No. 677,762. Patented July 2, 1901.

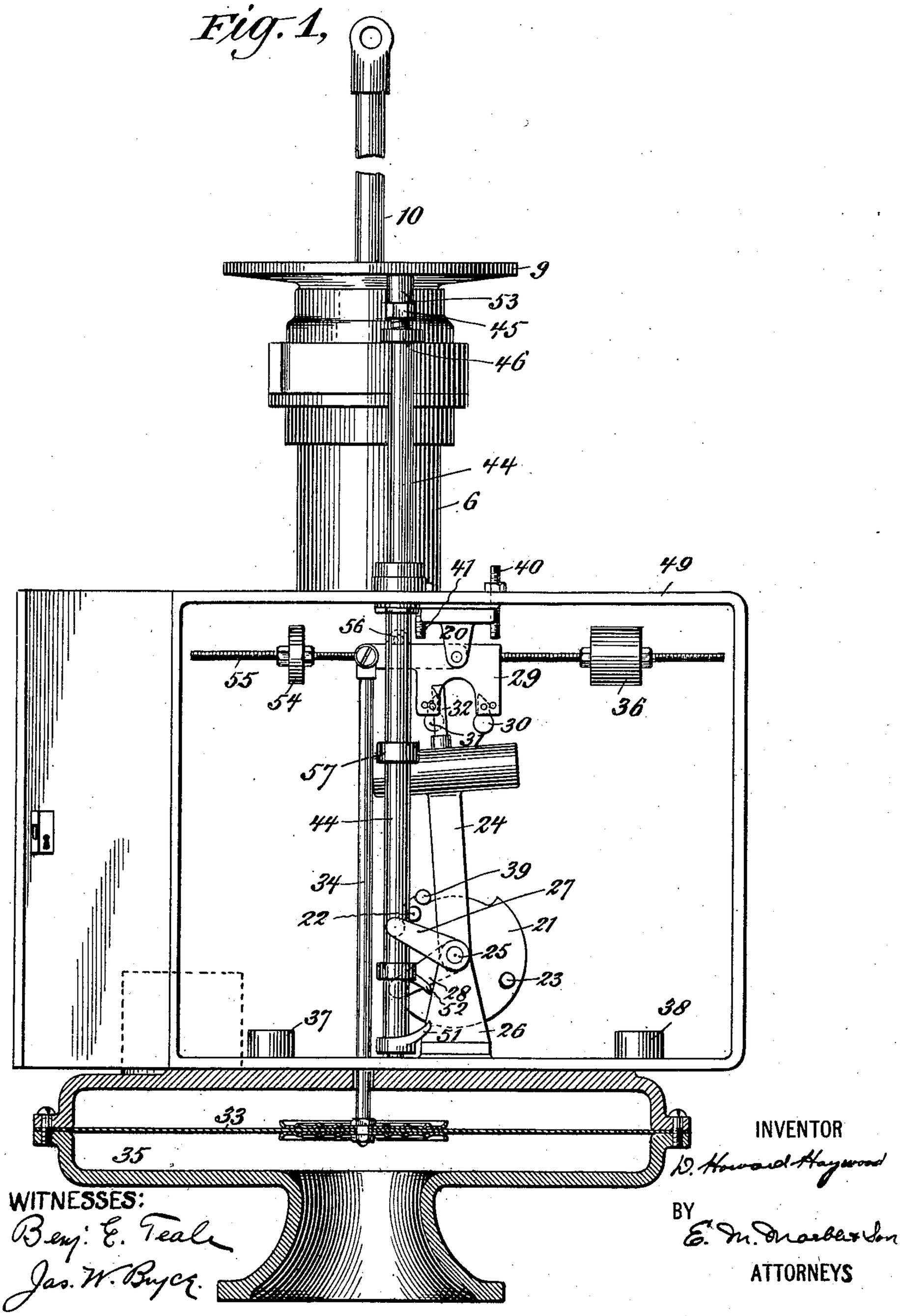
D. H. HAYWOOD.

REGULATOR.

(Application filed July 25, 1900.)

(No Model.) 5 Sheets—Sheet 1.

Fig. 1,



WITNESSES:
Benj. E. Teale
Jas. W. Byck.

INVENTOR
D. Howard Haywood
BY
E. M. Marble & Son
ATTORNEYS

No. 677,762.

Patented July 2, 1901.

D. H. HAYWOOD.

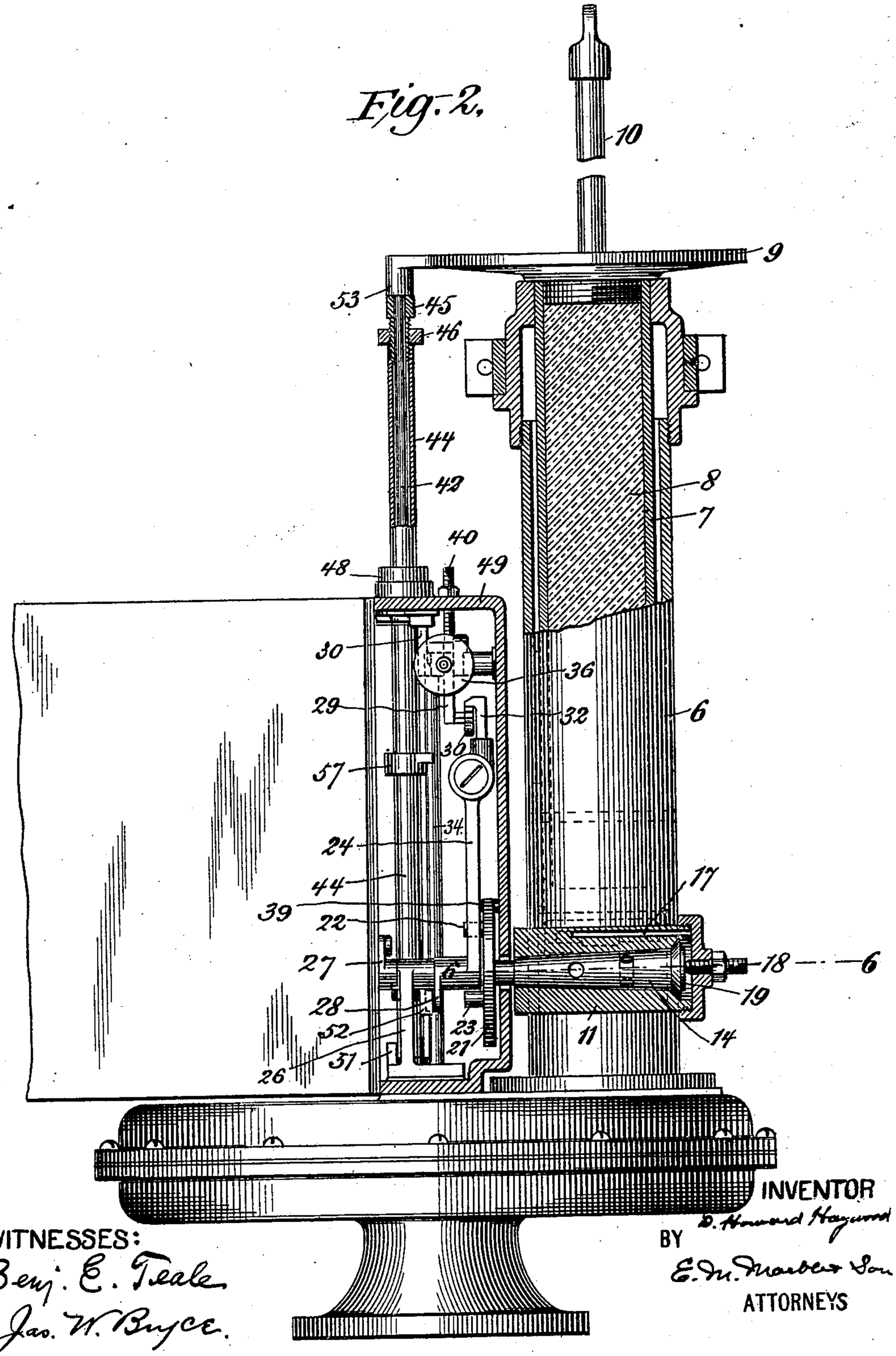
REGULATOR.

(Application filed July 25, 1900.)

(No Model.)

5 Sheets—Sheet 2.

Fig. 2.



WITNESSES:

Benj. C. Teale

Jas. W. Bryce.

INVENTOR

D. Howard Haywood

BY

E. M. Marble & Son

ATTORNEYS

No. 677,762. Patented July 2, 1901.

D. H. HAYWOOD.

REGULATOR.

(Application filed July 25, 1900.)

(No Model.) 5 Sheets—Sheet 3.

Fig. 3,

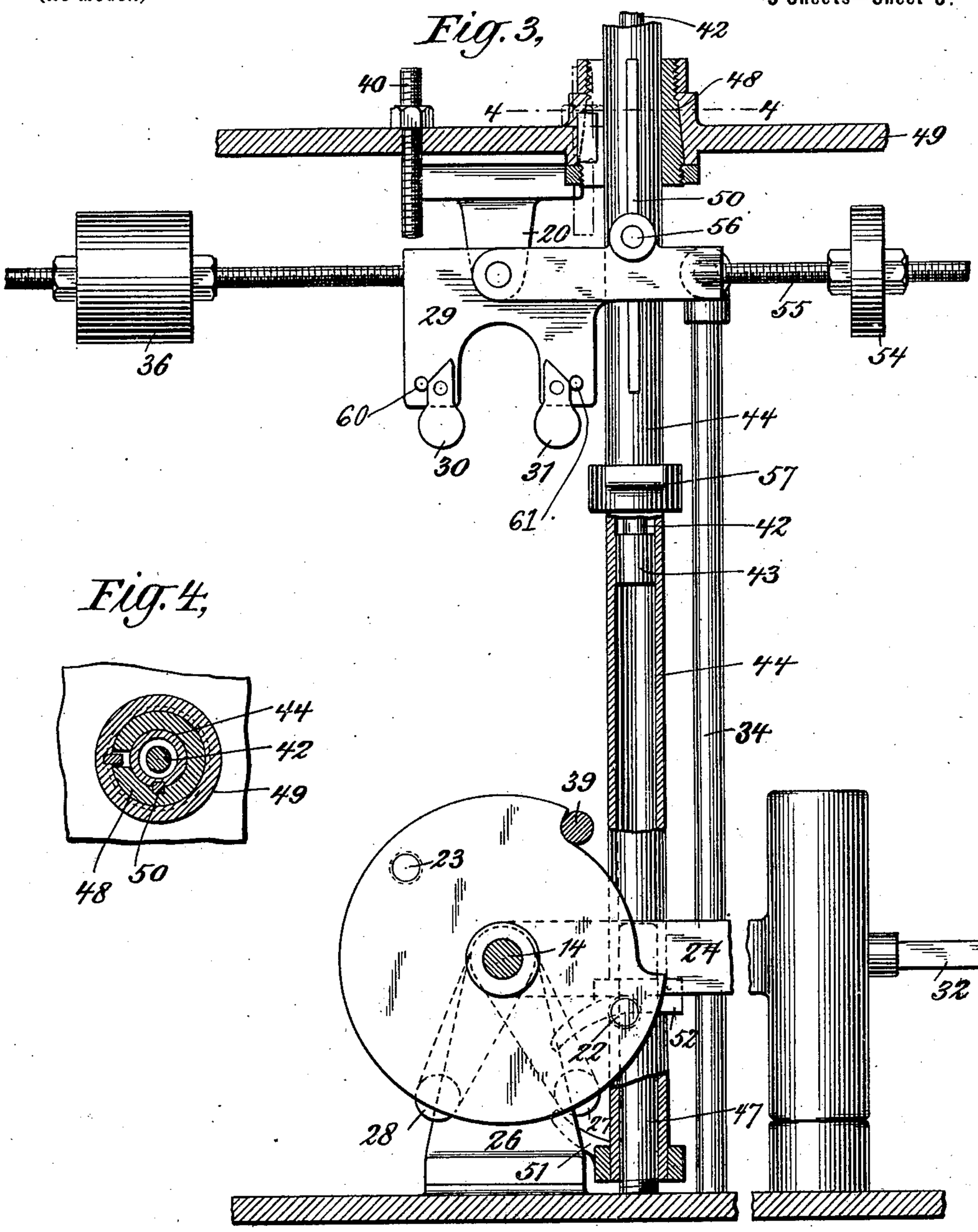


Fig. 4,

WITNESSES:

Benj. E. Teale

Jas. W. Bryce.

INVENTOR

D. Howard Haywood

BY

E. M. Marble & Son

ATTORNEYS

No. 677,762. Patented July 2, 1901.

D. H. HAYWOOD.

REGULATOR.

(Application filed July 25, 1900.)

(No Model.) 5 Sheets—Sheet 4.

Fig. 5.

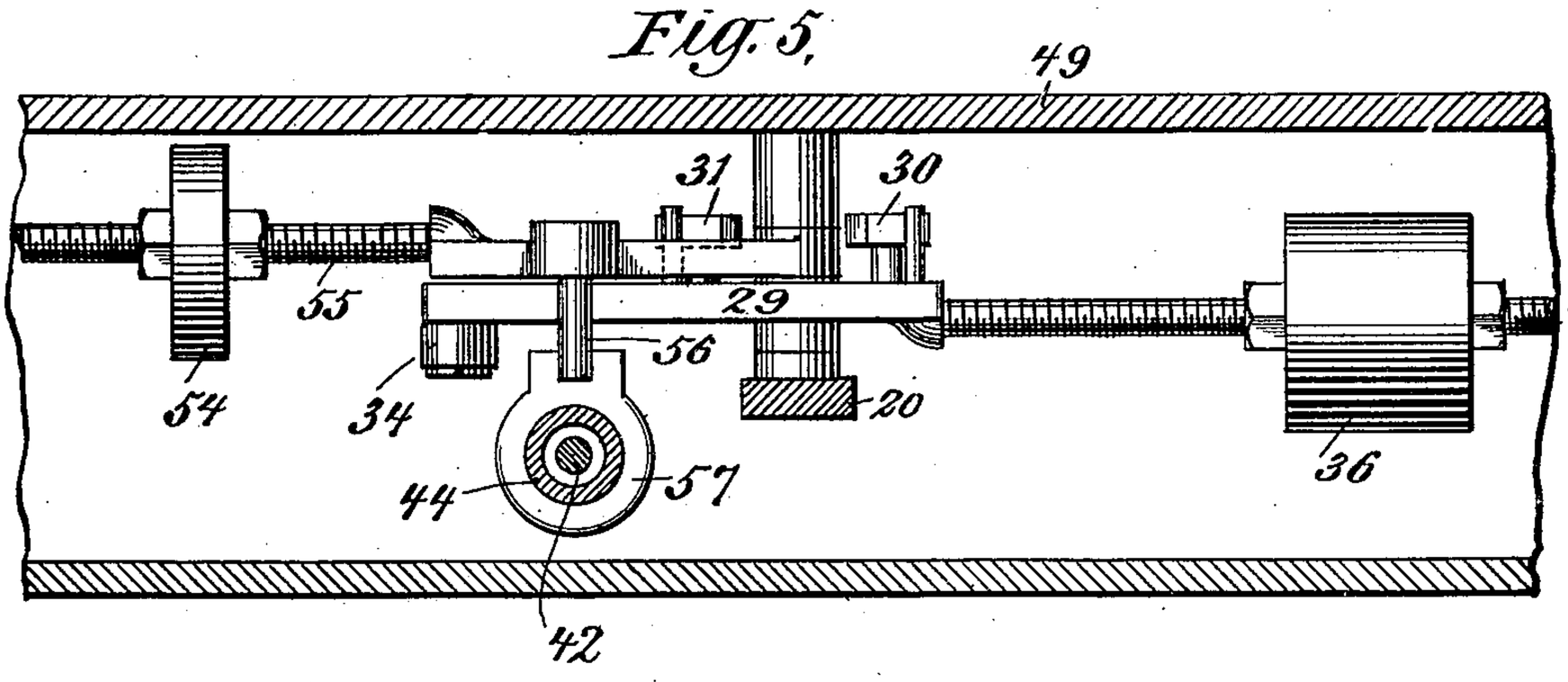
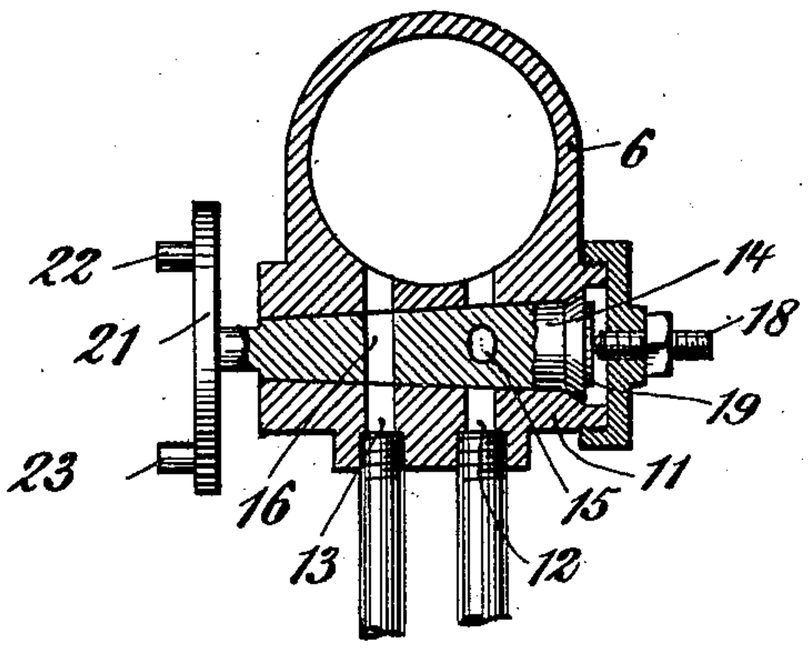


Fig. 6.



WITNESSES:

Benj. E. Teale

Jas. W. Bryce

INVENTOR

D. Howard Haywood

BY

E. M. Marble & Son

ATTORNEYS

No. 677,762. Patented July 2, 1901.

D. H. HAYWOOD.

REGULATOR.

(Application filed July 25, 1900.)

(No Model.) 5 Sheets—Sheet 5.

Fig. 8,

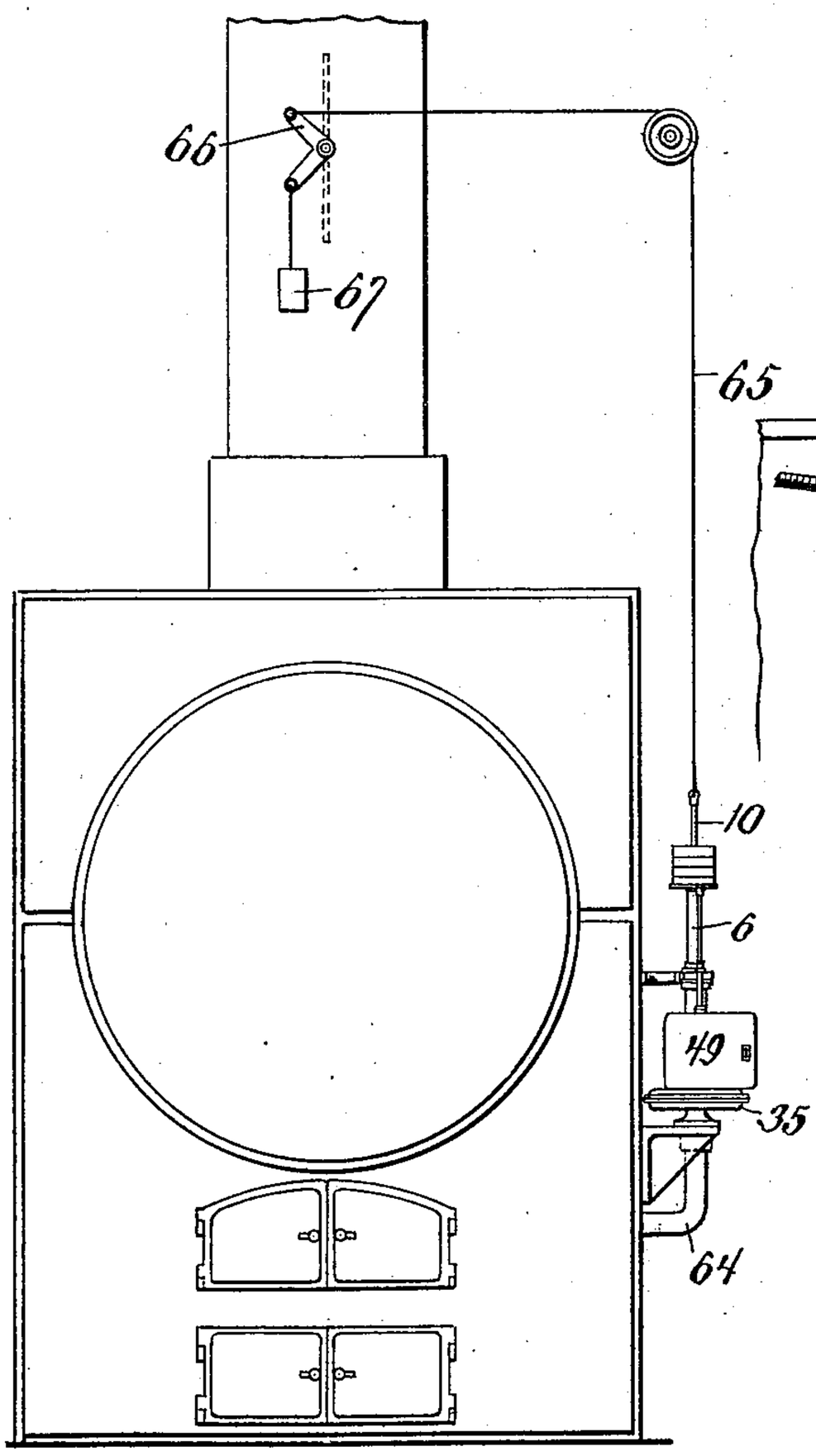
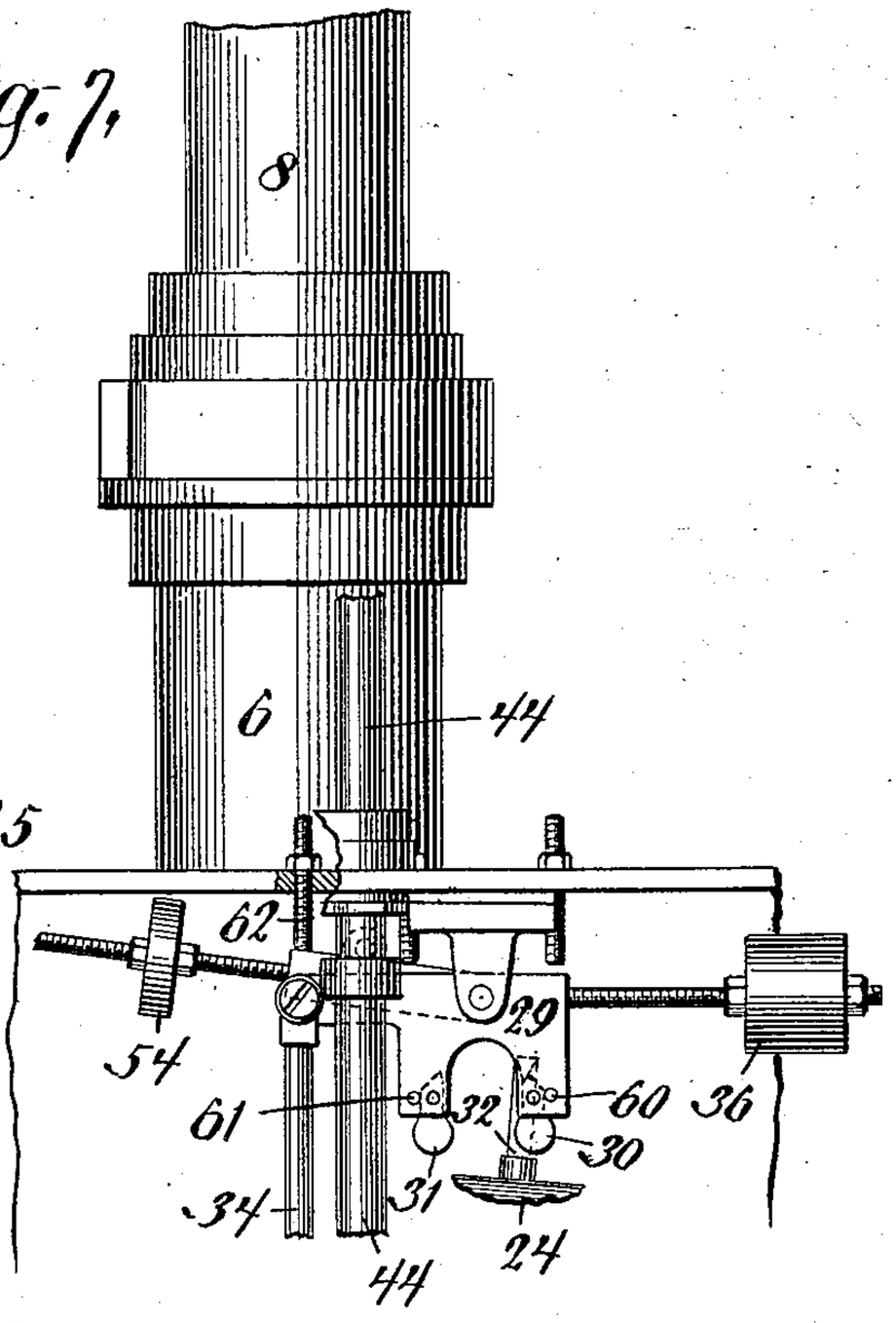


Fig. 7,



WITNESSES:

A. D. Hopkins

Harry S. Marble

INVENTOR

D. Howard Haywood

BY

E. M. Marble Son

ATTORNEYS

UNITED STATES PATENT OFFICE.

DANIEL HOWARD HAYWOOD, OF NEW YORK, N. Y., ASSIGNOR TO BEVERLY W. WRENN, OF SAME PLACE.

REGULATOR.

SPECIFICATION forming part of Letters Patent No. 677,762, dated July 2, 1901.

Application filed July 25, 1900. Serial No. 24,857. (No model.)

To all whom it may concern:

Be it known that I, DANIEL HOWARD HAYWOOD, a citizen of the United States, residing at New York, in the county of New York and State of New York, have invented certain new and useful Improvements in Regulators; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to improvements in regulators, and particularly to regulating devices for valve and damper operating apparatus.

Broadly speaking, my invention consists in mechanism by which any device which calls for the expenditure of a comparatively large quantity of power for its operation may be controlled in its movement by a means which is sensitive to variations of extreme delicacy.

In the drawings forming a part of this specification I have shown my invention as applied to apparatus adapted to open and close dampers in furnace-offtakes automatically for the purpose of controlling the draft through the furnace.

As herein shown, the apparatus consists of a suitable motor for operating the damper, a controlling device operated by changes of the condition within the combustion-chamber of the furnace, an actuating device, and means operated by the actuating device for controlling the operation of the motor.

I have also shown a compensating means for compensating for the changes in condition in the combustion-chamber of the furnace due to the changes in position of the damper.

My invention further consists in certain novel details of construction and combination of parts, as will be hereinafter more fully set forth.

The objects of my invention are, first, to improve and render more efficient regulators of the class above mentioned; second, to increase the delicacy of the control and sensitiveness of the apparatus; third, to increase the durability, strength, and reliability of the device, and, fourth, to simplify and render as inexpensive as possible the construction of the parts.

I will now proceed to describe a regulator embodying my invention and will then point out the novel features in claims.

In the drawings, Figure 1 is a front elevation of an apparatus embodying my invention with the diaphragm and diaphragm-chamber thereof shown in a central vertical section. Fig. 2 is a partial side elevation and partial vertical section of the same. Fig. 3 is a view of certain parts shown in Fig. 1, but viewed from the opposite side, the parts being shown also in somewhat different positions to those in which they are shown in Fig. 1 and certain parts being broken away in order to more clearly illustrate the construction. Fig. 4 is a detail view, in horizontal section, of a friction device employed, the line of section being on the plane of the line 4 4 of Fig. 3. Fig. 5 is a detail top view of the tripping-plate and associated parts. Fig. 6 is a detail view, in horizontal section, upon the plane of the line 6 6 of Fig. 2, showing the valve and its casing and the various parts in connection therewith. Fig. 7 illustrates the use of a stop in connection with the resetting devices. Fig. 8 shows the regulator applied to a furnace for operating a damper in the furnace take-off.

Similar reference characters designate corresponding parts in the several figures.

The motor shown herein is a hydraulic motor, and comprises a cylinder (designated by reference character 6) to which is fitted a plunger or piston having a suitable hydraulic packing—as, for instance, a cupped leather ring. This ring is shown in dotted lines in Fig. 2, but does not appear elsewhere in the drawings. It is not shown more fully in detail, as it forms no part of this invention. The plunger 7 is preferably constructed hollow and loaded with lead, as at 8, for the purpose of operating to return the plunger to its lowermost position. A further object in so loading the plunger is to dispose the weight in such a manner as to keep the center of gravity of the machine as low as possible. The upper end of the plunger is closed by means of a table or platform 9, which is secured thereto and upon which may be added additional weight or weights, as may be desired. A central rod 10 of the desired length is secured to the platform or table, and hence to the plunger, and suitable connections may

be made between the rod 10 and the damper which it is desired to operate, as by connecting the same to the damper-chain commonly in use.

A valve-casing 11 is arranged near the lower end of the cylinder 6, and the said valve-casing is in communication with the interior of the cylinder below the piston or plunger and also with a source of supply of water under pressure. Thus far I have found that by connecting the said valve-casing with a water-supply under city pressure I have obtained all the power that has been necessary from the hydraulic motor.

In addition to the port leading from the interior of the cylinder 6 to within the valve-casing and from thence to a source of supply the valve-casing has also another port which may connect the interior of the cylinder with exhaust. Reference character 12 designates the port leading from the source of supply, and 13 designates the port leading to exhaust. A valve 14 is fitted to the valve-casing 11 and has two ports therein—an inlet-port 15 and an exhaust-port 16. These two ports are so arranged that when the port 15 is in register with the port 12, so that the source of supply is open to the interior of the cylinder 6, the port 16 will be out of register with the exhaust 13 and the interior of the cylinder will be closed to such exhaust. In a similar manner when the port 16 is in register with the port 13 the port 15 will be out of register with the port 12.

In the position in which the ports are illustrated in Figs. 1, 2, and 6 of the drawings the port 16 of the valve is in register with the port 13 and the interior of the cylinder is open to exhaust.

I preferably connect the space which is inclosed between the end of the casing and the end of the valve with exhaust, as through port 17, in order to prevent water under pressure from working into this space or chamber and causing the valve to stick. The valve is kept up to its seat by a steel pin 18, which may be adjusted against an antifriction-disk 19, with which the valve is provided. The valve is also preferably provided with a taper shoulder which acts to further prevent the valve from becoming jammed in the casing. To the opposite end of the valve is secured an operating-disk 21, upon which are mounted operating-pins 22 and 23.

An actuating device, here shown as a pivoted weight 24, is rigidly secured to a stud 25, journaled in a bracket 26. The axis of the stud 25 is preferably in a line with the axis of the valve, but is not connected with said valve. Resetting-arms 27 and 28 are also secured to the stud 25, the function of which will be explained more fully hereinafter.

The actuating device or pivoted weight 24 is maintained in position, as shown in Figs. 1 and 2 of the drawings, by contact with a trip. The trip comprises a pivoted plate 29, carrying two trip-pawls or catches 30 and 31. An extension or finger 32, projecting upwardly from the weighted lever 24, rests against one of these trip-pawls when the apparatus is set in operation. Stop-pins 60 and 61, projecting from the plate 29, prevent the pawls 30 and 31 from yielding to the pressure of the arm or lever 24 against one or the other of said pawls. In Fig. 1 this finger is shown resting against pawl 31.

The trip is connected to a diaphragm 33 by means of a connecting-rod 34, and the diaphragm 33 is mounted in a suitable diaphragm-chamber 35. The upper part of the diaphragm-chamber 35 is open to the atmosphere, while the lower part is arranged to be connected with the combustion-chamber of the furnace. The trip-plate 29, which is pivotedly mounted upon a stationary bracket 20, is provided upon that side of its pivotal support which is opposite to its connection with the connecting-rod 34 with a threaded rod, upon which is mounted a counterbalance-weight 36. The counterbalance-weight 36 is adapted to counterbalance the weight of the diaphragm and the parts carried by it, and also to partially counterbalance the suction upon the lower side of the diaphragm, due to the connection of the lower part of the diaphragm-chamber with the combustion-chamber of the furnace. When the suction in the lower part of the diaphragm-chamber 35 pulls upon the diaphragm to such an extent as to overcome the moment of the weight 36 in the opposite direction, the actuating device or pivoted lever 24 will be released from its engagement with the tripping-pawl 31 and will be free to rotate upon its support. From the position shown in Fig. 1 the said actuating device or pivoted weight will fall to the left, and in falling the shank thereof will engage with the pin 22, and by such engagement will carry the disk around with it.

The disk, as before explained, carries the valve, and hence the falling of the actuating device or pivoted weight will cause the rotation of the valve and the reversal of its position. The port 16 will be moved out of register with the port 13, and the port 15 will be moved into register with the port 12.

The movement of the actuating device or pivoted weight is limited in one direction by a stop 37, which stop may be a spring-buffer or may be a rubber or wooden plug. In the present machine I have obtained good results by constructing the stop 37 of wood. I also provide a stop 38 upon the opposite side of the center of rotation of the actuating device, which may also be of wood.

A stop is provided to limit the movement of the disk 21 in either direction, and hence of the valve 14, and to prevent the overthrow of the same due to inertia. Such stop, as here shown, comprises a stationary pin 39, against which shouldered portions of the disk engage at opposite limits of its movement.

Adjustable stops 40 and 41 limit the movement of the trip, and through the connecting-

rod 34 also limit the movement in either direction of the diaphragm.

When the valve has been moved into such position as to bring the port 15 into register with the port 12, water under pressure will be admitted to the lower end of the cylinder 6. The piston or plunger 7 will be forced upwardly and the damper or other device connected to the motor will be operated.

A resetting-rod 42 is secured to the table or platform 9 and is carried upwardly upon the upward movement of the plunger. The lower end of the resetting-rod 42 is provided with a head 43. (Shown more clearly in Fig. 3.)

The resetting-rod 42 telescopes into a resetting-sleeve 44, the said rod passing through an adjustable bushing 45, with which the upper end of the resetting-sleeve is provided. A suitable lock-nut 46 locks the adjustable sleeve into such position as it may have been adjusted. The lower end of the resetting-sleeve 44 is mounted and adapted to slide upon a stationary upright pin 47.

At a point intermediate of its length the resetting-sleeve 44 passes through a split bushing 48, which is mounted in a casing 49, in which certain parts of the mechanism are inclosed. The bushing 48 has a tapered portion which engages with a corresponding taper in the said casing. Suitable adjusting-nuts are provided, by the manipulation of which the split bushing may be adjusted. When moved in one direction by the manipulation of these adjusting-nuts, such movement in this case being upwardly, the said split bushing will be contracted or drawn together and will thereby more closely embrace and press with frictional contact the resetting-sleeve 44. A key secured to the casing and projecting into the open or split portion of the bushing prevents the rotation of the bushing within the casing, and a spline or feather 50, with which the resetting-sleeve 44 is provided, engages with a suitable groove in the split bushing 48 and prevents the rotation of the resetting-sleeve 44 therein. This construction will be more readily understood by reference to Figs. 3 and 4. Near its lower end the resetting-sleeve 44 is provided with two resetting-cams 51 and 52. In its upward movement, caused by the rise of the plunger 7, the resetting-rod 42 will travel until its head 43 comes in contact with the lower face of the bushing 45 in the upper end of the resetting-sleeve 44. Further upward movement of the resetting-rod 42 will carry the resetting-sleeve 44 with it. The cam 51 will at such time engage and carry along with it the resetting-lever 27, (see Fig. 3,) which will cause the rotation of the actuating device or pivoted weight 24 to a sufficient extent to bring the center of gravity of the said pivoted weight upon the opposite side of its pivot-pin 25. In so doing the finger 32 of the actuating device will first of all pass the pawl 31, which will swing aside for such purpose, and the said actuating device will be held from further movement by the engagement of the upper end of its finger 32 with the tripping-pawl 30. The range of movement of the plunger or piston is correctly timed and limited, so that it shall in the latter part of its upward movement lift the resetting-sleeve 44 to an extent sufficient to thus reset the actuating device and no more. During this movement of the actuating device or pivoted weight 24 the operating-disk 21 will remain stationary, owing to the fact that the shank of the weight will pass freely between the two operating-pins 22 and 23, and the operating-disk is hence clear of the moving parts. The machine will now remain stationary in the position to which the parts have moved—namely, with the plunger at its uppermost position—the actuating device resting against the tripping-pawl 30 and the valve with its port 15 in a line with the inlet-port 12. The parts will remain in such position until the downward moment, exerted by the counterbalance-weight 36, overcomes the suction or pull beneath the diaphragm 33, as will be the case when such pull is decreased by the opening of the furnace-door. When such suction or pull is so overcome, the tripping-plate 29 will rotate upon its support and the trip-pawl 30 will be removed from in front of the finger 32 of the pivoted weight or actuating device. The pivoted weight or actuating device will then fall toward the right, (as viewed from the front of the machine or looking at the machine in the direction of Fig. 1 of the drawings,) and in its movement the actuating device will by its engagement with the operating-pin 23 upon the operating-disk 21 reverse the position of the valve 14, closing the inlet-port 12 and opening the exhaust-port 13 to the interior of the cylinder through the port 16 in the valve. The water beneath the piston or plunger 7 will be discharged from the cylinder 6 through the said ports 16 and 13, and the plunger or piston and the resetting-rod will be moved downwardly until a projection or boss 53, with which the platform or table 9 is provided, comes in contact with the top face of the bushing 45 of the resetting-sleeve 44. The resetting-sleeve 44 will then be carried downwardly for the rest of the stroke of the plunger or piston, and in its movement the cam 52 carried thereby will engage with the resetting-lever 28 and through the said resetting-lever will rotate the actuating device or pivoted weight upon its pivotal support until the same is once more in engagement with the tripping-pawl 31.

It will be noticed that the resetting-levers are arranged upon opposite sides of the resetting-sleeve 44, and their resetting-cams 51 and 52 also project on opposite sides thereof. By such arrangement the cam 52 will not interfere with the resetting-lever 27 nor will the cam 51 interfere with the resetting-lever 28.

The split bushing 48 is arranged in this particular application of the device to exert such a frictional pressure upon the resetting-sleeve that the actuating device is not reset

until the motor has substantially completed its stroke in either direction regardless of the position of the trip during such stroke of the motor. If it were desirable that the device should quickly recover itself upon a sudden lowering and raising of the pull upon the diaphragm and that the motor should not under such conditions make a full stroke in either direction, a stop, such as the screw-pin 62 in Fig. 7, may be employed to limit the upward motion of the resetting-sleeve 44, and the split bushing 48 may be relaxed until it offers less frictional resistance to the motion of the resetting-sleeve 44 than do the head 43 of the rod 42 and bushing 45, or either of them. Under these conditions the sleeve 44 is lifted the instant the piston 8 begins to rise, and when its collar 57 engages pin 56 of the weight-arm 55 and lifts the same said arm 55 encounters the stop-pin 62. The upward movement of the resetting-sleeve 44 is thereby limited, and during the remainder of the movement of the piston the resetting-rod slips with respect to the resetting-sleeve.

In the particular use to which I have so far applied my invention and for which use it is particularly adapted, as shown in the drawings herewith, the lower end of the diaphragm-chamber 35 is arranged to be connected with the combustion-chamber of a furnace, and the piston or plunger through its rod 10 is connected with a damper-chain.

Under normal conditions—that is to say, when the fire in the furnace is drawing properly and the furnace-doors are closed and the damper is open—a considerable pull will be exerted upon the lower side of the diaphragm 33 owing to a tendency to vacuum in the combustion-chamber. The amount of this pull will vary largely under different conditions due to differences in the height of the smoke-stack, &c.; but for purposes of this description it will be assumed that the pull on the diaphragm at such times is such as to cause a pull of twenty ounces upon the rod 34. The counterbalance-weight 36 will be adjusted along its supporting-rod to such a point that the lessening of the pull upon the connecting-rod 34, through the diaphragm 33, of, say, two ounces will cause the weight 36 to overbalance such pull and to rock the tripping device upon its support.

Under the normal or running conditions, in which, as before stated, the damper would be wide open, the piston or plunger would be at the uppermost end of its stroke and the actuating device or pivoted weight resting against the pawl 30. If now the furnace-door be opened and cold air be admitted to the interior of the furnace, the inrushing air will decrease the partial vacuum which has existed in the combustion-chamber, and the pull upon the diaphragm and its connecting-rod will be decreased. The counterbalance-weight 36 in overbalancing such pull will so rotate the tripping-plate device as to lower the pawl 30 to permit the actuating device or pivoted weight to fall and in so falling to rotate the valve to close the inlet-port and open the exhaust-port, whereby the water in the cylinder may be discharged. The plunger will move downwardly and in so moving will close the damper. During its final downward movement it will reset the actuating device and the parts will be in such position as they are shown in Fig. 1 of the drawings. The result of the above will be that further cold air will be prevented from entering the furnace due to the draft having been shut off in the offtake, and economy to a great extent will result.

With the furnace-door open the suction upon the diaphragm 33, and consequently the pull upon its connecting-rod 34, will be reduced to almost nothing, at the most to, say, about one ounce. The reason that there may be even this slight vacuum is that even though the damper be closed there will be some slight escape of furnace-gases to the offtake through orifices in the damper or the like, which orifices or their equivalent are always provided to prevent the forcing of the furnace-gases out into the boiler-room when the furnace-damper is closed. Now when the furnace-door is closed the tendency to vacuum in the combustion-chamber is slightly increased, so that there is a slight increase of pull upon the lower side of the diaphragm 33. The total amount of pull at such times upon the rod 34 may not amount to more than, say, two ounces. This in so far as the device has been at present described would not be sufficient to overbalance the counterbalance-weight 36 and to operate the tripping device in such a way as to release the actuating device to operate the valve for the purpose of admitting water to the cylinder, and thereby open the damper. For the purpose of taking care of such condition of things, however, I have provided a compensating device, which comprises a compensating weight 54, adjustably supported upon a beam 55. The beam 55 is pivotally supported upon the bracket 20, which supports the tripping-plates. As here shown, the same pivot-pin which supports the tripping-plate has been employed for this purpose in order that the axis of rotation of the tripping-plate and that of the beam 55 may be the same. This is but a matter of convenience. The said beam 55 is moved, however, entirely independently of the movement of the tripping-plate. The beam 55 is provided with a pin or projection 56, and at certain times this pin or projection rests upon the tripping-plate 29 upon that side of its pivotal support which is opposite to the weight 36. When so resting upon the tripping-plate, the weight 34 acts to partially counterbalance the weight 36. Provision is made in the screw-threaded portion of the beam for the correct adjustment of the weight 54 along the same, so that the amount of such counterbalancing shall be easily determined and readily accomplished. When the parts

are in position as shown in Fig. 1, which is the position just described, and the furnace-door is opened and the damper is closed, the compensating weight 54 is adjusted to so counteract the effect of the counterbalancing-weight 36 that the tripping-plate will be rotated upon its axis to remove the pawl 31 from the actuating device when the pull upon the lower side of the diaphragm, and consequently upon its connecting-rod 34, shall have reached a strength of, say, two ounces. It has just been stated that the closing of the furnace-door will raise the pull upon the diaphragm to an equivalent of two ounces, and hence the action of closing the furnace-door will cause the tripping device to operate and to release the actuating-weight, which will then fall to the position shown in Fig. 3 of the drawings. This will rotate the valve, closing the exhaust and opening the inlet. The piston or plunger will be raised and the damper opened. During the latter portion of the stroke, in the manner before explained, the actuating device will be reset, and the finger 32 thereof will again rest against the pawl 30. The resetting-sleeve 34 is further provided with a projection 57, which projection upon the last of the upward movement of the said resetting-sleeve will engage with the end of the pin or projection 56 upon the compensating beam 55. Upon the completion of the upward movement the said projection 57 will lift the pin 56 from engagement with the tripping-plate and will consequently lift the compensating beam and weight entirely clear of the tripping device. The counterbalance-weight 36 will then be free to exert its entire force to operate the tripping-plate; but the damper having been opened the partial vacuum in the combustion-chamber of the furnace has been reëstablished and will have been raised from, say, two ounces to, say, twenty ounces, and the weight 36 will not so operate, therefore, until the said pull upon the diaphragm shall have lowered to, say, eighteen ounces. By the use of this compensating device it will be seen that by the lowering of the pull or pressure upon the connecting-rod 34 from above, say, eighteen ounces to below such amount is sufficient to operate the device in one direction, while the raising of the pull or pressure from below, say, two ounces to above such amount is sufficient to operate the device in the other direction. It will also be seen that the counterbalance and compensating weights are independently adjustable, and the machine may therefore be readily adjusted to meet any and all conditions.

In the drawings the weight 36 is shown as being much larger than the weight 54. Weight 36 counterbalances the weight of the diaphragm 33 and the rod 34, and therefore must be much heavier than the weight 54. The addition of the moment of weight 54 to that of the diaphragm and rod 34 suffices to so nearly counterbalance the moment of weight 36 that the increase in pull on the diaphragm from the assumed pull of one ounce to the assumed pull of two ounces overbalances the weight 36.

The faces of the tripping-pawls 30 and 31, which engage the finger 32 of the actuating device 24 when holding said actuating device in an upright position, are beveled slightly, as are the corresponding faces of the contact-finger 32. This is done to neutralize the slight friction between the finger 32 and the tripping-pawl with which it is in engagement when the plate 29 moves to release weight 24 and also the friction between plate 29 and its support. The weight of the arm 24 acting through the beveled contact-surfaces upon the tripping-pawl which is holding it suffices to balance this friction, and thereby to increase greatly the sensitiveness of the apparatus.

In Fig. 8 I have shown the regulator applied to a furnace for operating a damper in the furnace-offtake. 64 designates a pipe which connects the portion of the diaphragm-chamber 35 below the diaphragm 33 with the combustion-chamber of the furnace, and 65 designates a cord or chain connecting the piston-rod 10 with the lever 66, which operates the damper. A weight 67 keeps said cord taut as the piston 8 rises.

It is obvious that my invention is capable of modification within wide limits without departing from the spirit and scope thereof, and hence I do not desire to be limited to the precise form or construction shown and described.

What I do claim, and desire to secure by United States Letters Patent, is—

1. In a regulator, the combination, with a motor, of a motor-controller, a falling weight adapted in its movement to operate the motor-controller, a tripping device for releasing the weight, and weight-restoring means which restores the weight during each operation of the motor and prior to the next succeeding operation thereof, and is operated by the motor.

2. In a regulator, the combination, with a motor, of a motor-controller, a falling weight adapted in its movement to engage and operate the motor-controller, but normally out of engagement therewith, a tripping device for releasing the weight, and means for restoring the weight after each fall thereof and prior to the next succeeding operation of the motor.

3. In a regulator, the combination with a motor, of a motor-controller, a pivoted actuating device whose pivotal point is normally below its center of gravity, a tripping device for releasing the actuating device, and restoring means which restores the actuating device during each operation of the motor and prior to the next succeeding operation thereof, and is operated by the motor.

4. In a regulator, the combination, with a motor, of a motor-controller, a pivoted actuating device whose pivotal point is normally below its center of gravity, a tripping device

for releasing the actuating device, and means for restoring the actuating device to its normal position after each fall thereof and prior to the next succeeding operation of the motor; said actuating device being adapted in its falling to engage and actuate the motor-controller, but being normally out of engagement therewith.

5. In a regulator, the combination, with a motor, of a motor-controller, a pivoted weight, a tripping device which normally holds the weight with its center of gravity above and nearly in a vertical line with its pivotal point, but just out of such vertical line, and is adapted to release the weight and permit it to fall, and means operated by the motor for restoring the weight to such upright position after each fall thereof.

6. In a regulator, the combination with a motor, of a motor-controller, a pivoted weight out of normal engagement with the motor-controller, a tripping device for releasing the pivoted weight, and means intermediate of the motor-controller and the pivoted weight whereby the motor-controller may be engaged with, and operated by, the pivoted weight after it has been released by the tripping device and has passed through a portion of its movement.

7. In a regulator, the combination, with a motor, of a motor-controller, a pivoted weight whose pivotal point is normally below its center of gravity and nearly, but just out of, a vertical line therewith, means for restoring the weight after each fall thereof, and a yielding catch and tripping device, which receives and holds the weight when so restored, until operated to release the weight.

8. In a regulator, the combination, with a motor, of a motor-controller, a pivoted weight, a yielding catch and tripping device which receives the weight when raised and holds the same in a nearly, but not quite, vertical position, until operated to release the weight, and means for raising the weight.

9. In a regulator, the combination, with a motor, of a motor-controller, a pivoted weight, a yielding catch and tripping device which receives the weight when raised and holds the same in a nearly, but not quite, vertical position, until operated to release the weight, and means operated by the motor for raising the weight.

10. In a regulator, the combination with a motor, of a motor-controller, a pivoted weight adapted to fall on either side of its support, means actuated by the motor in its operation for returning the pivoted weight to a position at which its center of gravity is above its point of support and slightly to one side of a vertical line passing through the said point of support, and upon that side of such line which is opposite to the side upon which the weight last fell, and a tripping device for releasing the weight to permit the same to fall upon that side of its center of support at which it has been set.

11. In a regulator, the combination, with a motor, of a motor-controller, a pivoted actuating device adapted in its movement to operate the motor-controller, a pivoted tripping device for releasing the actuating device, an automatic controlling device connected to the tripping device upon one side of its pivotal support, and a counterbalance for the controlling device.

12. In a regulator, the combination with a motor, of a motor-controller, an actuating device, a tripping device for releasing the actuating device, an automatic controlling device for actuating the tripping device, a counterbalance tending to move the automatic controlling device in one direction, a compensating device operating to partially neutralize the effect of the counterbalance, and means operated by the motor in its movement in one direction for placing the compensating device out of such operative engagement.

13. In a regulator, the combination with a motor, of a motor-controller, an actuating device, a tripping device for releasing the actuating device, a counterbalance-weight tending to move the automatic controlling device in one direction, a compensating weight operating to partially neutralize the effect of the counterbalance-weight, and means operated by the motor in its movement in one direction for placing the compensating weight out of such operative engagement.

14. In a regulator, the combination with a motor, of a motor-controller, an actuating device adapted in its movement to operate the motor-controller, a pivoted tripping device, a diaphragm attached to the tripping device upon one side of its pivotal support, a counterbalance secured to the tripping device at the other side of its pivotal support, a compensating device pivotally mounted in axial line with the axis of movement of the tripping device, means whereby the compensating device is in engagement with the tripping device during one portion of the movement of the motor, and means whereby the compensating device is moved out of engagement with the tripping device during another portion of the movement of the motor.

15. In a regulator, the combination with a motor, of a motor-controller, a pivoted weight adapted in its movement to operate the motor-controller, a tripping device for releasing the weight, and a resetting device for restoring the weight operated by the motor, and engaging the weight near the completion of a stroke of a motor.

16. In a regulator, the combination with a motor, of a motor-controller, a pivoted weight adapted in its movement to operate the motor-controller, a tripping device for releasing the weight, and a resetting device for restoring the weight operated by the motor, and engaging the weight near the completion of a stroke of the motor in either direction.

17. In a regulator, the combination with a motor, of a motor-controller, a pivoted weight

adapted in its movement to operate the motor-controller, a tripping device for releasing the weight, a resetting-rod carried by the motor and means operated by the resetting-rod in its movement to restore the weight.

18. In a regulator, the combination with a motor, of a motor-controller, an actuating device adapted in its movement to operate the motor-controller, a tripping device for releasing the actuating device, a resetting-rod carried by the motor, a resetting-sleeve engaging with the resetting-rod, and a cam carried by the resetting-sleeve and adapted in its movement to engage with and restore the actuating device.

19. In a regulator, the combination with a motor, of a motor-controller, an actuating device adapted in its movement to operate the motor-controller, a tripping device for releasing the actuating device, a resetting-rod carried by the motor, a resetting-sleeve having a limited movement and in its movement adapted to restore the actuating device, and a friction device for preventing the accidental movement of the resetting-sleeve.

20. In a regulator, the combination with a motor, of a motor-controller, an actuating device for operating the controller, a tripping-plate, and a catch upon said plate, the said catch being rigid in one direction but yielding in the other.

21. In a regulator, the combination with a motor, of a motor-controller, an actuating device for operating the motor-controller, a tripping-plate, and two catches mounted upon the said plate, the said catches adapted to coact with the actuating device and to release the same in opposite directions, and each of the said catches being rigid in one direction and yielding in the other.

22. In a regulator, the combination with a motor, of a motor-controller, an actuating device adapted to operate the motor-controller, a tripping device for releasing the actuating device, a resetting-rod carried by the motor, a resetting-sleeve having a limited movement with respect to a stationary support, a compensating device adapted at certain times to coact with the tripping device, and means carried by the resetting-sleeve for restoring the actuating device and for placing the compensating device in or out of engagement with the tripping device.

23. In a regulator, the combination with an actuating device, movable alternately in opposite directions from a position in which it is set for operation, of a pivoted tripping-plate, and catches carried thereby and adapted each to permit the actuating device to pass when the same is moving in one direction and to hold said actuating device from moving in the opposite direction until the tripping-plate is operated so as to release the actuating device.

24. In a regulator, the combination with an actuating device, movable alternately in opposite directions from a position in which it is set for operation, of a pivoted tripping-plate, and catches carried thereby and adapted each to permit the actuating device to pass when the same is moving in one direction and to hold said actuating device from moving in the opposite direction until the tripping-plate is operated so as to release the actuating device, said catches and the portion of the actuating device with which they engage being constructed and arranged to cause the pressure of the actuating device on either side of said catches, when said actuating device is in position for operation, to compensate for friction in the operation of the tripping mechanism.

25. In a regulator, the combination, with a pivoted actuating device, movable alternately in opposite directions from a position in which it is set for operation, of a pivoted tripping-plate, and tripping-pawls carried thereby and adapted each to permit the actuating device to pass when the same is moving in one direction and to hold said actuating device from moving in the opposite direction until the tripping-plate is operated so as to release the actuating device, said pawls being pivoted to the tripping-plate at points within the arc of travel of the portion of the actuating device with which they engage, and the coacting surfaces of the pawls and actuating device being beveled, so as to cause the pressure of said actuating device on either side of said pawls, when the actuating device is in position for operation, to compensate for friction in the operation of the mechanism.

26. In a regulator, the combination, with an actuating device adapted to control suitable mechanism, of a tripping device for releasing the actuating device, a counterbalance connected to the tripping device, a compensating device adapted to be in operative connection with the tripping device, and means for placing the compensating device out of such operative connection at intervals.

27. In a regulator, the combination, with a motor, a motor-controller, and an actuating device adapted to move alternately in opposite directions from a position in which it is set for operation, when released by a tripping device, and in such movement to operate the motor-controller, of a pivoted tripping device adapted to so release the actuating device when operated, a diaphragm attached to the tripping device upon one side of its pivotal support, a counterbalance connected to the tripping device and tending to operate the same in opposition to the diaphragm, a compensating device adapted to be placed in operative connection with the tripping device, and when so connected to oppose the counterbalance, and means for restoring the actuating device to position for operation, after each operation thereof, and for disengaging the compensating device from said tripping

device and counterbalance after the operating device has operated in one direction and until it operates in the other direction.

28. In a regulator, the combination, with a motor, a motor-controller, and a pivoted actuating device adapted to move alternately in opposite directions from engagement with a tripping device, when released by such tripping device, and in such movement to operate the motor-controller, of a pivoted tripping device adapted to release said actuating device when operated, a diaphragm attached to the tripping device upon one side of its pivotal support, a counterbalance connected to the tripping device and tending to operate the same in opposition to the diaphragm, a compensating device adapted to be placed in operative connection with the tripping device, and when so connected to oppose the counterbalance, and a resetting device arranged to be moved alternately in opposite directions as the motor operates, and when so moved to reset the actuating device, said resetting device being arranged likewise to disengage the compensating device from said tripping device and counterbalance during motion of the resetting device in one direction.

29. In a regulator, the combination, with a motor, a motor-controller, a power-storing actuating device for operating the motor-controller, and means for restoring the actuating device to condition for operation after each operation thereof, of a tripping device, which engages the actuating device only when the same has been placed in condition for operation.

30. In a regulator, the combination, with a motor, of a motor-controller, a power-storing actuating device for operating the motor-controller, and means operated by the motor for restoring the actuating device to condition for operation after each operation thereof, of a tripping device, adapted to be automatically controlled, which engages the actuating device only when the same has been placed in condition for operation.

31. In a regulator, the combination, with a motor, a motor-controller, a power-storing actuating device for operating the motor-controller, and means operated by the motor for restoring the actuating device to condition for operation after each operation thereof, of a tripping device which engages the actuating device only when the same has been placed in condition for operation, and a pressure-operated controlling device connected to said tripping device, and adapted to operate the same.

32. In a regulator, the combination, with a motor, a motor-controller, a power-storing actuating device adapted to move alternately in opposite directions from a position in which it is set for operation, and in such movement to operate, and reverse, the motor-controller, and means operated by the motor for restoring the actuating device to condition for operation after each operation thereof, of a tripping device which engages the actuating device only when the same has been placed in condition for operation.

33. In a regulator, the combination, with a motor, a motor-controller, a pivoted actuating device, whose pivotal point is normally below its center of gravity, a tripping device for releasing the actuating device, and means operated by the motor for restoring the actuating device to its normal position, of a pressure-operated controlling device, adapted to be operated by the changes of pressure within the combustion-chamber, and arranged when so operated to operate the tripping device.

34. In a regulator, the combination, with a motor, a motor-controller, a pivoted weight adapted in falling to operate the motor-controller, and means operated by the motor for raising the said weight into engagement with the said tripping device after each fall of the weight, of a pressure-operated controlling device, arranged to be operated by variations in pressure in a combustion-chamber, connected with said tripping device, and arranged to operate said tripping device in accordance with changes of pressure in such combustion-chamber.

35. In a regulator, the combination, with a motor, a motor-controller, a falling weight adapted in its movement to operate the motor-controller, a tripping device for releasing the weight, and weight-restoring means which restores the weight during each operation of the motor prior to the next succeeding operation thereof, of a pressure-operated controlling device, adapted to be operated by changes of pressure within a combustion-chamber, and adapted when so operated to operate said tripping device.

36. In a regulator, the combination, with a motor, a motor-controller, a pivoted weight whose pivotal point is normally below its center of gravity, and nearly but just out of, a vertical line therewith, means for restoring the weight after each fall thereof, and a yielding catch and tripping device, which receives and holds the weight when so restored, until operated to release the weight, of a pressure-operated controlling device, controlling the operation of such tripping device.

37. In a regulator, the combination, with a motor, a motor-controller, a pivoted weight adapted to fall on either side of its support, means for returning the pivoted weight to a position at which its center of gravity is above its point of support and slightly to one side of a vertical line passing through the said point of support, and upon that side of such line which is opposite to the side upon which the weight last fell, and a tripping device for releasing the weight to permit the same to fall upon that side of its center of support at which it has been set, of a pressure-operated controlling device, adapted to be operated by changes of pressure within a combustion-

chamber, and controlling the operations of said tripping device.

38. In a regulator, the combination, with a motor, a motor-controller, a pivoted weight, adapted to fall on either side of its support, means for returning the pivoted weight to a position at which its center of gravity is above its point of support and slightly to one side of a vertical line passing through the said point of support, and upon that side of said line which is opposite to the side upon which the weight last fell, a tripping-plate, catches thereon, each adapted to permit free passage of the weight in one direction, and to hold it, until said tripping-plate be operated, against movement in the other direction, and a pressure-operated controlling device, adapted to operate said tripping-plate.

In testimony whereof I affix my signature in the presence of two witnesses.

DANIEL HOWARD HAYWOOD.

Witnesses:

H. B. P. WRENN,

HARRY M. MARBLE.