No. 661,222. Patented Nov. 6, 1900.

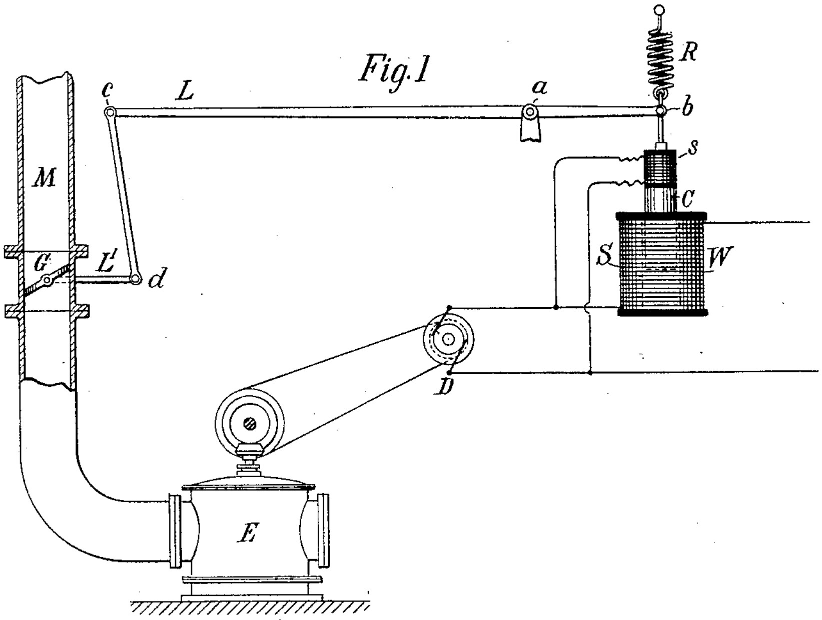
R. D. MERSHON.

METHOD OF GOVERNING PRIME MOVERS.

(Application filed Nov. 6, 1899.)

(No Model.) 2 Sheets—Sheet 1.

Fig. 1



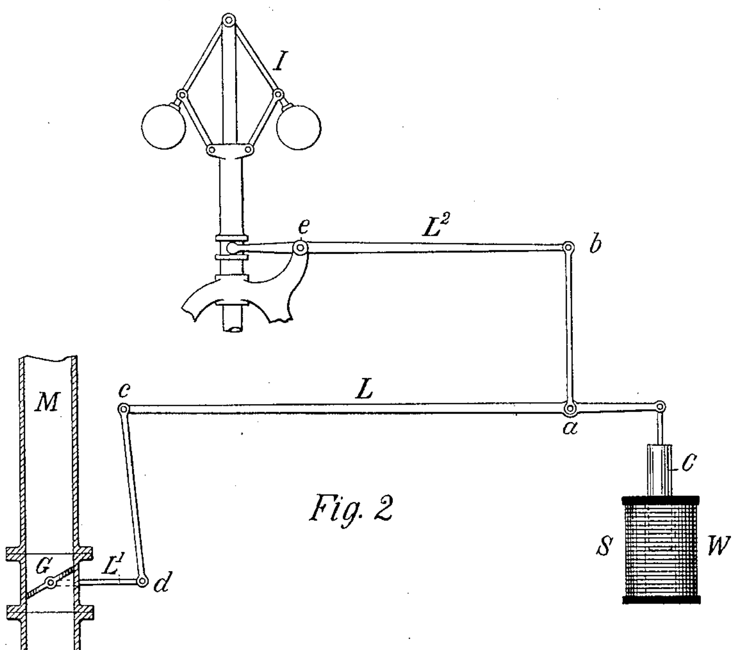


Fig. 2

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Att'y

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Fig. 3

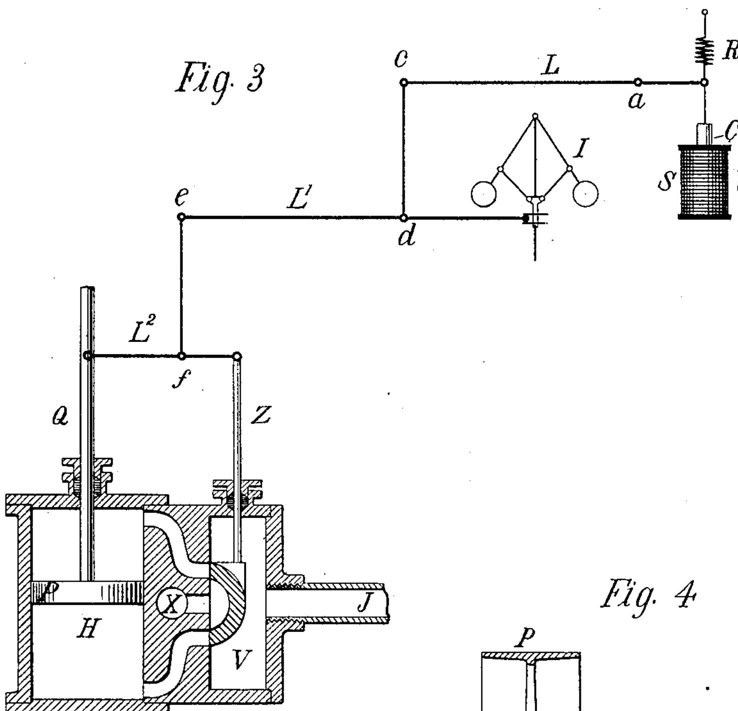
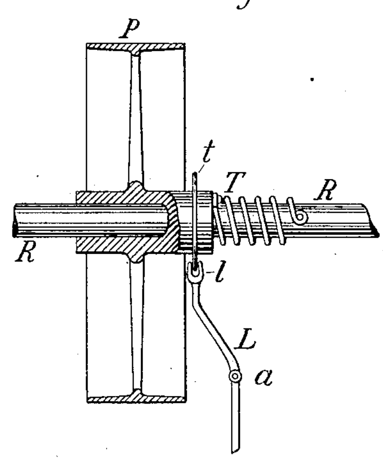


Fig. 4



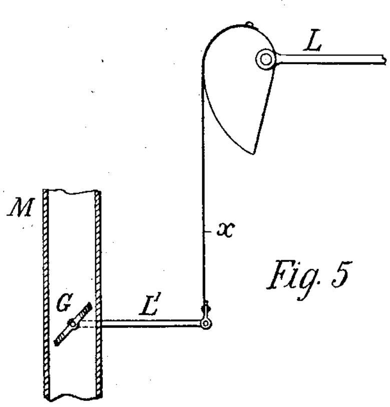


Fig. 5

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UNITED STATES PATENT OFFICE.

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METHOD OF GOVERNING PRIME MOVERS.

SPECIFICATION forming part of Letters Patent No. 661,222, dated November 6, 1900.

Application filed November 6, 1899. Serial No. 736,066. (No model.)

To all whom it may concern:

Be it known that I, RALPH D. MERSHON, a citizen of the United States, residing at New York city, in the State of New York, have invented a new and useful Method of Governing Prime Movers, of which the following is a specification, reference being had to the accompanying drawings, which form a part hereof.

The governors ordinarily used for controlling prime movers—such, for example, as the common centrifugal governor—are dependent for their action upon a change of speed in the prime mover; but the action of such governors is defective. In addition to the fact that they cannot act until the speed has changed the principle on which they are based demands that between no load and full load there shall be a permanent change of speed, there being for each load carried a certain speed to which the prime mover must settle in order that the governor shall permit the supply of sufficient power to carry that load. Generally the speed at full load is less than that at no load, and the difference or fall of speed determines the stability of regulation, the stability being, other things equal, greater if the fall of speed is greater and less if the fall is less. The stability of regulation or definiteness and steadiness with which the prime mover will assume the speed proper to the load thrown upon it depends also upon the amount of inertia and lost motion in the regulating and governing apparatus and upon the amount of fly-wheel effect in the prime mover itself. Too much inertia or lost motion in the former relative to the amount of inertia in the latter may result, when there is a change of load, in a series of surgings above and below normal speed of progressively-decreasing extent. In many cases, therefore, the conditions with a centrifugal governor are such that the only remedy which can be applied for such surging is to allow the fall of speed to be greater than desirable or to add to the prime mover a fly-wheel, whose weight is very objectionable. These defects in the ordinary governing apparatus are especially objectionable when the prime mover is used for driving an electrical generator, since a very uniform speed of the generator is in most cases highly desirable, and variations in speed with changes of load greatly disturb the operation of the translating devices supplied with current by the generator.

It is the object of my present invention to overcome these difficulties and to provide a governor for prime movers which is not primarily dependent for its action upon a change of speed in the motor governed by it, but which assumes a definite position for every load thrown upon the prime mover without regard to speed and in which the range of variation of speed and the amount of fly-wheel effect necessary for securing stability are greatly reduced.

My invention consists, broadly stated, in making use as the controlling element of the governing apparatus of a wattmeter or power-indicator forming part of or connected with the prime mover so as to be responsive to changes in the load upon it; and it consists, further, in using as the controlling element or elements of the governing apparatus such a wattmeter or power-indicator in combination with a speed indicator or measurer connected with or actuated by the prime mover, as is more specifically hereinafter described.

In the drawings I have shown diagrammatically forms of apparatus which may be used for practicing my method of regulation.

Figure 1 is a diagrammatic representation of the application of a wattmeter as the controlling element of the governing apparatus for a water-wheel, steam-engine, or other prime mover. Figs. 2 and 3 are diagrammatic representations of the application of a wattmeter in combination with a speed-indicator as such controlling element, and Figs. 4 and 5 show details of construction.

The same letters of reference refer to like parts in all the drawings.

In Fig. 1, W is a wattmeter actuated by the prime mover and so arranged that it responds directly to and indicates by means of the lever L changes of load upon the prime mover. It may be electrical or mechanical.

Where the prime mover is used to drive an electrical generator, any of the ordinary forms of electrical wattmeter connected with the circuit of the generator, so as to indicate the amount of electrical energy developed in it, may be used as the controlling element. W in Fig. 1 is intended to represent such an electrical wattmeter in one of its simplest forms, in which S is a solenoid included in the main circuit of the generator D, and C is an iron core moving freely in the hollow of the solenoid and provided with a retractile spring R. With this arrangement the position of the core will vary with changes in the strength of the current, and the core will thus indicate by its position the load upon the generator. By methods of construction and adjustment of the solenoid and its core and the retractile spring which are well known in the art the core C may be made to assume and maintain a definite position for any given load on the generator and so to indicate the amount of electrical energy developed by it when the electromotive force is kept constant and the current strength alone varies. Where the electromotive force, as well as the current strength, varies or when applied to an alternating-current generator, especially if the power factor of its load varies, a second coil *s*, included in a shunt-circuit across the terminals of the generator D, should, as is well known, be applied to or around the core or the solenoid, so as to coöperate in its magnetizing effect with the main coil.

L is a lever pivoted to a fixed support at *a* and to the core of the solenoid at *b*.

M is the main supply-pipe, conveying water, for example, to a water-wheel E, used as a prime mover for driving the electrical generator D, and G is a gate controlling the flow of water in the pipe.

L′ is a lever controlling the gate G and pivoted by means of the connecting-rod *c d* to the lever L. The arrangement of the levers and gate is such that the gate is opened by a downward movement of the core C and closed by an upward movement of it.

When the prime mover is not used for driving an electrical generator or the use of an electrical wattmeter is inconvenient or undesirable for any other reason, any of the well-known forms of "transmission-dynamometer" may be used as a mechanical wattmeter for the controlling element—such, for example, as that shown in Fig. 4, where R is a shaft, P is a pulley mounted on the shaft so that it can turn freely upon it, and T is a spring one end of which is secured to the shaft and the other to the pulley. The shaft, which is the main transmission-shaft of the prime mover, drives the pulley or is driven by it, and the tension or compression of the spring varies with the torque transmitted, and therefore with the load upon the prime mover. The length of the spring varies with variations in its tension or compression, and the longitudinal position of the pulley on the shaft therefore indicates the load on the prime mover. The lever L is pivoted at *a*, engages by its forked end *l* with the flange *t* on the pulley, and so indicates the variations in position of the shaft and the pulley and therefore the load on the prime mover. It corresponds to the lever L of Fig. 1 and is connected to the other parts of the apparatus in the same way.

As the indicator of the wattmeter, whether electrical or mechanical, assumes and maintains a determinate position for any given load upon the prime mover, it is obvious that with the parts arranged and connected as shown in Fig. 1 the gate G will assume and maintain a determinate position for any given load and that when there is a change in the load the indicator of the wattmeter will at once assume and maintain a new position and effect a corresponding change in the position of the gate or valve G without waiting, as is the case with the ordinary governor, for a change to be effected in the speed. This results in a correct adjustment at all times of the power supplied to the prime mover to the load carried by it, provided the law of operation of the gate with the movement impressed upon it corresponds to that of the wattmeter with which it is connected. For example, if the wattmeter employed follows the straight-line law—that is to say, if the movement of the indicator is directly proportional to any change in the load which it indicates—then the corresponding movement of the gate G, if one in which the flow is directly proportional to the distance the gate is moved, should follow the same law; but if the wattmeter follows a law represented by a curve then the corresponding movement of the gate, or, rather, its action in increasing or decreasing the supply of water, should be made to follow a law represented by the same curve. This result may be effected by properly shaping the gate or by connecting the lever by means of cams with rolling connections or irregularly-shaped gears in ways which are well understood. If, for example, the core of the wattmeter shown in Fig. 1 is drawn into the solenoid decreasing distances for equal increments of load, the levers L and L′ may be connected by a cam movement with a flexible connector *x*, as shown in Fig. 5, which will give the lever L′ a correspondingly-increased movement for a given movement of the lever L. In any such arrangement the cam must of course be shaped so as to take into account the variation in obliquity of the various connecting-levers as well as the laws of the wattmeter and gate.

In Fig. 2 I have shown the wattmeter of Fig. 1 combined with a speed-indicator for controlling the position of the gate G. In this case the wattmeter acts, as before, to open the gate G upon an increase of load and to close it upon a decrease, and at the same time the speed-indicator I, which I have shown as consisting of an ordinary centrifugal governor, acts by shifting the fulcrum of the lever L′ to close the gate upon an increase of speed and to open it upon a decrease of speed. The combined action of these two devices is to adjust the supply of power to the prime mover to the load carried by it and at the same time to maintain a substantially uniform speed. For this purpose it is important that the apparatus should be so designed and adjusted that with the wattmeter at either limit of its movement the speed indicator or measurer shall be able to control the power supplied. If, for instance, the nature of the load be such that an increase of speed means an increase of power supplied by the prime mover and if the throwing off of some of the load should produce an increase of speed, owing to the fact that it would take an appreciable time for the wattmeter to actuate the mechanism controlling the supply of power to the prime mover, (assuming the speed-indicator not to be in use,) or if there should be an increase of speed for any other reason the speed might go on increasing indefinitely, since the wattmeter would until it reached the limit of its movement continually call for more power as the load increased. If, however, the speed-indicator be introduced, as shown in Fig. 2, and there be allowed a speed variation of, say, two per cent., then the speed-indicator will be able to control the speed within the prescribed limit and the wattmeter will be able to do its part in changing the power supplied the instant there is any need of change by reason of change of load, provided the speed-indicator has sufficient control over the power supplied throughout the range of movement of the wattmeter to arrest acceleration of speed beyond the prescribed limits. The same considerations apply to a decrease of speed due to decrease of load or any other cause.

In Figs. 1 and 2 I have shown the controlling devices as applied directly to moving the gate G; but with a water-wheel of any considerable size it will be necessary or at least desirable for the purpose of securing the requisite quickness and accuracy of action to interpose between the controlling element and the gate or nozzle some form of relay mechanism. In Fig. 3 I have shown the use of a hydraulically-operated piston for this purpose. The lever L′ instead of operating the gate directly operates a valve V, which controls the admission of fluid under pressure to the piston-chamber H. Water is admitted to the valve-chamber V through the inlet-pipe J and escapes through the exhaust-port X. The piston P, working in the piston-chamber, is connected by means of its piston-rod Q with the gate controlling the admission of water to the water-wheel. It is obvious that various other forms of relay mechanism, mechanical or electrical, may be used, the essential feature being that all work shall, as far as possible, be taken off from the controlling element and transferred to mechanism that is merely controlled and directed by it and that for each position of the governing mechanism the gate shall assume a definite predetermined position.

I have described my invention particularly as applied to governing a water-wheel; but it is obvious that the same principles and substantially the same mechanism will apply to the governing of a steam-engine, a gas-engine, an electric motor, or any other form of prime mover. It may be applied either to shutting off the supply by an ordinary throttling-valve or to changing the point of cut-off.

My invention is particularly useful for governing prime movers used for driving electrical generators, since great constancy of speed with variable loads is especially desirable in such cases; but it may be used in any case where very close regulation for constant speed is desirable.

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

1. The method of regulating for constancy or approximate constancy, the speed of an electric generator carrying a variable load whose variations are due to variations in electromotive force or current or both, which consists in causing the electromotive force and current to produce a magnetic resultant which resultant and its variations are proportional to the power and variations of the power delivered by the generator, causing variations in such magnetic resultant to produce corresponding variations in the driving power applied to the generator, thereby producing an approximately constant speed on the part of the generator regardless of variations in the load.

2. The method of regulating for constancy or approximate constancy, the speed of an electric generator carrying a variable load whose variations are due to variations in electromotive force or current or both, which consists in causing the electromotive force and current to produce a magnetic resultant, which resultant and its variations are proportional to the power and variations of the power delivered by the generator, causing variations in such magnetic resultant to produce independently of the normal operation of the speed-governor of the prime mover, corresponding variations in the driving power applied to the generator, thereby producing an approximately constant speed on the part of the generator regardless of variations in the load.

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Witnesses:

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