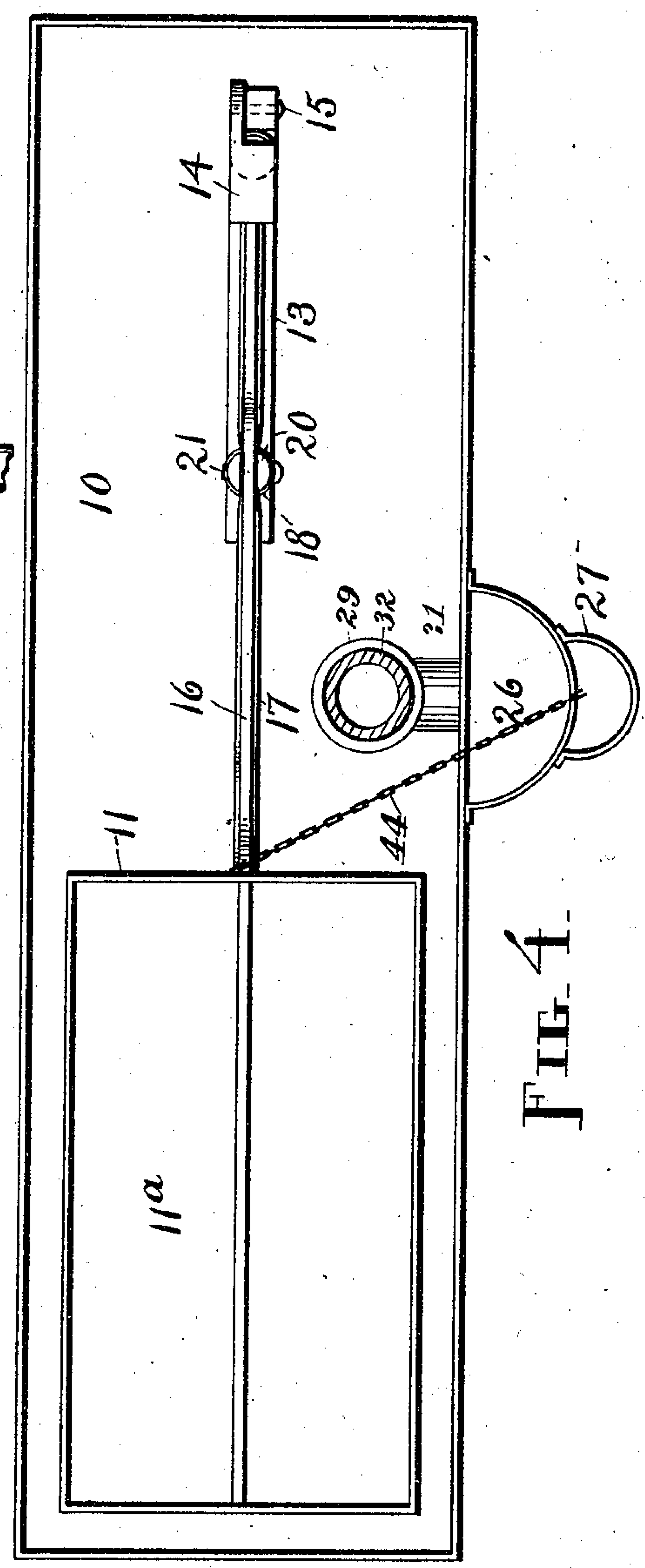

Fig. 4.

Witnesses

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NO MODEL. 3 SHEETS—SHEET 3.

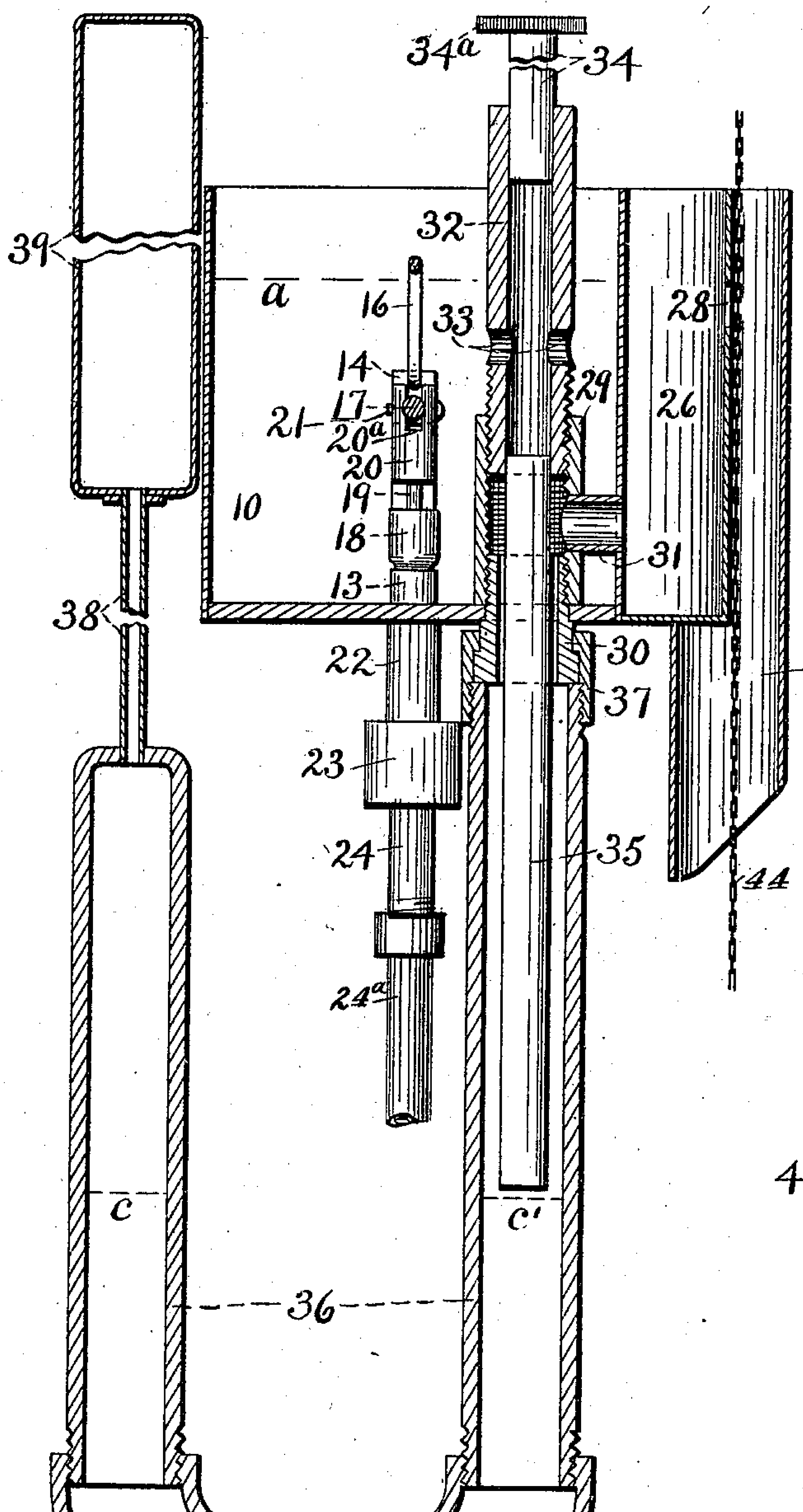

FIG. 5.

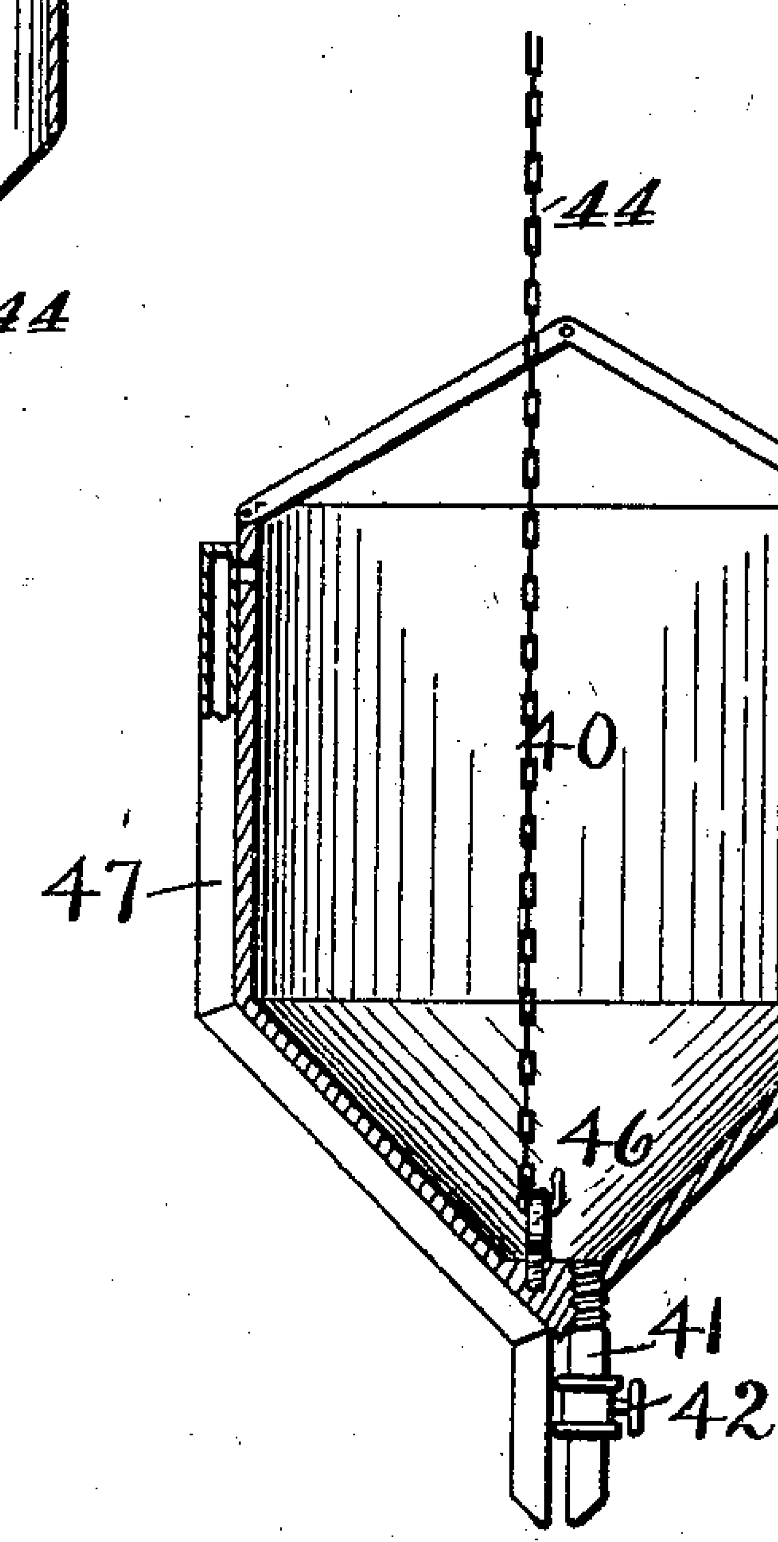

FIG. 6.

Witnesses
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UNITED STATES PATENT OFFICE.

ARTHUR JOHN HOPKINS, OF AMHERST, MASSACHUSETTS.

HEAT-REGULATOR.

SPECIFICATION forming part of Letters Patent No. 725,341, dated April 14, 1903.

Application filed November 4, 1901. Serial No. 81,019. (No model.)

To all whom it may concern:

Be it known that I, ARTHUR JOHN HOPKINS, a citizen of the United States of America, residing at Amherst, in the county of Hampshire and State of Massachusetts, have invented a new and useful Heat-Regulator, of which the following is a specification.

My invention relates to improvements in regulators for governing the heat from furnaces, boilers, and the like, in which two mediums of different degrees of density (one being very sensitive to atmospheric changes) employed to control a liquid which serves both as an intermediate factor and as a motive power and suitable appliances for utilizing these elements in a practical manner are made use of, all as hereinafter fully described, and especially pointed out in the claims.

The objects of my improvement are, first, to provide a heat-regulator in which the amount of work that can be performed thereby does not depend upon the degree of sensitiveness of the device and in which said amount of work and degree of sensitiveness are both practically unlimited; second, to produce a regulator which is inexpensive and simple in construction and operation, safe, durable, compact, and not liable to get out of order, and, third, to produce an automatic heat-regulator in which the advantages enumerated above are present and one that is free from any of the disadvantages of other devices in this class.

Since this regulator when complete should include an expanding medium or thermostat as one of its four primary elements, the other elements being an intermediate factor controlled by said thermostat, a motive power which depends upon and is evolved from said intermediate factor, and the load directly governed by said motive power, a thermostat and regulating means therefor are shown and described for the purpose of rendering clear and comprehensive an explanation of the general operation of my invention. It will be understood, however, that any practical thermostat may be substituted for the one above alluded to. A light expanding liquid—as acetone, chloroform, or alcohol—and a heavy liquid, as mercury, enter into the formation of this particular thermostat. Acetone and mercury provide an exceedingly sensitive but entirely adequate means of control for the intermediate factor, which is water by preference. Water is easily controlled and readily changes from the intermediate factor to a motive power sufficient for all practical purposes. As a motive power water is employed in this regulator for moving the load in both directions. The load may consist of one or more draft-governors on a hot-air furnace, a steam valve or valves of a boiler, and the like. In my device it is desirable to maintain the water-supply at an approximately constant level in order to render its flow easy to control and to provide a current of substantially uniform "head." After the current passes the point of control, however, the water increases in volume and weight and possesses energy by reason of its position. In other words, I am able to control a water-current of extremely low head by a very sensitive expanding medium and quickly transform it into a heavy motive power to move the load. Simplicity and low cost of construction follow as a consequence of the use of one element, as water, for both the intermediate factor and motive power. Another advantage resides in the fact that after the water has been employed to produce one effect upon the governors no further supply is needed to bring about the reverse effect.

I attain the objects, accomplish the results, and utilize the elements above alluded to in a general way by the mechanism illustrated in the accompanying drawings, in which—

Figure 1 is a general view of my regulator on a reduced scale, showing its application to a furnace; Fig. 2, a view showing a method of applying it to a steam-valve; Fig. 3, a full-size longitudinal vertical section through the tank; Fig. 4, a plan view of said tank; Fig. 5, a vertical section through the tank, thermostat, and eductor; and Fig. 6, a vertical section through the drip-cup.

Similar figures and letters refer to similar parts throughout the several views.

A tank 10 is provided to hold the liquid (water, preferably) used in my device in the first instance as an intermediate factor, and said water is retained at an approximately constant level (denoted by broken lines *a* in Figs. 3 and 5) by means of a float 11 and valve 12. A support 13 is secured to the floor of the tank 10, to which the holder 14 is pivoted at 15. The bent rods 16 and 17 connect the float 11 with the holder 14, being securely fastened at opposite ends to each. The float is preferably constructed with a drop-top 11^a for the purpose of leaving space for the introduction of shot or other heavy material should it be desired to raise the water-level, since by increasing the weight of the float a larger body of water is required to elevate the same for the closing of the valve 12. The valve 12 operates in a tube 18, extending through the support 13 and the bottom of the tank and provided with a valve-seat 18^a. The stem 12^a of the valve is attached to a rod 19, depending from a sleeve 20, slotted at 20^a to receive the float-rod 17, to which it is pivoted at 21. The tube 18 opens into a tube 22, which is fastened thereto below the tank-bottom, and the coupling 23 connects a nipple 24 with said tube 22. A pipe 24^a leads from the nipple 24 to a constant source of water-supply.

From the foregoing it will be understood that when water is drawn out of the tank 10 the float 11 will descend and open the valve 12 for the admission of more water, rising again with the latter to close said valve when the mark *a* is reached by the water. In this manner a water-level with very little variation is maintained, since the quantity of water flowing from the tank is small, as will presently appear.

It is obvious that other means for governing the intake of the tank may be employed, but that just described is simple and has been found to work satisfactorily.

A hole is located in the bottom of the tank for the reception of a tube 30, and on the outside of the tank adjacent to said hole an eduction-cup 26 is formed, outside of which latter is an eduction-tube 27, the centers of the hole, cup, and the tube preferably being in the same straight line. The hole 28 in the upper part of the cup 26 opens from the latter into the tube 27. An internally-threaded regulator-tube 29 rests upon the floor of the tank and is held in place by the externally threaded and shouldered tube 30, the small end of which passes upward through the hole in said floor to screw into said tube 29. The tube 29 opens into the cup 26 through a short connection 31. The adjusting-tube 32 of the regulating device is externally threaded at its lower terminal to screw into the tube 29, opens into the tank through holes 33, located below low-water level, and is closed at the top by a rod 34, rigidly attached thereto and extending upward through the floor *b* into the room above. The rod 34 terminates in a head 34^a to grasp for turning the tube 32. A tube 35, preferably of glass, is fixed in the lower end of the tube 32. A **U**-shaped receptacle 36 has one terminal securely connected with the tube 30, into which it opens, by means of a coupling 37, and the glass tube 35 extends some distance below this terminal. The outside diameter of the tube 35 is smaller than the passage below the end of its supporting-tube 32, which opens into the connection 31. A small pipe 38 rises from the closed top of the outer terminal of the **U**-shaped receptacle 36 and has a liquid-reservoir 39 mounted on the upper end thereof. The pipe 38 opens into both the receptacle 36 and the reservoir 39. The reservoir 39 should be supported some five feet from the floor in the room above by the pipe 38, which passes upward through said floor. Mercury stands in the lower part of the receptacle 36 about as indicated by the dotted lines *c* and *c'* in Fig. 5, and the acetone or other liquid in the reservoir 39, pipe 38, and upper part of the connected arm of the receptacle 36 rests upon the mercury at *c*. The receptacle, reservoir, and connecting-pipe, with their contents of sensitive elements, make up or complete the thermostat or initial factor which I prefer to employ with my invention, although, as before stated, a suitable substitution may be made.

A vertically-movable drip-cup 40, having an outlet 41 at the bottom, governed by a valve 42, is designed to be suspended by a chain or cord 43 below the eduction-tube 27. A chain or cord 44, supported by a pulley 45, Fig. 1, and having one end fastened to the float 11 or one of its rods 16 or 17 at some suitable point, as at *d*, Fig. 3, and the other end to a convenient part of the drip-cup 40, as the screw-eye 46, Fig. 6, is adapted to raise said float and close the valve 12 when said drip-cup is in its lowest position, as will be explained more fully hereinafter. In order to provide against an overflow of the drip-cup from any cause, some convenient means, as an outside tube 47, may be employed. This tube opens at the top into the upper part of the drip-cup and at the bottom on a level with the base of the outlet 41. The drip-cup is so suspended that it opens directly above a receiver 48, which may be connected with a sewer.

Referring to Fig. 1, a furnace *e* is shown having an ordinary draft-door 49 and check-damper 50, connected by a chain or cord 51, passing over a pulley 52. The cord 43 passes over a pulley 53 and under a pulley 54 to be attached to the cord 51. The several pulleys are supported by or from the floor-joists, and the tank is suspended therefrom by a bracket 55 or otherwise. The door 49 is weighted sufficiently to counterbalance the damper 50 and the drip-cup 40 when empty and overcome friction, thus holding the former open and maintaining the latter in its elevated position through the medium of the connecting-cords, as shown by full lines.

Assuming that the tank is filled with water to the proper height, the regulator set to an average temperature of 69°, for example, and the parts standing as shown by full lines in Fig. 1, the operation of my regulator is as follows: As the fire in the furnace decreases in fervency the air surrounding the reservoir 39 becomes cooler and the acetone in the thermostat begins to contract, the mercury drawing away from the base of the glass tube 35, which has previously been covered thereby, so that no water could escape. When the base of the tube 35 is open, as indicated in Fig. 5, water which has been standing therein, having entered from the tank through the holes 33 and the passage in the tube 32, runs out onto the mercury, rises around the outside of said tube, passes into the cup 26 from the passage in which the glass tube is inclosed through the connection 31, rises in said cup, and overflows through the hole 28 into the tube 27, from which it falls into the drip-cup 40. The cord 44, although slack, owing to the elevated position of the drip-cup, extends into the latter and serves as a guide for the falling water to prevent spattering, as well as for another purpose hereinbefore mentioned. The head of water in the tank is represented by the distance between the mark at *a* and the base of the hole 28, and the arrangement of the float and valve is such that the mark representing water-level will not fall below the center of said hole, except as stated hereinafter. Hence it will be seen that, with the exception alluded to, water must continue to overflow into the drip-cup as long as the base of the glass tube is clear of mercury. When the accumulating weight of water in the drip-cup is sufficient to overcome the force exerted by the weighted door 49 and friction, said cup begins to descend and to open said door and close the damper 50. The drip-cup continues to move downward until the positions of the door and damper are respectively reversed and the parts stand as indicated by dotted lines in Fig. 1. A stop 56 on the front of the furnace above the door 49 or other suitable device may be employed to limit the movement of the parts in the directions just described. The descent of the drip-cup has drawn the cord 44 taut by the time the lowest position is reached and caused the valve 12 to be closed. Now no more water can enter the tank and after the entire head of water has been exhausted no more can flow into the drip-cup until it is elevated. Seldom, if ever, will the entire head be exhausted in this manner; but the positive closing of the valve 12 at this time causes the head to decrease, and thus economize in the use of water. The changed positions of the draft-governors having produced a hotter fire and a consequent rise in temperature in the atmosphere about the reservoir 39, the acetone begins to expand, and a rise of one-tenth (more or less) of a degree in temperature is sufficient to bring about the closing of the base of the glass tube by the mercury, which is pressed completely over said base by the expanding acetone. The water is now shut out of the eductor, which quickly empties into the drip-cup. The drip-cup valve 42 is set to permit water from the cup to escape slowly into the receiver 48 below, more slowly, of course, than it runs in when the inner end of the eductor is open. Water having been cut off from the drip-cup in the manner above described, the contents of the same escapes through the outlet 41 until said cup is lightened sufficiently for the weighted door 49 to overcome all resistance offered thereto and swing downward into its closed position, at the same time opening the damper 50 and elevating said cup. The drip-cup may empty in ten minutes, more or less, according to size and the position at which the valve is set. The parts now stand as originally, ready to repeat the cycle before described. Some furnaces and fuel will not respond to the regulator as readily as others, so that results may be affected; but the material efficiency of the regulator itself is not affected. When it is desired to alter the average temperature—to reduce it at night, for instance—screw down the tube 32 to decrease the maximum distance between the mercury and the base of the glass tube. A lower degree of temperature and greater contraction of acetone than before are now required to open the way into the eductor for opening the furnace in the manner described. Suppose the average night temperature to be 60°, a drop of about one-tenth of a degree causes the regulator to open the furnace, and a rise of one-tenth closes it in the same manner as when the device was set to an average of 69°. Conversely, the raising of the tube 32 increases the maximum distance between the mercury and the base of the glass tube, and a higher degree of temperature and greater expansion of acetone than in the first instance is required to prevent the escape of water into the drip-cup. The cycle of operation in every case so far as relates to rise and fall above and below the average remains the same.

In Fig. 2 a section of a steam-pipe *f* is shown with a valve-stem 57, to which a pulley 58 is fixed. A drip-cup 40 is suspended from a chain or cord 43ª, passing over a pulley 53ª and having one end fastened to the pulley 58. A weight 59 is suspended from the pulley 58 by a chain or cord 51ª, having one end fastened to said pulley. An approximately full drip-cup overcomes the weight 59, rotates the pulley 58, and opens the steam-valve, and when the contents of said cup has escaped said valve is released to the action of the weight which closes it.

Numerous ways of applying my regulator to heating apparatuses may be employed according to the exigencies of the case, the regulator, however, remaining practically the same.

By increasing the size of the drip-cup an increase in time necessary to overcome balance results; but a greater load can be moved thereby, while the sensitiveness of the thermostat is not affected.

Changes in shape, size, arrangement, and construction other than those hereinbefore noted may be made within proper limits without departing from the nature of my invention.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. The combination with a liquid-tank, of an eductor comprising a cup 26 communicating through intermediate tubular members with the interior of said tank, and a tube 27 opening into said cup slightly below the approximately constant liquid-level maintained in the tank; and a thermostat to control the flow of liquid from the tank through said eductor, substantially as set forth.

2. The combination with a liquid-tank, of an eductor comprising a cup 26 communicating through intermediate tubular members with the interior of said tank, and a tube 27 opening into said cup slightly below the approximately constant liquid-level maintained in the tank; a thermostat to control the flow of liquid from the tank through said eductor; and a movable drip-cup to receive liquid from the eductor, substantially as set forth.

3. The combination with the governor or governors of a heater, of a liquid-tank; an eductor comprising a cup 26 communicating through intermediate tubular members with the interior of said tank, and a tube 27 opening into said cup slightly below the approximately constant liquid-level maintained in the tank; a thermostat adapted to control the flow of liquid from the tank through said eductor; and a movable drip-cup connected with said governor or governors to receive liquid from the eductor, substantially as set forth.

4. The combination, in a heat-regulator, of a water-tank having a float therein connected with a valve, with an eductor, a movable drip-cup to receive water from said eductor, and means to positively actuate said float to close the connected valve when said drip-cup is at the farthest limit of its travel.

5. The combination of a water-tank, an eduction-cup, an eduction-tube opening into the latter, and a receptacle below said tank, with a tubular member 29 in the tank opening into said cup and receptacle, and tubular members 32 and 35 supported by said member 29 and opening into the tank and receptacle, for the purpose set forth.

6. The combination with a water-tank, of an eductor comprising a cup 26 communicating through intermediate tubular members with the interior of said tank, and a tube 27 opening into said cup; a thermostat adapted to control the flow of water through said eductor; and means to maintain an approximately uniform "head" of water in the tank, the opening between said cup and tube being slightly below the approximately constant water-level, substantially as set forth.

7. The combination with the governor or governors of a heater, of a tank arranged to maintain liquid at an approximately constant level; an eductor comprising a cup 26 communicating through intermediate tubular members with the interior of said tank, and a tube 27 opening into said cup slightly below said approximately constant liquid-level; a thermostat adapted to control the flow of liquid from the tank to said cup; a movable drip-cup connected with said governor or governors; and a valve to regulate the escape of liquid from said drip-cup, for the purpose set forth.

8. The combination, in a heat-regulator, of a water-tank, with an eductor, a movable drip-cup to receive water from the eductor, and a chain or cord hanging from the eductor-outlet to guide the water into said drip-cup and prevent spattering, substantially as set forth.

9. The combination, in a heat-regulator, of a water-tank having a float therein connected with a valve, with an eductor, a movable drip-cup to receive water from the eductor, a chain or cord connected with said float and drip-cup and loose only when the latter is at the farthest limit of travel, and means independent of said chain or cord for supporting the drip-cup, substantially as set forth.

10. The combination, in a heat-regulator, of a water-tank having a float therein connected with a valve, with an eductor, a movable drip-cup to receive the water from the eductor, and a running chain or cord connected with said float and drip-cup and passing through the eductor-outlet, substantially as set forth.

11. In a heat-regulator, the combination of a tank connected with a water-supply, with a float provided with rods, a holder attached to the terminals of said rods opposite the float-terminals, a support to which said holder is pivoted, a slotted sleeve pivoted to one of the rods between the float and support, a rod projecting from said sleeve, and a valve at the end of said last-mentioned rod, interposed in said water-supply, substantially as shown and described.

12. In a heat-regulator, the combination of a tank connected with a water-supply having an interposed valve, with a float having a drop-top, a rod rigidly attached at one terminal to said float and having the other terminal pivoted at a fixed point in said tank, and pivotal connections between said rod and valve, for the purpose set forth.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

ARTHUR JOHN HOPKINS.

Witnesses:

F. A. CUTTER,

F. A. MIDDLEBROOK.