(No Model.) 2 Sheets—Sheet 1.

W. E. EASTMAN.

AUTOMATIC GOVERNOR FOR LIQUID FUEL BURNERS.

No. 405,663. Patented June 18, 1889.

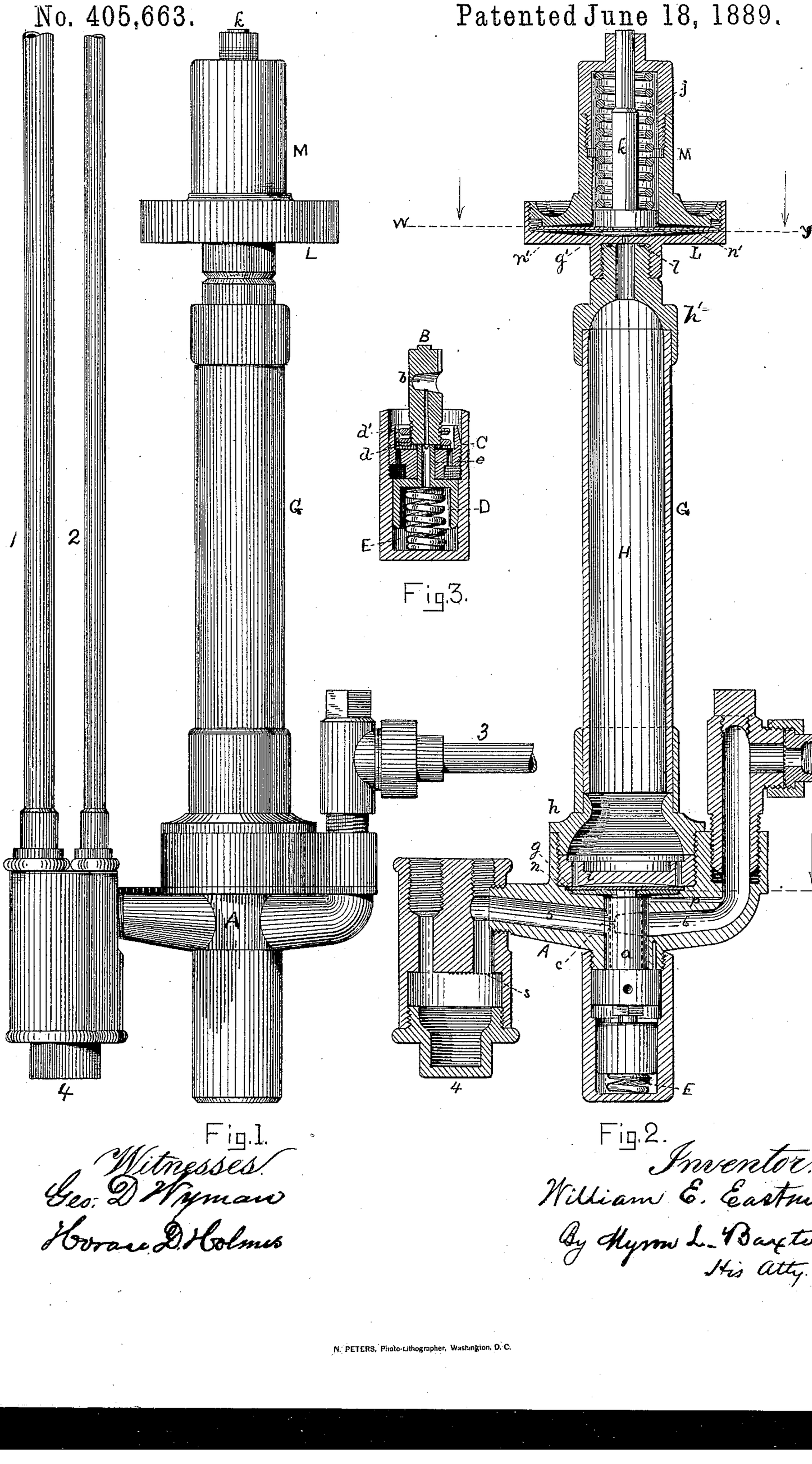

Fig. 3.

Fig. 1.

Fig. 2.

Witnesses:
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Inventor:
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His Atty.

(No Model.) 2 Sheets—Sheet 2.

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AUTOMATIC GOVERNOR FOR LIQUID FUEL BURNERS.

No. 405,663. Patented June 18, 1889.

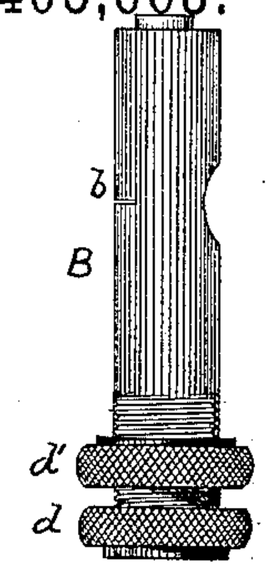

Fig. 4.

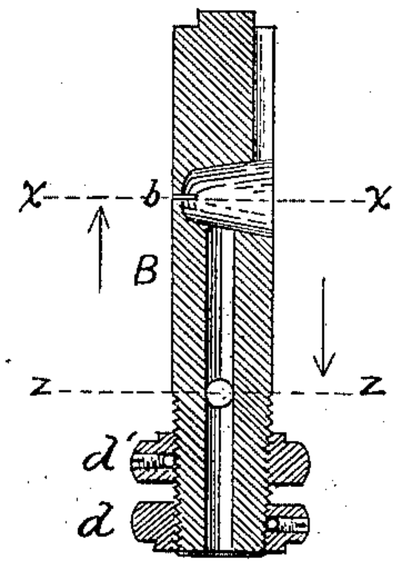

Fig. 5.

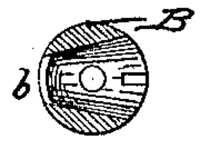

Fig. 6.

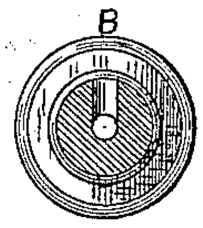

Fig. 7.

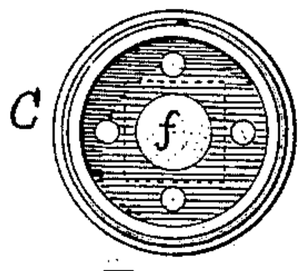

Fig. 8.

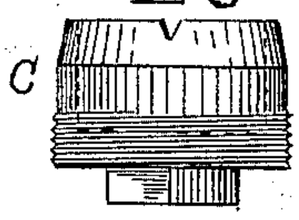

Fig. 9.

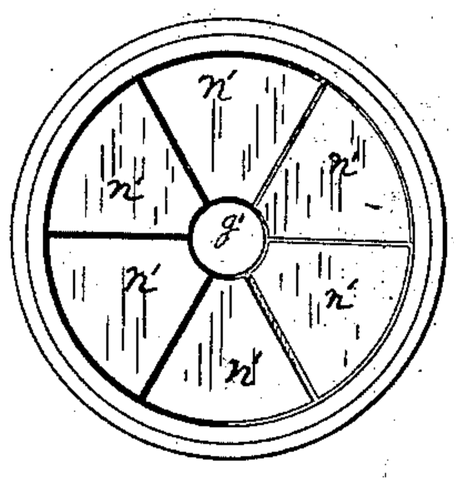

Fig. 10.

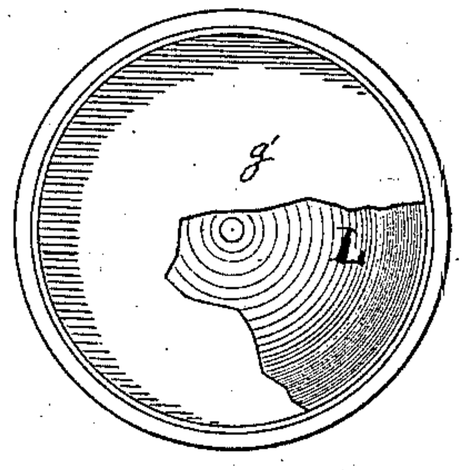

Fig. 11.

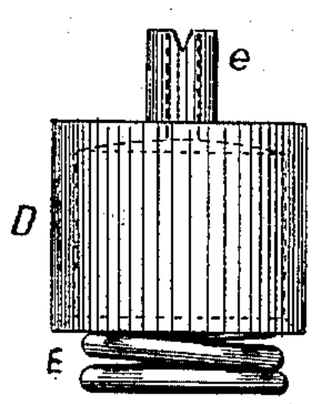

Fig. 12.

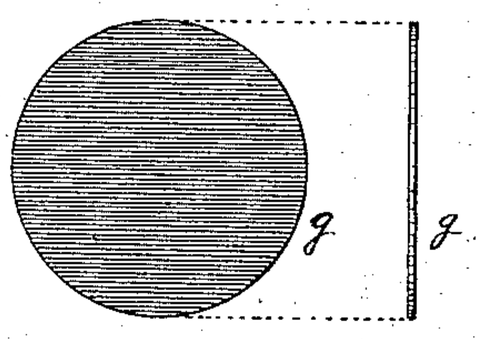

Fig. 13.

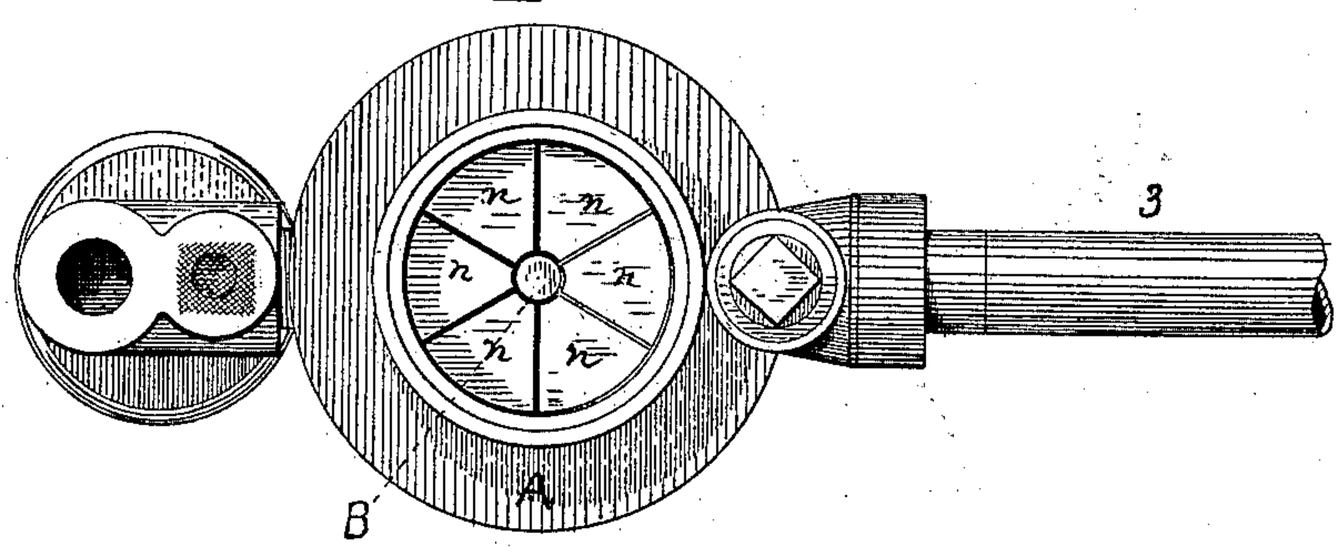

Fig. 14.

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UNITED STATES PATENT OFFICE.

WILLIAM E. EASTMAN, OF BOSTON, MASSACHUSETTS, ASSIGNOR TO THE EASTMAN FREIGHT CAR HEATER COMPANY, OF PORTLAND, MAINE.

AUTOMATIC GOVERNOR FOR LIQUID-FUEL BURNERS.

SPECIFICATION forming part of Letters Patent No. 405,663, dated June 18, 1889.

Application filed November 26, 1888. Serial No. 291,836. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM E. EASTMAN, a citizen of the United States, residing at Boston, in the county of Suffolk and State of Massachusetts, have invented certain new and useful Improvements in Automatic Governors for Liquid-Fuel Burners; 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 that class of liquid-fuel burners to which the fuel is supplied by gravity or pressure instead of a capillary wick; and its object is to provide a sensitive and reliable governor for regulating the flow of fuel, the action being automatic and governed by the temperature of certain of its parts.

In the accompanying drawings, Figure 1 is a perspective of the governor. Fig. 2 is a vertical section thereof, except as regards the valve and its adjuncts, and also the puppet. Fig. 3 is a sectional view of the said valve and adjuncts without the valve-case *a*. Fig. 4 is a perspective of the piston. Fig. 5 is a vertical section of the piston. Fig. 6 is a horizontal section in the line *x x* of Fig. 5. Fig. 7 is a horizontal section in the line *z z* of Fig. 5. Fig. 8 is a top plan view of the cup or seat which limits the downward motion of the piston. Fig. 9 is a side view thereof. Fig. 10 is a section in line *w*, Fig. 2, and shows a part of the relief-diaphragm in the center, the remainder being covered by the supporting-segments *n'*. Fig. 11 is a section in line *y*, Fig. 2, and shows the relief-diaphragm without its supporting-segments and with a portion cut away to show the diaphragm-seat L and orifice through its center. Fig. 12 shows the follower D, which by pressure of the spring E keeps the piston B always in contact with the governing-diaphragm *g* and the segments *n*. Fig. 13 shows the governing-diaphragm, top view and edge view. Fig. 14 is a section in line *v*, Fig. 2, showing segments *n* and top of piston B.

The tube 1 is the feed-tube to the governor, properly connected to an elevated reservoir. (Not shown.) Tube 2 allows the exit of air as the liquid fuel or oil enters, and is connected with the reservoir above the surface of the oil therein. As a liquid fuel I use kerosene-oil, although other combustible liquid may be used, and in this specification I use the term "oil" for any liquid fuel. The tube 3 leads to the stove or burner. The oil in entering the governor passes down to the sediment-cup 4, and thence vertically upward through the wire-gauze strainer S into the inclined channel 5, thence through the valve, along the inclined channel 6, as clearly shown, toward the stove or burner.

The object of the sediment-cup 4 is to allow the subsidence of any impurities. As shown in Fig. 2, this cup is detachable and can be emptied when necessary. The inclination of the channel 5 is to effect the complete evacuation of air when the oil first enters, the air passing up through the tube 2, and the inclination of the channel 6 also effects the evacuation of air from that side of the valve, the oil driving it before it as it flows toward the stove, and the channel *p* is provided for a similar purpose, to remove the air from the space above the level of the inner ends of the main channels. The expulsion of all air from the valve and adjacent parts is of prime importance, as the feed-orifice is so small that a minute air-bubble will hinder or stop the flow. The piston, its seat, and the follower are all formed with reference to the expulsion of air.

Within the solid cast base A is the vertical cylindrical bore between the channels 5 and 6. Within this cylindrical bore and rigidly connected to the base A is the tubular valve-case *a*, having through its wall a minute hole or orifice *c* on the side toward the channel 5. Within this tubular valve-case is the piston B, provided with a minute opening, or, preferably, a transverse slot *b*, as hereinafter more fully explained, which at a certain position of the piston coincides perfectly with the orifice *c* in the valve-case and allows it to deliver through the piston B all the oil that can flow through it; but when the piston is moved either up or down from this position the orifice *c* is partially closed and the quantity of oil flowing through it is diminished.

The piston B has its lower seat upon the floor of the cup C, and the adjusting-nut *d* regulates the position of the slot *b* in relation to the orifice *c*. The piston B is actuated from below by the follower D, forced upward by the spring E, the upwardly-projecting stem *e* of the follower passing through the opening *f* in the cup C. Without any counter-pressure from above the piston would be forced up until the slot *b* would be partly above the orifice *c*, and this position would be maintained by the adjusting-nut *d'*, which would find its stop or seat against the lower end of the valve-casing *a*. The two adjusting-nuts *d* and *d'* would then allow the piston to nearly close the orifice *c* in its upstroke and to nearly close it again at the extent of its downstroke when forced down from above in the manner hereinafter set forth.

The operation of the valve is controlled by an unequal expansion pair or combination, somewhat in the manner specified in my previous patents of the United States, numbered 269,189, 308,955, 387,055, and 387,056, but in a more certain and practical manner.

The tube G, Fig. 2, incloses an expansible liquid. In practice I use a brass tube filled with kerosene, though it is evident that any liquid that would not freeze under the conditions of use and whose expansion would be greater than that of its inclosing-tube—such as alcohol—might be used. This tube G is fitted at its ends with suitable screw-threaded attachments *h* and *h'*, and is attached to the base A by the former. Just below this attachment *h* is the diaphragm-seat *i*, with perforations and a concave lower surface, which screws down upon the periphery of the governing-diaphragm *g* and holds it against a ledge in the base A. This is a thin elastic metallic diaphragm, and hermetically seals the lower end of the chamber H. Below this diaphragm is a set of segments *n* of stiff metal. (Shown in Fig. 14.) Their inner ends rest upon the ledge around the upper end of the piston B (see Fig. 4) and their outer curved ends upon a ledge in the base A. When, therefore, pressure is exerted by expansion of the liquid above, it is transmitted to the piston by the segments, which prevent bulging downward of the diaphragm. These segments are of thickness just equal to the height of the projection of the end of the piston, so that the part of the diaphragm immediately over the projecting end bears upon it, while pressure from the remainder of the surface is applied through the segments to the ledge. At the upper end of the chamber H is located another diaphragm *g'*, with supporting-segments of identical construction with those of the lower end. In this case the segments are placed above the diaphragm and operate my puppet-indicator *k* against the pressure of the spring *j* in the same manner that the lower segments operate the piston B against the pressure of the spring E. The puppet *k* and spring *j* are contained within the puppet-casing M, (which, for convenience, is made in two parts, as shown.) The top of the puppet *k* comes up just flush with the top of the casing M when no pressure sufficient to overcome the strength of the spring *j* is exerted; but of course when sufficient pressure is exerted by the expansible contents of the chamber H to move the diaphragm *g'* the top of the puppet protrudes more or less. For adjusting, suppose that the chamber H in all its extent is filled completely with cold expansible liquid, with no pressure exerted upon either diaphragm. Now the diaphragm-seat casting L is unscrewed slightly from the piece *h'*, so that the joint will leak. Then the governor is raised slowly to a temperature of, say, 90° Fahrenheit, more or less, as circumstances of its future use may require, and the contained expansible liquid allowed to escape at the leaky joint. Now the diaphragm-seat casting L is screwed down until a perfect joint is secured by the lead-ring packing *l*. Further heating results in the depression of the lower diaphragm *g*, at first increasing the flow of liquid fuel through the valve, but, finally, as the temperature increases, reducing it to a minimum until the fire shall by the decreased flow decrease in intensity; but before this takes place an increased expansion of the contents of the chamber may take place after the valve has reached its lower seat. The reason that the valve-diaphragm is first actuated is because the spring E opposes, say, only six pounds initial pressure, while the puppet-spring *j* exerts an initial pressure of, say, sixty pounds. Now the valve, having moved its whole distance downward, cannot further relieve the expansive pressure of the liquid in the chamber, which becomes very great, and if no relief were provided distortion or rupture of the tube G might ensue. At this point the pressure acts upon the relief-diaphragm *g'*, which at once, if the heat increases, moves upward and forces the puppet above the top of the casing M. This is the essential part of my present invention, in that by the use of the diaphragm *g'*, the puppet *k*, and the spring *j*, I provide a safety-valve for the excessive expansion of the fluid, and at the same time an indicator whereby to regulate the quantity of the fluid and subsequently to test the integrity of all the parts of the inclosing-chamber, because at any time if the chamber is in working condition an excess of temperature will cause the puppet to protrude from the casing M; but if there has been leakage the puppet will not be forced up.

In practice I find it best to screw down the seat-casting L before beginning to heat, (for adjustment,) or somewhat before the proper temperature is reached, so that when it is reached the puppet-top will be slightly above the casing, and then to loosen the joint and permit leakage enough to just bring the pup-

pet down. After then closing the leak a very slight increase of temperature will operate the puppet.

As shown in Fig. 2, the relief-diaphragm *g'* is about midway in its possible movement and the piston B is upon its lower seat. Operated as described, the supply of oil to the burner is at first small, then increases gradually to the maximum, and then, if too much is being supplied, it is by action of increased heat diminished. By the use of the transverse slot in the piston B a slight lateral variation does not affect the coincidence of the orifices, the vertical adjustment alone requiring precision.

It will be understood by reference to my patents cited that when the governor and burner are not in use the flow of oil is prevented by a suitable cock placed at any convenient place in the pipe leading from the tank, and that when said cock is opened the flow through the governor is small in amount, due to the valve-piston being upon its upper seat.

Having thus fully described my invention, I claim and desire to secure by Letters Patent of the United States the following:

1. In an automatic governor for liquid-fuel burners, an unequal expansion pair or combination, an elastic diaphragm, and stiff metallic segments that prevent bulging of the said diaphragm and transmit its pressure in whole or in part to a valve.

2. In an automatic governor for liquid-fuel burners, a hermetically-sealed chamber containing an expansible liquid, and provided at one point with an elastic diaphragm for operating a governing-valve and at another point with an elastic diaphragm for relieving pressure from excessive expansion.

3. In an automatic governor for liquid-fuel burners, a hermetically-sealed chamber containing an expansible liquid, and provided at one point with an elastic diaphragm for operating a governing-valve and at another point with an elastic diaphragm for relieving pressure from excessive expansion, in combination with an indicator which shows that such excessive expansion is operating.

4. In an automatic governor for liquid-fuel burners, a valve operated by an unequal-expansion combination, in combination with an elastic diaphragm and stiff metallic segments which transmit pressure from parts of the said diaphragm remote from the part that is in contact with the valve.

5. In an automatic governor for liquid-fuel burners, the combination of the puppet-indicator, the relief-diaphragm, and the spring *j*.

6. In an automatic governor for liquid-fuel burners, the puppet-indicator *k*, actuated through an elastic diaphragm and supporting-segments by expansion in excess of that required to operate the governing-valve, in combination with said elastic diaphragm and supporting-segments.

7. In an automatic governor for liquid-fuel burners, the combination of a valve operated by expansion in opposition to the pressure of a comparatively weak spring, and a puppet-indicator operated by increase of expansion against the pressure of a stronger spring, in combination with said comparatively weak spring and said stronger spring.

8. The combination of the chamber H and liquid contents, the diaphragm *g'*, supporting-segments *n'*, puppet *k*, and spring *j*.

9. The combination of the valve-case *a*, piston B, adjusting-nuts *d d'*, the spring E, with the diaphragm *g*, and supporting-segments *n*.

10. The combination of the valve-case *a*, piston B, adjusting-nuts *d d'*, spring E, diaphragm *g*, supporting-segments *n*, the chamber H, and its expansible liquid contents, with the diaphragm *g'*, supporting-segments *n'*, the indicating-puppet *k*, and the spring *j*.

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

WILLIAM E. EASTMAN.

Witnesses:
EROS L. EASTMAN,
GEO. D. WYMAN.