No. 695,464. Patented Mar. 18, 1902.

N. LOMBARD.

SPEED REGULATOR.

(Application filed Dec. 12, 1901.)

(No Model.) 3 Sheets—Sheet 1.

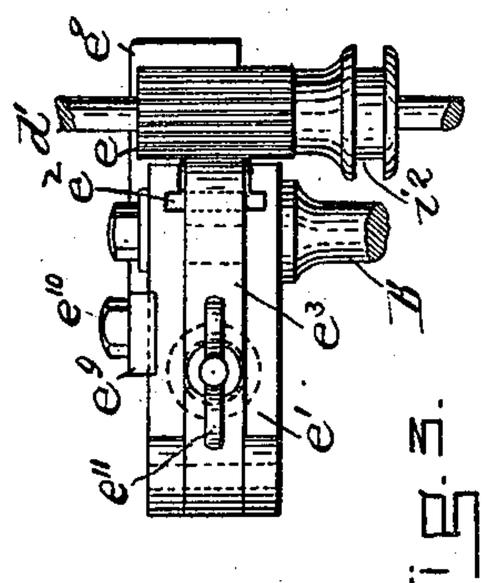

FIG. 3.

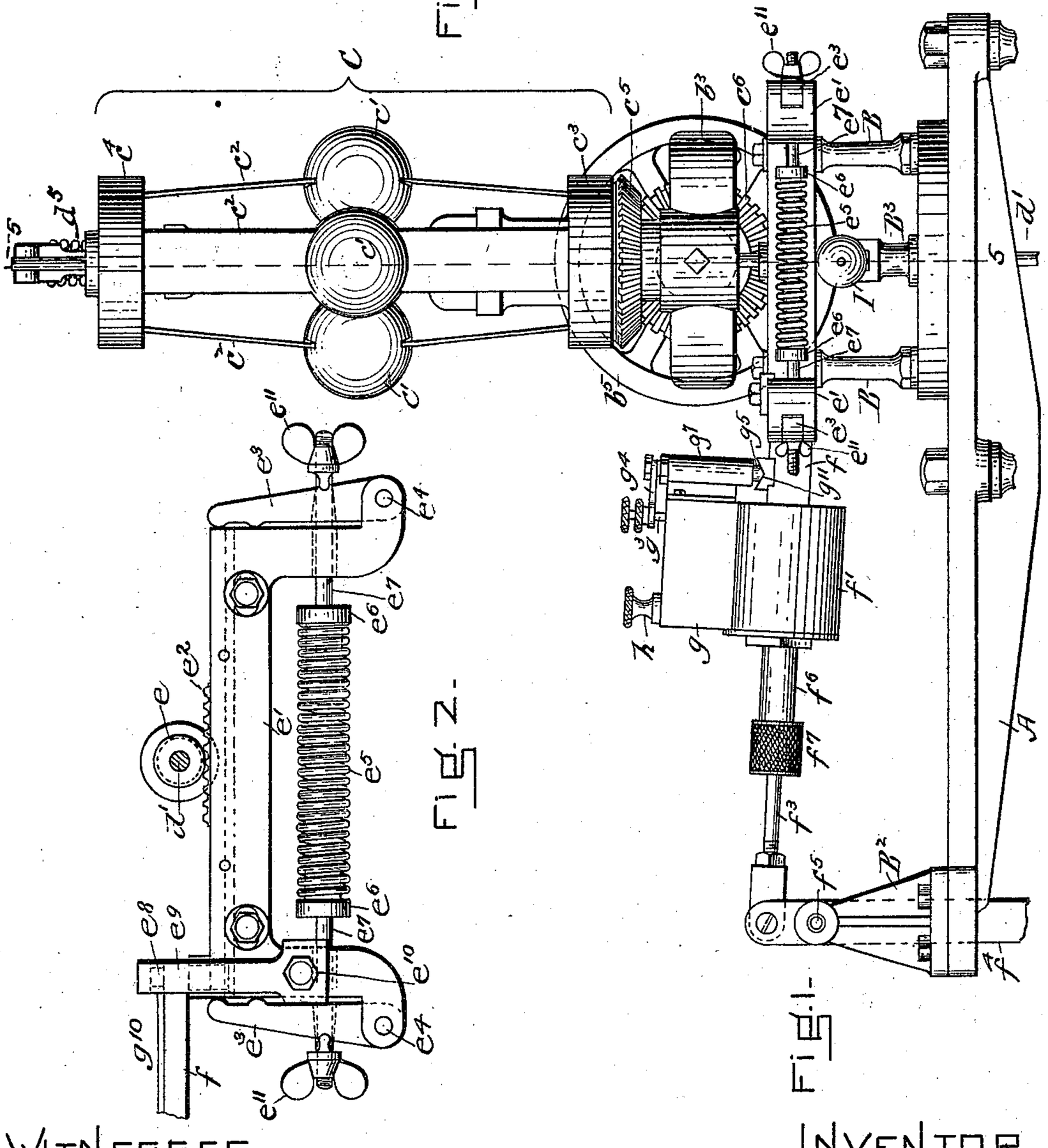

FIG. 1.

FIG. 2.

WITNESSES
A. L. Robinson
R. L. Roberts

INVENTOR
Nathaniel Lombard
By Geo. L. Roberts & Bro.
Attys.

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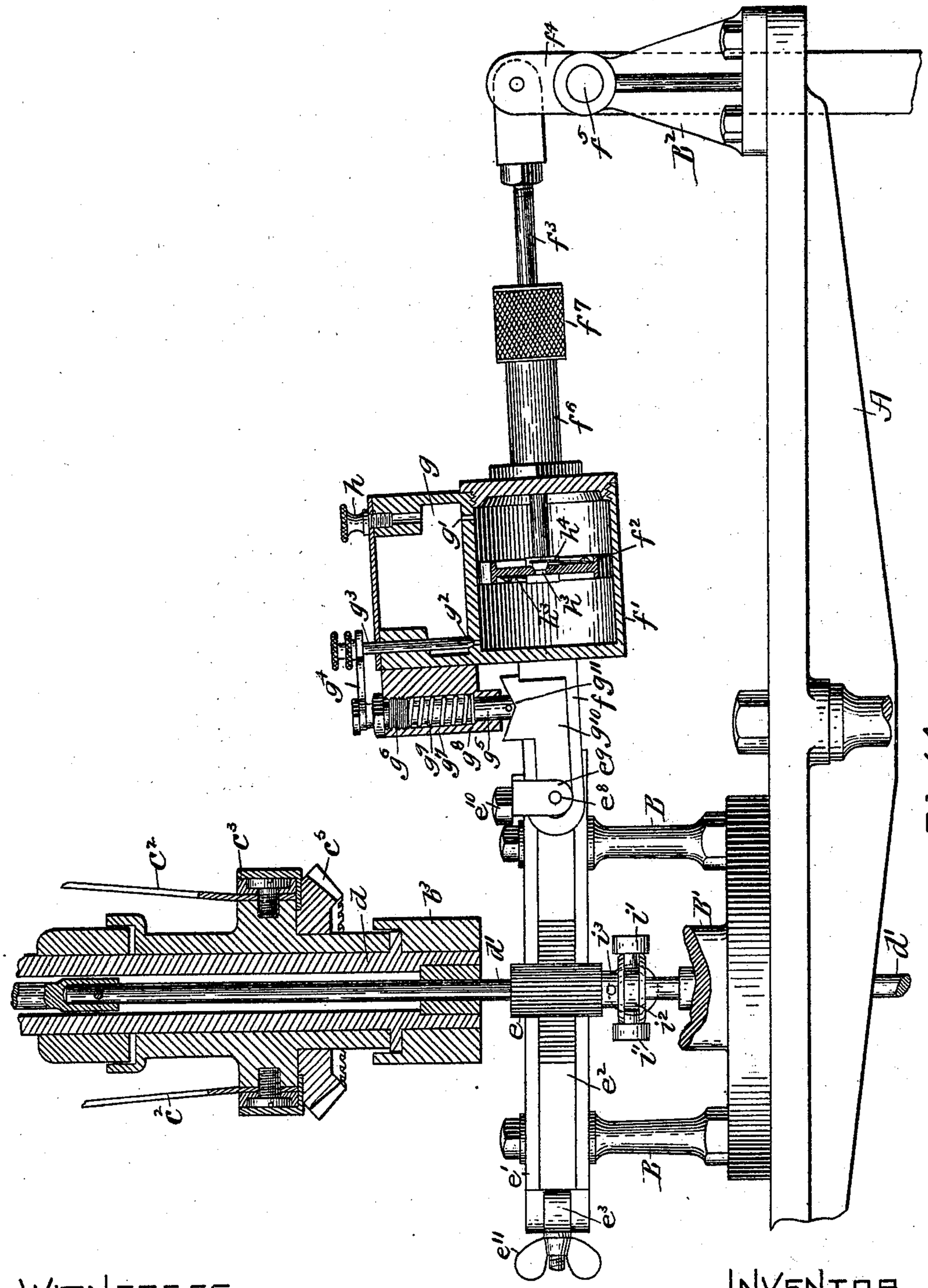

FIG. 4.

WITNESSES
A. L. Robinson
R. L. Roberts

INVENTOR
Nathaniel Lombard,
By Geo. L. Roberts & Bro.
Attys.

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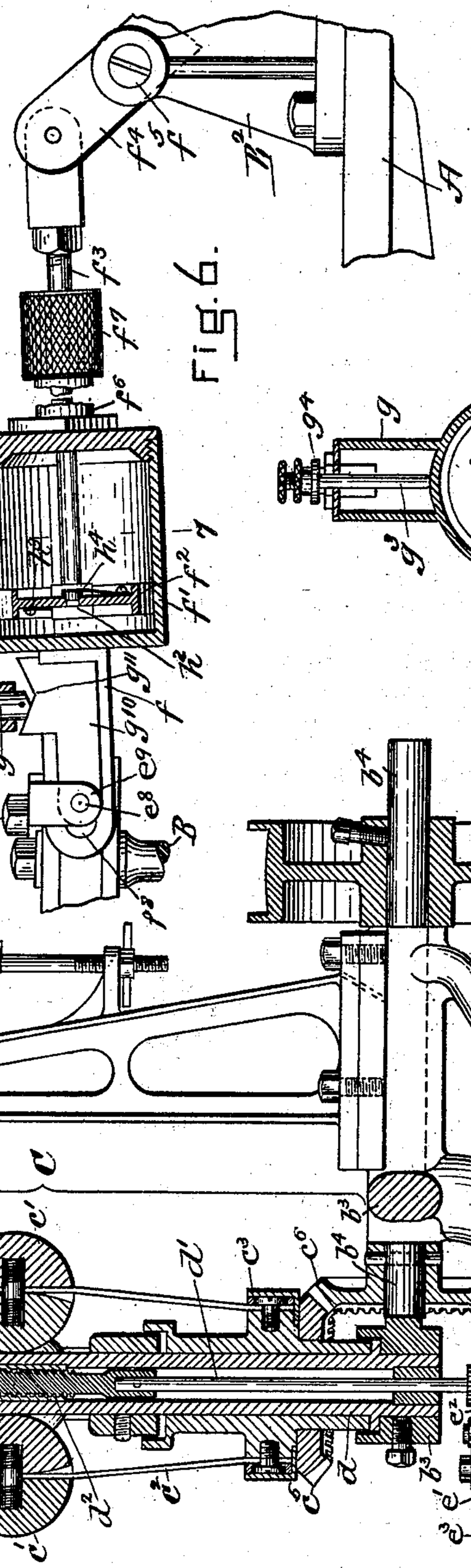

Fig. 6.

Fig. 7.

Fig. 5.

WITNESSES
A. L. Robinson
R. L. Roberts.

INVENTOR
Nathaniel Lombard
By Geo. H. Roberts & Bro.
Attys

UNITED STATES PATENT OFFICE.

NATHANIEL LOMBARD, OF BOSTON, MASSACHUSETTS, ASSIGNOR TO THE LOMBARD GOVERNOR COMPANY, OF BOSTON, MASSACHUSETTS, A CORPORATION OF NEW JERSEY.

SPEED-REGULATOR.

SPECIFICATION forming part of Letters Patent No. 695,464, dated March 18, 1902.

Application filed December 12, 1901. Serial No. 85,633. (No model.)

To all whom it may concern:

Be it known that I, NATHANIEL LOMBARD, 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 Speed-Regulators, of which the following is a specification.

The improvements relate to speed-regulators, particularly of the class shown and described in my Letters Patent No. 533,656, dated February 5, 1895, in which the valve that regulates the speed of the engine or other prime motor is opened and closed by the movement of weights which are acted upon by centrifugal force when they are revolved; and my invention consists in improvements in the construction shown in said patent by which said valve is quickly yet moderately returned to its normal position whenever that has been disturbed by the action of said revolving weights, and by this means the so-called "racing" of the engine or prime motor is prevented, as also the pounding or fluctuation from one extreme of speed to another by reason of the alternate opening and closing of the valve caused by the vibration of said weights. In my said prior patent this valve is returned to its normal position by the action of a spring which works against liquid in a cylinder which is caused to circulate from one side to the other of a piston therein with greater or less rapidity in accordance with the size of the opening in a manually-adjustable gate in the passage which connects the two ends of said cylinder, while in my improved construction the gate or valve in said connecting-passage is automatically opened and closed when the said cylinder is moved in one direction and then the other. The construction and operation of these improvements will be readily understood from the description hereinafter contained in connection with the accompanying drawings, wherein—

Figure 1 is what may be termed a "rear elevation" of a speed-governor with my improved valve-controlling and speed-regulating attachments. Fig. 2 is a plan of a detail, showing the spring and connected parts, which constantly tends to return the regulating-valve to its normal position. Fig. 3 is an elevation of the same parts shown in Fig. 2 viewed from the right of that figure. Fig. 4 is what may be termed a "front elevation" of substantially the same parts shown in Fig. 1. The portion of the centrifugal governor illustrated is in section, as also the liquid-cylinder and the connected parts which regulate the return of the valve to its normal position. Fig. 5 is an end elevation of the apparatus with the centrifugal governor sectioned on line 5 5, Fig. 1. Fig. 6 is an elevation of a detail, with the liquid-regulating cylinder in section, showing the piston sectioned through one of the ports therein and in a position to which it has been forced by reason of a sudden increase of speed of the prime motor. Fig. 7 is an end sectional elevation of the regulating-cylinder on line 7 7, Fig. 6.

Like the mechanism shown in my said prior patent, the present improvements are intended to be employed in the regulation of what I term the "secondary" valve—that is, one which supplies the motive power to mechanism which operates the primary valve or gate that furnishes the motive power to the prime motor. In the first instance the centrifugal governor, which is revolved by direct connection with the prime motor, acts upon this secondary valve to move it in one direction or the other in accordance with the variation of speed in the prime motor due to a decrease or increase of the load or amount of work put upon it. Such change of the secondary valve supplies the motive force to the mechanism which operates the gate of the prime motor, and by the connection of this mechanism with my improved regulating devices those devices are caused to act immediately upon the secondary valve in a manner to counteract the effect thereon of the last-previous action of the centrifugal governor, and thus return the secondary valve to its normal or closed position, and this is the constant tendency of my improvements whenever the secondary valve is moved from its normal position.

Referring to the drawings by designating characters, A is the portion of the frame which supports the speed-governor mechanism; B B′ B², standards upon which the parts of the governor are secured; C, the centrifugal governor, provided with weights c', sustained by spring-metal strips c^2, the lower ends of which strips are secured to a fixed collar c^3 and the upper ends to a vertically-sliding collar c^4.

d is a tube secured to and supported at its lower end in a portion of the frame b^3, which projects from the standard B′. (Shown in section in Fig. 5.) Within the tube d is a rod d', which at its lower end supports a secondary valve of the character illustrated in my said prior patent, but which is not shown in these drawings. The upper end of the rod d' is provided with a screw-thread d^2, which engages a thread within the lower end of a sleeve d^3, which may slide in the tube d. The upper end of the sleeve d^3 enters the collar c^4, and when that collar is drawn downward by the movement outward of the weights c', due to increased speed, it bears upon a projection d^4 on the sleeve d^3 and forces that sleeve, and with it the rod d', downward, which moves the said secondary valve with it, and thus opens one set of ports in that valve, which causes the motive power to act upon the mechanism connected with the gate of the prime motor and tends to close it, thereby reducing the speed and allowing the weights c' to move inward. At the same time the secondary valve is drawn up by the action of the spring d^5 through the lever d^6 and rod d^7. The weights c' are caused to revolve by means of a beveled gear c^5, secured to the hub of the collar c^3, which gear meshes with another beveled gear c^6 upon a shaft b^4, which also has a belt-pulley b^5 secured to it. This pulley is belted to another, which is driven directly from the prime motor.

The alternate movement of the rod d' with the attached secondary valve first in one direction and then the other by the swinging out and in of the weights c' produces a very injurious effect upon the engine or prime motor by quickly increasing and decreasing its speed, and sometimes when the load is suddenly taken off the prime motor it will "race" to such an extent as to cause injury, and my improvements are intended to obviate these difficulties.

Upon the valve-rod d', just below the centrifugal governor C, a comparatively long pinion e is secured, and in a suitable guide in a frame e' a rack e^2 is held in conjunction with the pinion e. The rack e^2 is held in its normal position in said guide by fingers e^3, pivoted at e^4 to the frame e' at opposite ends and which are controlled by a spring e^5, held between collars e^6 upon rods e^7, which rods are secured to the ends of said spring and pass through portions of the frame e' and through each of the fingers e^3, and each rod has a thumb-screw e^{11} upon the outer end to bear upon a finger e^3 and also to adjust the tension of the spring e^5. One end of the rack e^2 is pivotally connected at f^8 with a piece f, projecting from the valve-regulating liquid-circulation cylinder f', within which is a piston f^2, secured to the piston-rod f^3, the outer end of which rod is pivoted to a lever f^4, which is supported in a bearing f^5 in the standard B², and this lever through intermediate devices (not herein shown) is connected with the mechanism that operates the valve of the prime motor, and is thus caused to move back and forth therewith. As the outer end of the cylinder f' is supported by the piston-rod f^3, this rod is given a long bearing by passing through a long sleeve f^6, which is attached to that end of the cylinder, and also through a packing-box f^7 at the end of said sleeve. Above the cylinder f' is a liquid-chamber g, provided with two ports g' g^2, opening into the said cylinder. The port g^2 is provided with a valve consisting of a rod g^3, which passes out through the upper wall of the chamber g. The upper end of the rod g^3 is screw-threaded and passes through a screw-threaded hole in one end of a link g^4, so that by turning said rod it may be adjusted longitudinally as desired. The other end of the link g^4 is secured to a rod g^5, which rod is held in a sleeve g^6, screwed into the top of a chamber in a projection g^7, attached to the end of the chamber g, and a hole through the lower end of that chamber. A collar g^8 is secured to the rod g^5 at a point which will bring it to the bottom of the said chamber when said rod is in its normal position, and between the said collar and the sleeve g^6 a spring g^9 is placed and adjusted so as always to tend to press the rod g^5 downward. The tension of the spring may be varied by screwing the sleeve g^6 in or out. The lower end of this rod g^5 is beveled off at an obtuse angle upon two sides of a diametrical line, and beneath the end of the rod there rests upon the projection f a piece of metal g^{10}, which has a flattened V-shaped groove g^{11} in its upper surface, the angle of the faces of which groove is the same as that of the beveled faces of the lower end of the rod g^5, but considerably greater in extent. When the parts are all in normal position, the apex of the beveled end of the rod g^5 should rest in the bottom of the groove g^{11}, as shown in Fig. 4. The metal piece g^{10} is pivotally secured at e^8 to an angular clamp e^9, which is bolted to the frame e' at e^{10}.

h is a screw-plug to close an opening through which the chamber g and cylinder f' are filled with liquid, preferably oil.

The piston f^2 is provided with two ports h' h^2, respectively closed by spring-valves h^3 h^4, opening upon opposite sides of the piston. These valves are provided as a safeguard against injury to the piston or connected parts when there is too great movement of the lever f^4 while the port g^2 is closed. Under such conditions one of the spring-valves h^3 or h^4

will be forced open by the pressure of the liquid when the piston moves.

For the purpose of operating the secondary valve by hand when desired, as in starting the engine, a lever I, pivoted in a standard B^3, is provided, and upon the inner end of this lever is a yoke i', each arm of which has an inwardly-projecting pin which engages an annular groove i^2 in a collar i^3, secured to the valve-rod d' below the pinion e.

The operation of my improved construction is as follows: It will be understood that the piece g^{10} is prevented from moving horizontally by its engagement with the angular clamp e^9, which is bolted to the frame e', although the end containing the groove g^{11} may move up and down as required upon the pivot e^8. Referring to Fig. 4, where all the parts are illustrated as in their normal position, with the apex of the angular lower end of the rod g^5 in the bottom of the angular groove g^{11} of the piece g^{10} and with the rod g^3 so adjusted that at this time it closes the port g^2, we will suppose that suddenly a large amount of load is taken off the prime motor. Immediately its speed will be increased, thus causing the weights c' of the centrifugal governor to be thrown outward, which action will draw down the collar c^4 and by its contact with the sleeve d^3 force it, with the attached rod d', downward and also the secondary valve on the lower end of that rod. This movement of that valve will open the ports which admit motive power to act upon the mechanism connected with the gate of the prime motor and tend to close that gate. As the lower end of the lever f^4 is connected with the same mechanism, it also will be moved from the position shown in Fig. 4 to that shown in Fig. 6. At the same time the liquid-circulation chamber f' g and the attached rack e^2 will be moved horizontally to the left, as shown in Fig. 6. This movement of the rack e^2, which is in engagement with the pinion e, will cause the pinion and the rod d' to turn from left to right, and thus screw the upper end of the rod into the sleeve d^3, shorten the rod, and raise it with the secondary valve at its lower end, and thereby tend to close the valve and counteract the previous effect of the centrifugal governor upon it. The movement to the left of the cylinder f' and rack e^2 will continue until the port g^2 has been opened sufficiently to permit a free circulation of liquid in said cylinder and the chamber g. The first movement of the upper end of the lever f^4 to the left will carry the cylinder f' and its attached mechanism with it, and as the piece g^{10} is secured to the frame the end of the rod g^5 will slide up the inclined surface of one side of the angular groove g^{11} therein, and through the connecting-link g^4 the valve-rod g^3 will also be raised, and thus open the port g^2 and permit a circulation of liquid from one side of the piston f^2 up through the port g^2 and down through the port g' into the cylinder f' upon the opposite side of the piston f^2. The resistance of the liquid in said cylinder being thus removed from the piston, the spring e^5, Fig. 2, by means of a finger e^3 will force the rack e^2 and cylinder f' back again—that is, to the right—and the piston f^2 will tend to assume the position illustrated in Fig. 6. This reverse movement of the rack e^2 will turn the pinion e and rod d' in the opposite direction—that is, from right to left—and unscrew the rod from the sleeve d^3, thereby lengthening the rod and forcing the secondary valve downward, thus tending to open that valve again. However, as the action of the centrifugal governor by reason of the increased speed of the prime motor tended to open the secondary valve and operate mechanism to close the gate of that motor such closing would decrease the speed of the motor and at the same time the speed of the centrifugal governor, the action of which would then tend to close the secondary valve and if otherwise uncontrolled would be liable to continue its action in the same direction and open other ports of the secondary valve, which would admit motive power to set in operation the mechanism to again open the gate of the prime motor; but, as explained above, the movement of the rack e^2 to the right would turn the rod d', so as to lengthen it, and thus move the secondary valve downward, which would compensate for the tendency to raise that valve by the action of the centrifugal governor when its speed of rotation was decreased, so that whenever the centrifugal governor acts upon the secondary valve to put in operation the mechanism which tends to open or close the gate of the prime motor that same mechanism acts upon the rack e^2 to move the secondary valve first in a direction opposite to that produced by the governor thereon and then automatically and steadily to return said valve to its normal or closed position, and at the same time by automatically closing the port g^2 between the cylinder f' and the chamber g prevent circulation of the liquid, and by that means prevent the movement of the piston in the cylinder f'. Thus a practically rigid connection between the lever f^4 and the rack e^2 will be formed, which will cause the beginning of each impulse of the lever f^4 to act quickly and positively upon said rack to counteract the effect produced upon the secondary valve by the governor.

I claim—

1. In combination with a speed-governor for a prime motor, a secondary valve to control the operation of the primary valve, a regulator for the secondary valve which is first operated by the primary-valve mechanism in a direction opposite to a given movement of the secondary valve caused by the governor, and is then moved in the other direction automatically and independently of the primary-valve mechanism, and devices to lock the regulator mechanism when the governor is in its normal position.

2. In combination with a speed-governor

for a prime motor, a secondary valve acted upon by the governor, to furnish motive power to operate the primary valve of said motor, a normally closed liquid-circulation chamber to regulate the movements of the secondary valve to counteract those produced by the governor, and independent means to open the valve of said circulation-chamber automatically, whenever the primary valve is operated.

3. In combination with a speed-governor for a prime motor, a secondary valve acted upon by the governor to control the motive power which operates the primary valve of the motor, independent devices which connect the primary-valve mechanism and the secondary valve to counteract the action of said governor upon the latter valve, and a liquid-circulation chamber interposed in said connecting devices, the ports of which chamber are automatically opened and closed to regulate the counteraction upon the secondary valve.

4. In combination with a motor speed-governor, a valve, controlled thereby, to supply motive power, a regulator for said governor, the operation of which is opposite to the action of the governor, a liquid-circulation chamber in the regulator system, the ports of which chamber are automatically opened whenever the governor departs from its normal speed, and are automatically closed while the governor is returning to its normal speed.

5. In combination with a motor speed-governor, a valve operated thereby to control the supply of motive power, independent mechanical connections between said valve and the motor mechanism, which counteract the governor's movements of the valve, a normally closed liquid-circulation chamber and piston therein, as a part of said mechanical connections, and devices to open the ports of the circulation-chamber automatically, whenever said motive-power valve is opened by variation of speed of the governor, and to close said ports automatically while the governor is assuming its normal speed.

6. A speed-regulator consisting of a liquid-circulation cylinder provided with a rod and piston, means to connect said cylinder and rod with the mechanism to be moved, a valve for the circulation-port of said cylinder, and mechanism independent of the cylinder to act upon said valve and automatically open or close said port to accommodate variations of speed in the moving parts.

NATHANIEL LOMBARD.

Witnesses:
R. L. ROBERTS,
A. L. ROBINSON.