

No. 778,125.

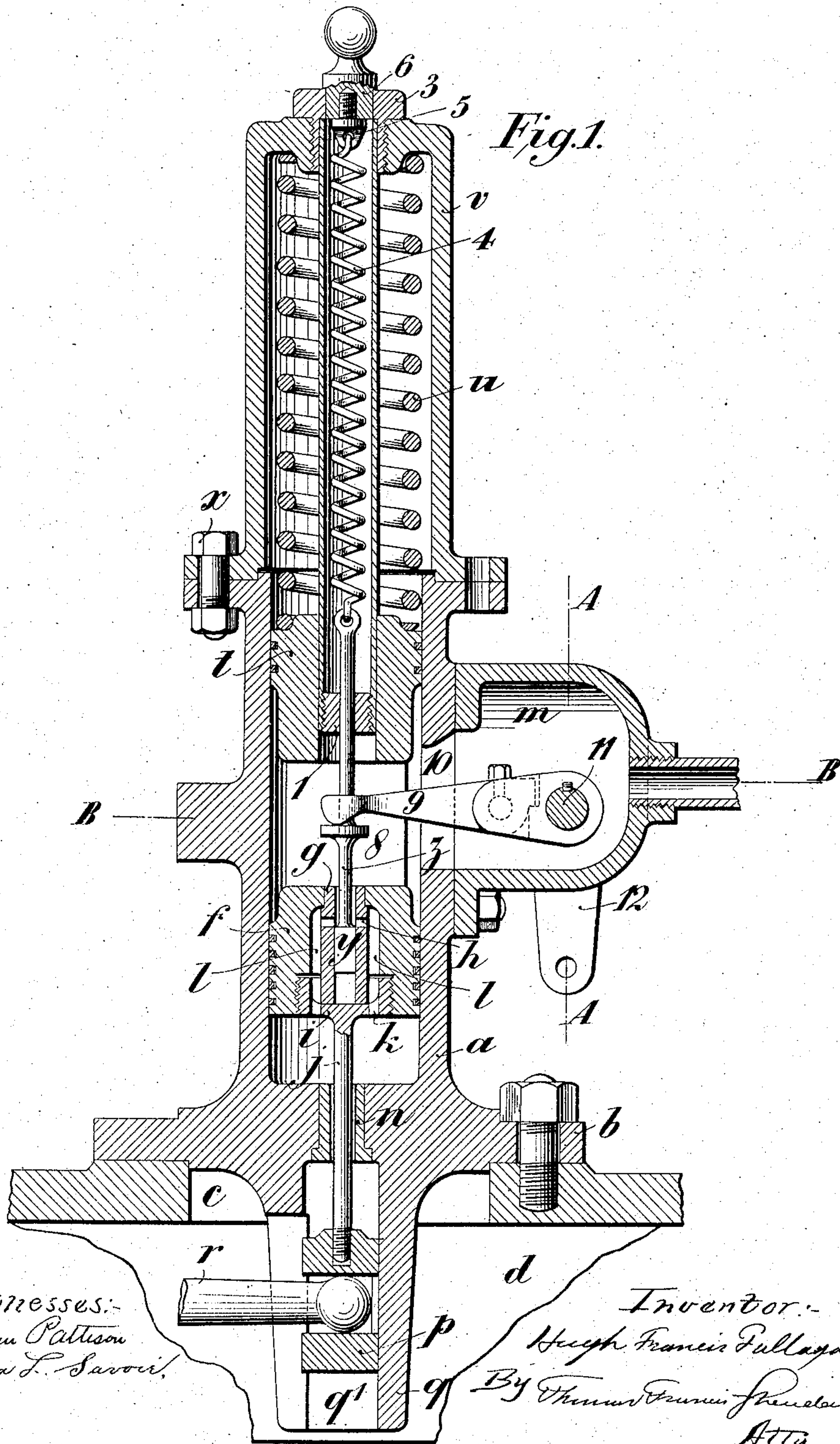
PATENTED DEC. 20, 1904.

H. F. FULLAGAR.
APPARATUS FOR GOVERNING ENGINES.

APPLICATION FILED JUNE 27, 1904.

NO MODEL.

4 SHEETS—SHEET 1.



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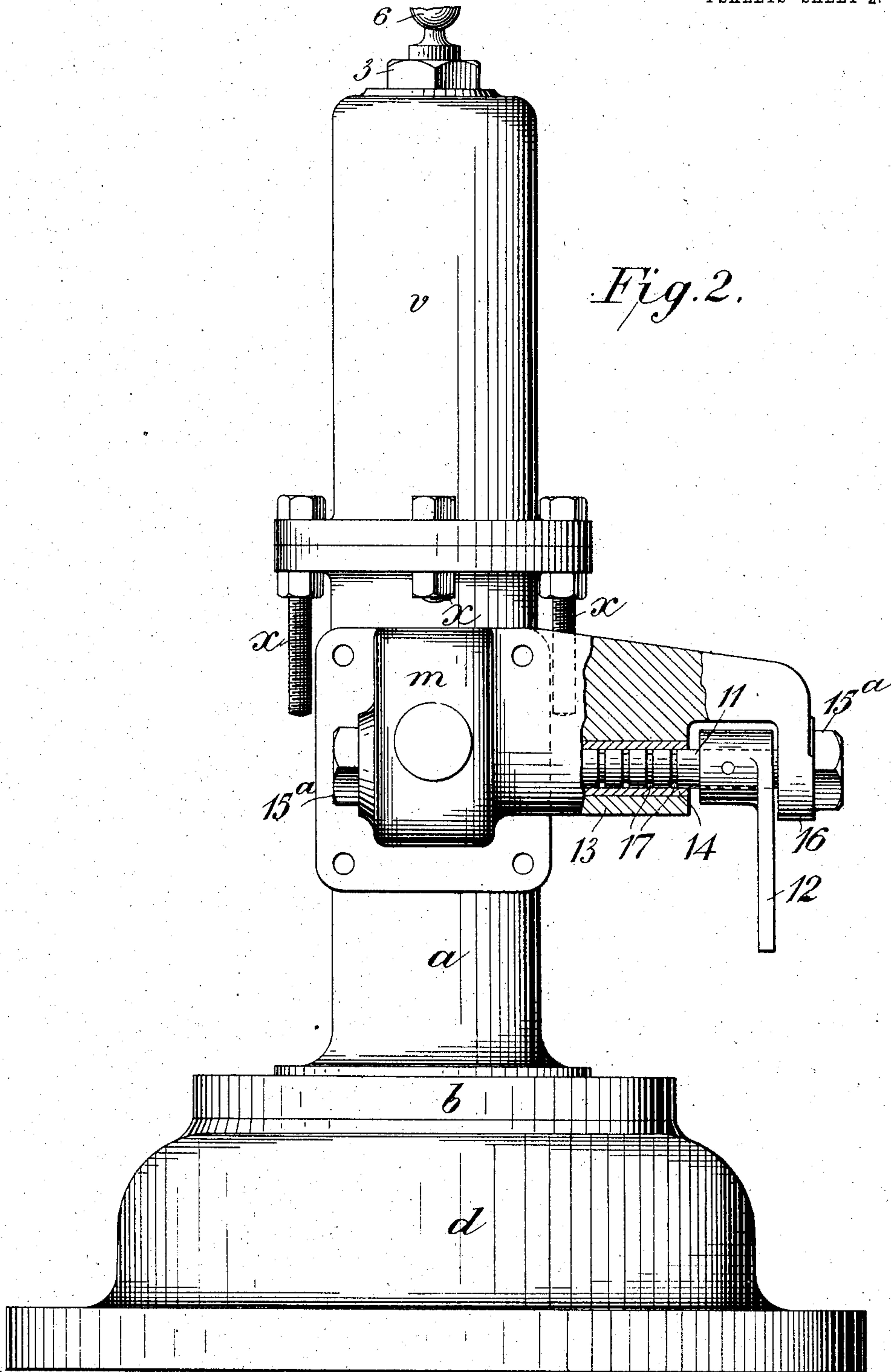
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NO MODEL.

4 SHEETS—SHEET 2.



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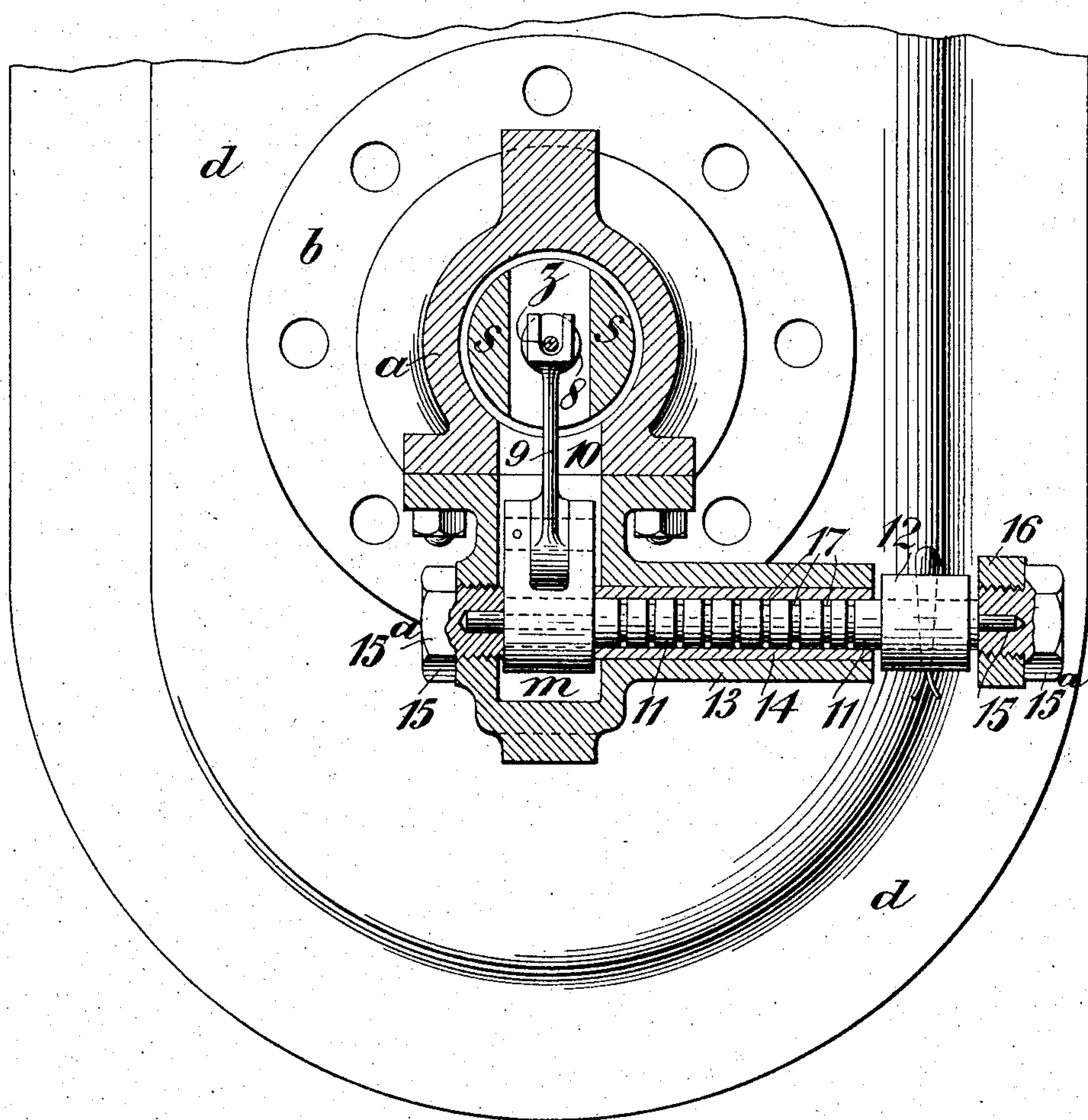
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4 SHEETS—SHEET 3.

Fig. 3.



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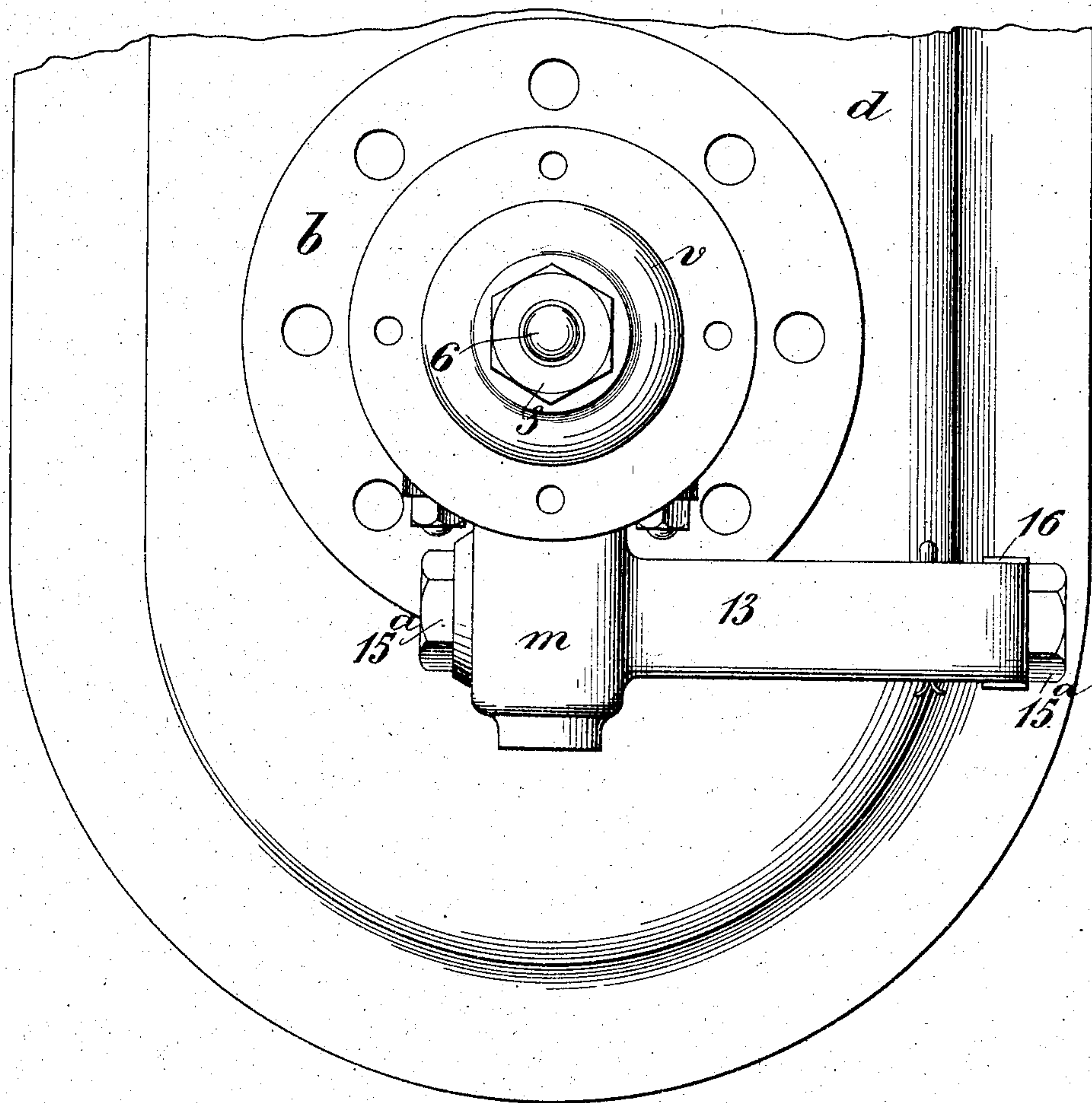
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NO MODEL.

4 SHEETS—SHEET 4.

Fig. 4.



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UNITED STATES PATENT OFFICE.

HUGH FRANCIS FULLAGAR, OF NEWCASTLE-UPON-TYNE, ENGLAND.

APPARATUS FOR GOVERNING ENGINES.

SPECIFICATION forming part of Letters Patent No. 778,125, dated December 20, 1904.

Application filed June 27, 1904. Serial No. 214,327.

To all whom it may concern:

Be it known that I, HUGH FRANCIS FULLAGAR, a subject of the King of Great Britain and Ireland, residing at Newcastle-upon-Tyne, in the county of Northumberland, England, have invented Improvements in or Relating to Apparatus for Governing Steam-Turbines and other Engines, of which the following is a specification.

This invention of improvements in or relating to apparatus for governing steam-turbines and other engines has for object to provide an improved governor-relay for use between an engine-governor and the means, including a valve, used for controlling the passage of motive fluid (hereinafter referred to as "steam") to a turbine or other engine, (hereinafter included in the term "turbine.")

A governor-relay according to this invention comprises a loaded piston that is adapted to be connected to the steam-valve whose position is to be controlled (hereinafter called the "main" valve) and is arranged to work in a cylinder to one end of which steam is constantly admitted when the relay is in use and from which there is an exit-passage through which the steam can flow to a condenser or elsewhere, a loaded valve (hereinafter called for distinction the "controlling-valve") that tends under the action of its load to move into a position to close the steam-exit passage to a greater or less extent, and a lever that is adapted to be connected to the engine-governor and is arranged to move the controlling-valve in a direction to open the steam-exit passage against the action of its load when the relay is in use to reduce the speed of the turbine. The arrangement of the parts is such that the piston and the controlling-valve can be so relatively adjusted as normally to close the steam-exit passage to such an extent that the steam-pressure in the relay-cylinder will hold the piston in a position in which it will hold the main valve partly open, as required for the desired normal speed of the turbine; but when the speed rises above the normal the lever will move the controlling-valve in opposition to the action of its load and open the exit-passage to a greater extent, so as to reduce the steam-pressure in the relay-cylinder

and allow the piston under the action of its load to close the main valve to a further extent, and when the speed falls below the normal the action of the lever on the controlling-valve will be reduced, so as to allow the controlling-valve under the action of its load to move in a direction to close the steam-exit passage to a greater extent and so enable the steam-pressure in the relay-cylinder to be increased and cause the piston to move against the action of its load and open the main valve to a further extent, each movement of the piston following that of the controlling-valve and acting, in addition to altering the position of the main valve, to restore the opening of the steam-exit passage to its normal amount, and each of the above-described operations taking place only when the speed of the turbine rises above or falls below the predetermined normal speed. The piston and controlling-valve may conveniently be each loaded by means of a spring. The steam-exit passage may be formed in the piston and be governed by a controlling-valve mounted to slide in such piston.

A governor-relay to work in the manner described can be constructed in various forms and be used in connection with engine-governors of various constructions, both mechanical and electrical, and with valve arrangements of various kinds.

One example of a governor-relay constructed according to this invention is represented in the accompanying drawings, whereof—

Figure 1 shows the apparatus in vertical section. Fig. 2 is a sectional elevation thereof taken at right angles to Fig. 1, the section corresponding to the line A A of Fig. 1. Fig. 3 shows the relay in horizontal section corresponding to the line B B of Fig. 1, and Fig. 4 is a plan.

In the example shown the relay-cylinder *a* is vertical and formed at its lower end with a flange *b*, by means of which it can be secured over an opening *c* in a steam-chest *d*, in which may be located the main steam-valve to be controlled. The relay-piston *f*, which fits the lower portion of the cylinder *a*, is bored out to two diameters and is fitted as to its portion of smaller diameter with a tube *g*, that is

formed at its upper portion with radial holes h and is held in place by the upper and enlarged end or head i of a downwardly-extending piston-rod j , that is formed with holes h and screwed into the lower end of the piston f , the arrangement being such as to form between the piston f and the tube g an annular steam-passage l , that is in communication through the perforated head i of the piston-rod j with the lower end of the interior of the cylinder a and through the holes h in the tube g with the space above the piston f , which is adapted to be in communication through a lateral chamber m with a condenser or with the external atmosphere. The piston-rod j extends through a bush n in an opening in the lower end of the cylinder a into the steam-chest d , wherein it is connected to a slide-block p , that is arranged to work vertically in guides q' in a downward extension q of the cylinder a and is adapted to receive and operate one end of a lever r , that is connected, preferably at an intermediate part of its length, to the main steam-valve and is pivoted, preferably at its other end, to a fixed part. The piston-rod j fits the bush n loosely or is grooved longitudinally, so as to allow steam to flow from the steam-chest d into the lower end of the cylinder a , the steam which thus enters the cylinder a flowing through the steam-passage l , the perforations h in the tube g , and the lateral chamber m to a condenser or elsewhere. The upper end of the piston f is connected by vertical side members s to an upper piston t , that fits the upper end of the relay-cylinder a and upon which rests the lower end of a coiled spring u , the upper end of which bears against the upper end of a cylindrical case v , that incloses the spring u , and is connected at its lower and flanged end to the flanged and upper end of the relay-cylinder a by bolts x , two of which are made long for compressing the spring u .

Fitted to slide vertically in the perforated tube g and so as to control the passage of steam through the perforations h is a piston-valve y , that is carried by a rod z , that extends upward through a guide 1, formed in halves and screwed into the lower end of a tube 2, that extends downward within the upper piston t and the coiled spring u and is fixed at its upper end to a centrally-perforated cap-piece 3, that is screwed into the upper end of the cylindrical spring-case v . The upper end of the valve-rod z at a point within the tube 2 is connected to the lower end of a coiled spring 4, the upper end of which is connected, by means of a screw-eye 5, to a removable hand-plug 6, that fits into the central opening in the cap-piece 3. The tube g , in which the valve y works, is closed at the bottom by the head i of the piston-rod j , and to permit the valve y to work freely therein it has one or more holes extending longitudinally there-
through to put the space above the valve y

into communication with the space below it. The valve-rod is provided at a point between the two pistons f and t with a collar 8, on which rests the forked inner end of a lever-arm 9, that extends through a lateral opening 10 in the cylinder a into the lateral chamber m and is connected to a horizontal spindle 11, which extends through one side of the lateral chamber and has fixed to its projecting end a lever-arm 12, adapted to be suitably connected to an engine-governor—as, for example, through a rod or wire and a coiled spring. (Not shown.) The lateral chamber m is secured over the lateral opening 10 and is, as preferred, formed on one side with a long tubular extension 13, fitted with a bush 14, through which the spindle 11 extends. To reduce friction, the ends of the spindle are formed with reduced portions or pivots 15, that are carried by and work in sockets 15^a, of which one—namely, that shown in the left-hand side of Fig. 2—is screwed into one side of the lateral chamber m and the other into an extension 16 of the top of the chamber m , terminating outside the outer lever-arm 12, and to prevent steam from passing through the tubular extension 13 the portion of the spindle 11 located therein is formed with a number of circumferential grooves 17, in which water of condensation will collect and form a packing to prevent the passage of steam.

To enable the controlling-valve y to be removed through the upper piston t without removing the lateral chamber m , with its spindle 11 and lever-arms 9 and 12, the inner lever-arm 9 is made in two parts connected together by a knuckle-joint that will permit the inner end portion to turn downward about a joint-pin 18 from its normal position when the outer portion is turned upward within the lateral chamber m , but will not permit the inner end portion to turn upward from its normal position independently of the outer end portion.

When the relay is in use and the turbine with which it is used is running at the normal speed, the two-armed lever 9 11 12 will depress the controlling-valve y and partly open the steam-exit formed by the holes h to such an extent that the steam-pressure in the lower end of the relay-cylinder a will cause the relay-piston f to hold the main steam-valve in the proper position for normal speed. When the speed rises above the normal, the two-armed lever 9 11 12 will depress the controlling-valve y against the action of its spring 4 and further open the steam-exit, so as to reduce the steam-pressure in the lower end of the relay-cylinder a and permit the relay-piston f to be forced downward by its spring u , so as to close the main valve partially and at the same time cause the perforated tube g to slide on the controlling-valve y , and thus reduce to the normal amount the free area of the holes h therein for the passage of steam. When the

speed falls below the normal, the pressure of the two-armed lever 9 11 12 on the controlling-valve y will be reduced and the valve will be raised by its spring 4, so as to reduce the free area of the exit-holes h in the tube, and thereby cause the steam-pressure in the cylinder a to increase and raise the relay-piston f and open the main valve to a greater extent, the rising of the relay-piston causing the tube g to slide on the controlling-valve y and open the exit-holes h in the tube to the normal extent. From this it will be seen that the piston f follows each movement of the controlling-valve y and causes the two parts g and y to resume their normal relative position after each operation of the relay.

The details of construction can be variously modified without departure from the essential features of the invention.

By means of the relay friction is considerably reduced and a more powerful control over the main steam-supply valve obtained.

What I claim is—

1. A valve-controlling governor-relay comprising an expansible chamber having an inlet and an outlet for pressure fluid and a portion of its wall adapted to be connected to the valve to be controlled so as to open or increase the opening of said valve on expansion of said chamber by said fluid, a load tending to prevent such expansion of said chamber, a loaded valve adapted to control the escape of pressure fluid through said outlet, and a device connected to the governor and to act upon the latter valve in opposition to its load and so when the speed of the engine is normal hold it in such a position as to close the outlet sufficiently to enable the pressure fluid in said chamber to hold the first-mentioned valve in the position required to insure said normal speed.

2. A valve-controlling governor-relay comprising an expansible chamber having an inlet and an outlet for pressure fluid and a portion of its wall adapted to be connected to the valve to be controlled so as to open or increase the opening of said valve on expansion of said chamber by said fluid, a load tending to prevent such expansion of said chamber, a valve adapted to control the escape of pressure fluid through said outlet, a load on the last-mentioned valve tending to cause it to close said outlet, and a device adapted to be connected to the governor and to act upon the last-mentioned valve so as to tend to open it further in opposition to the action of its load.

3. A valve-controlling governor-relay comprising a cylinder, a piston fitting and adapted to work in said cylinder, and adapted also to be connected to the valve to be controlled, a load on said piston tending to move said piston in said cylinder and thereby to reduce the size of a chamber formed by said cylinder and said piston, said chamber having an inlet for pressure fluid and said piston hav-

ing a passage extending longitudinally there-through, a valve adapted to control the escape of pressure fluid through said passage from said chamber, a load on the last-mentioned valve tending to cause it to close said passage, and a device adapted to be connected to the governor and to act upon the last-mentioned valve so as to tend to open it further in opposition to the action of its load.

4. A valve-controlling governor-relay comprising an expansible chamber having an inlet and an outlet for pressure fluid and a portion of its wall adapted to be connected to the valve to be controlled so as to open or increase the opening of said valve on expansion of said chamber by said fluid, a load tending to prevent such expansion of said chamber, a valve adapted to control the escape of pressure fluid from said chamber through said outlet and to be connected to the engine-governor so as to be moved and thereby opened or have its opening increased by said governor on increase of the speed of the engine to be governed, and a load tending to prevent such movement of the last-mentioned valve.

5. A valve-controlling governor-relay comprising an expansible chamber having an inlet and an outlet for pressure fluid and a portion of its wall adapted to be operatively connected to the valve to be controlled, a load tending to move said portion of said wall in the direction opposite to that in which it would be moved by the expansion of said chamber, a valve adapted to control the escape of pressure fluid from said chamber through said outlet and to be connected to the engine-governor so as to be moved thereby in the first-mentioned direction and to be opened or to have its opening increased by movement in relation to said portion of said wall in the first-mentioned direction, and a load tending to move the last-mentioned valve in the direction opposite to the first-mentioned direction.

6. A valve-controlling governor-relay comprising a cylinder, a piston fitting in said cylinder and adapted to work therein and to be operatively connected to the valve to be controlled, a load tending to move said piston in said cylinder so as to reduce in size a chamber which is formed by said cylinder and said piston and which is provided with an inlet and an outlet for pressure fluid, a valve adapted to control the escape of pressure fluid from said chamber through said outlet and to be connected to the engine-governor so as to be moved thereby in the same direction as that in which said load tends to move said piston and to be opened or to have its opening increased by movement in relation to said piston in said direction, and a load tending to move the last-mentioned valve in the direction opposite to the first-mentioned direction.

7. A valve-controlling governor-relay comprising an expansible chamber having an inlet for pressure fluid and a portion of its wall

adapted to be operatively connected to the valve to be controlled and having in it an outlet for the escape of pressure fluid from said chamber, a load tending to move said portion of said wall in the direction opposite to that in which it would be moved by the expansion of said chamber, a valve located in said wall and adapted to control the escape of pressure fluid from said chamber through said outlet and to be connected to the engine-governor so as to be moved thereby in the first-mentioned direction and to be opened or to have its opening increased by movement in relation to said portion of said wall in the first-mentioned direction, and a load tending to move the last-mentioned valve in the direction opposite to the first-mentioned direction.

8. A valve-controlling governor-relay comprising an expansible chamber having an inlet and an outlet for pressure fluid and a portion of its wall adapted to be operatively connected to the valve to be controlled, a load tending to move said portion of said wall in the direction opposite to that in which it would be moved by the expansion of said chamber, a valve adapted to control the escape of pressure fluid from said chamber through said outlet and to be opened or to have its opening increased by movement in relation to said portion of said wall in the first-mentioned direction, and means for moving the last-mentioned valve in opening and closing directions in accordance with the action of the governor.

9. A valve-controlling governor-relay comprising an expansible chamber having an inlet and an outlet for pressure fluid and a portion of its wall adapted to be operatively connected to the valve to be controlled, a load tending to move said portion of said wall in the direction opposite to that in which it would be moved by the expansion of said chamber, a valve adapted to control the escape of pressure fluid from said chamber through said outlet and to be opened or to have its opening increased by movement in relation to said portion of said wall in the first-mentioned direction, a load tending to move the last-mentioned valve in the first-mentioned direction, and a lever adapted to be connected to the engine-governor and to move the last-mentioned valve in the first-mentioned direction.

10. A valve-controlling governor-relay comprising a cylinder, a piston fitting in said cylinder and adapted to work therein and to be operatively connected to the valve to be controlled, a second piston also fitting in said cylinder and adapted to work therein and to act upon the first-mentioned piston so as to move it in such a direction as to reduce in size a chamber which is formed by said cylinder and said piston and which is provided with an inlet and an outlet for pressure fluid, a load on said second piston tending to force it toward the first-mentioned piston, a valve adapt-

ed to control the escape of pressure fluid from said chamber through said outlet and to be opened or to have its opening increased by movement in relation to said piston in said direction, and a lever projecting between said pistons and adapted to be operatively connected to the governor and to operate the last-mentioned valve in said direction.

11. A valve-controlling governor-relay comprising a cylinder, a piston fitting in said cylinder and adapted to work therein and to be operatively connected to the valve to be controlled, a second piston also fitting in said cylinder and adapted to work therein and to act upon the first-mentioned piston so as to move it in such a direction as to reduce in size a chamber which is formed by said cylinder and said piston and which is provided with an inlet and an outlet for pressure fluid, a casing secured to said cylinder, a coiled spring arranged to act in compression at one end upon said second piston and at its other end upon said casing, a valve adapted to control the escape of pressure fluid from said chamber through said outlet and to be opened or to have its opening increased by movement in relation to said piston in said direction, and a lever projecting between said pistons and adapted to be operatively connected to the governor and to operate the last-mentioned valve in said direction.

12. A valve-controlling governor-relay comprising a cylinder, a piston fitting in said cylinder and adapted to work therein and to be operatively connected to the valve to be controlled, a second piston also fitting in said cylinder and adapted to work therein and to act upon the first-mentioned piston so as to move it in such a direction as to reduce in size a chamber which is formed by said cylinder and said piston and which is provided with an inlet and an outlet for pressure fluid, a casing secured to said cylinder, a coiled spring arranged to act in compression at one end upon said second piston and at its other end upon said casing, a valve adapted to control the escape of pressure fluid from said chamber through said outlet and to be opened or to have its opening increased by movement in relation to said piston in said direction, a lever projecting between said pistons and adapted to be operatively connected to the governor and to operate said valve in said direction, and a coiled spring having its ends connected to said valve and to the end of said casing remote therefrom so as to act in tension thereupon.

13. A valve-controlling governor-relay comprising a cylinder, a piston fitting in said cylinder and adapted to work therein and to be operatively connected to the valve to be controlled, a second piston also fitting in said cylinder and adapted to work therein and to act upon the first-mentioned piston so as to move it such a direction as to reduce in size

a chamber which is formed by said cylinder and said piston and which is provided with an inlet and an outlet for pressure fluid, a casing secured to said cylinder, a coiled spring arranged to act in compression at one end upon said second piston and at its other end upon said casing, a valve adapted to control the escape of pressure fluid from said chamber through said outlet and to be opened or to have its opening increased by movement in relation to said piston in said direction, a lever projecting between said pistons and adapted to be operatively connected to the governor and to operate said valve in said direction, a tube which is secured to the end of said casing remote from said cylinder and extends into said second piston, which is centrally perforated and adapted to fit and work thereon, a guide secured in the end of said tube nearer to the first-mentioned piston, a rod secured to the last-mentioned valve and fitting in said guide and extending therethrough into said tube, and a coiled spring which has one end connected to the end of said casing remote from said cylinder and its other end connected to the end of said rod within said tube and is adapted to act in tension thereupon.

14. A valve-controlling governor-relay comprising a cylinder, a piston fitting in said cylinder and adapted to work therein and to be operatively connected to the valve to be controlled, a second piston also fitting in said cylinder and adapted to work therein and to act upon the first-mentioned piston so as to move it in such a direction as to reduce in size a chamber which is formed by said cylinder and said piston and which is provided with an inlet and an outlet for pressure fluid, a casing secured to said cylinder, a coiled spring arranged to act in compression at one end upon said second piston and at its other end upon said casing, a valve adapted to control the escape of pressure fluid from said chamber through said outlet and to be opened or to have its opening increased by movement in relation to said piston in said direction, a lever projecting between said pistons and adapted to be operatively connected to the governor and to operate said valve in said direction, a centrally-perforated cap-piece secured in the end of said casing remote from said cylinder, a tube which is fixed to said cap-piece so that the central perforation of said cap-piece and the interior of said tube intercommunicate and which extends into said second piston, which is centrally perforated and adapted to fit and work thereon, a guide secured in the end of said tube nearer to the first-mentioned piston, a rod secured to the last-mentioned valve and fitting in said guide and extending therethrough into said tube, a removable plug or stopper in said cap-piece, and a coiled spring which has one end connected to said plug or stopper and its other end connected

to the end of said rod within said tube and is adapted to act in tension thereupon.

15. A valve-controlling governor-relay comprising an expansible chamber having an inlet for pressure fluid and a portion of its wall adapted to be operatively connected to the valve to be controlled, a load tending to move said portion of said wall in the direction opposite to that in which it would be moved by the expansion of said chamber, a tube closed at one end and fitting and secured at its other end in a hole in said portion of said wall and provided intermediately with a passage in communication with the interior of said chamber, a piston-valve located in said tube and adapted to control the passage of pressure fluid therethrough from said chamber and to be opened or to have its opening increased by movement in relation to said portion of said wall in the first-mentioned direction, and means for moving the last-mentioned valve in opening and closing directions in accordance with the action of the governor.

16. A valve-controlling governor-relay comprising a cylinder, a piston fitting in said cylinder and adapted to work therein and to be operatively connected to the valve to be controlled, a second piston also fitting in said cylinder and adapted to work therein and to act upon the first-mentioned piston so as to move it in such a direction as to reduce in size a chamber which is formed by said cylinder and said piston and which is provided with an inlet and an outlet for pressure fluid, a load on said second piston tending to force it toward the first-mentioned piston, a valve adapted to control the escape of pressure fluid from said chamber through said outlet and to be opened or to have its opening increased by movement in relation to said piston in said direction, a load tending to move the last-mentioned valve in the direction opposite to the said direction, a lever-arm projecting through an opening in said cylinder and between said pistons and adapted to be operatively connected to the governor and to operate the last-mentioned valve in the first-mentioned direction, a casing secured to said cylinder over said opening and provided with an outlet for the escape of pressure fluid, a spindle which is mounted fluid-tight in said casing and to which said lever-arm is secured, and an operating lever-arm which is fixed to said spindle outside said casing and is adapted to be operatively connected to the governor.

17. A valve-controlling governor-relay comprising a cylinder, a piston fitting in said cylinder and adapted to work therein and to be operatively connected to the valve to be controlled, a second piston also fitting in said cylinder and adapted to work therein and to act upon the first-mentioned piston so as to move it in such a direction as to reduce in size a chamber which is formed by said cylin-

der and said piston and which is provided with an inlet and an outlet for pressure fluid, a load on said second piston tending to force it toward the first-mentioned piston, a valve adapted to control the escape of pressure fluid from said chamber through said outlet and to be opened or to have its opening increased by movement in relation to said piston in said direction, a load tending to move the last-mentioned valve in the direction opposite to said direction, a lever-arm projecting through an opening in said cylinder and between said pistons and adapted to be operatively connected to the governor and to operate the last-mentioned valve in the first-mentioned direction, a casing secured to said cylinder over said opening and provided with an outlet for the escape of pressure fluid, a spindle which is mounted fluid-tight in said casing and to which

said lever-arm is secured, and an operating lever-arm which is fixed to said spindle outside said casing and is adapted to be operatively connected to the governor, the first-mentioned lever-arm being composed of two parts of which one is fixed to said spindle and is connected to the other of said parts by a joint adapted to enable the lever-arm composed of said parts to be bent and so reduced in length by turning said spindle in the sense opposite to that required for moving the secondly-mentioned valve in the first-mentioned direction.

Signed at Newcastle-upon-Tyne, in the county of the same city, this 6th day of June, 1904.

HUGH FRANCIS FULLAGAR.

Witnesses:

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