(No Model.)

R. H. MATHER.

GOVERNOR FOR ENGINES.

No. 500,019. Patented June 20, 1893.

Fig. 1

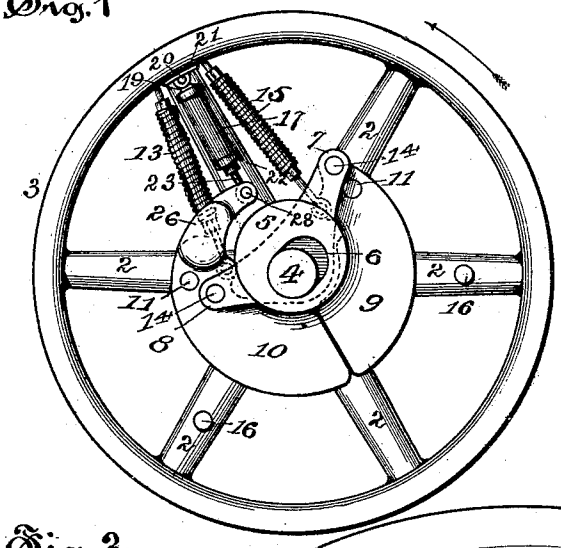


Fig. 3

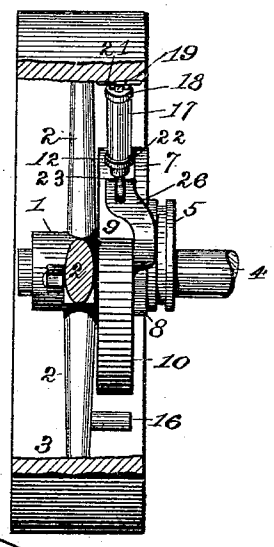
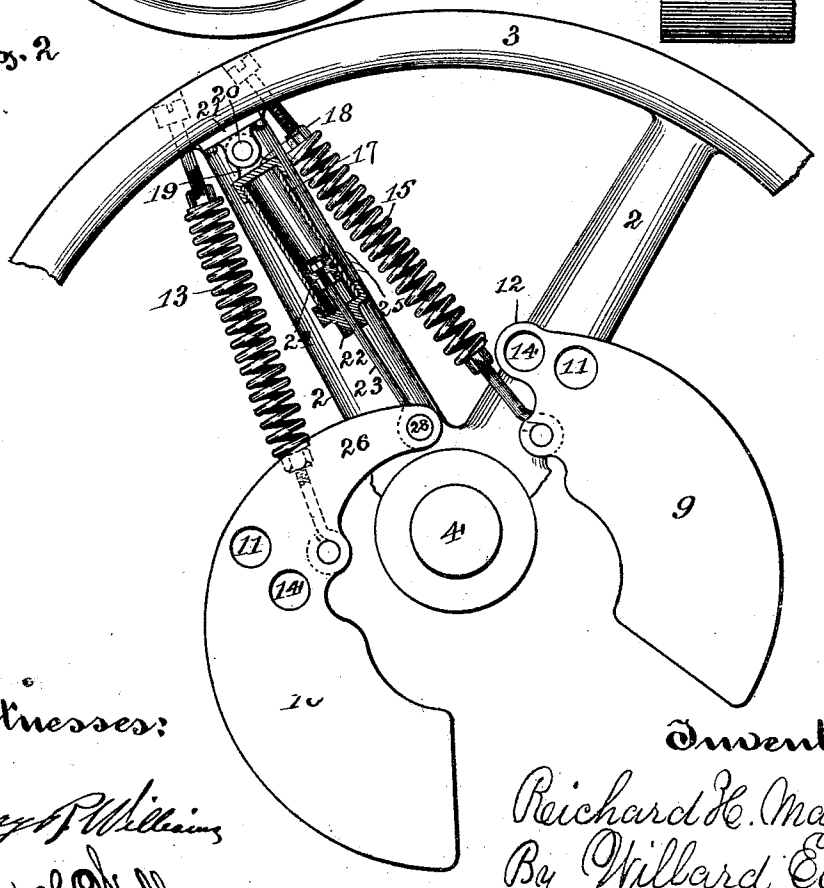


Fig. 2



Witnesses:

Harry P. Williams

Albert H. Walker

Inventor,

Richard H. Mather.

By Willard Eddy.

Atty

UNITED STATES PATENT OFFICE.

RICHARD H. MATHER, OF WINDSOR, CONNECTICUT.

GOVERNOR FOR ENGINES.

SPECIFICATION forming part of Letters Patent No. 500,019, dated June 20, 1893.

Application filed March 19,1890. Serial No. 344,477. (No model.)

To all whom it may concern:

Be it known that I, RICHARD H. MATHER, of Windsor, in Hartford county, Connecticut, have invented certain new and useful Improvements in Governors for Steam Engines, which improvements are described in the following specification and are illustrated by the accompanying drawings.

Said improvements relate in general to all kinds of steam-engine governing devices, and in particular to the class of centrifugal governors. In making governors of this class, it has been usual to sacrifice, to a greater or less extent, that theoretically correct regulation isochronism, which is produced when the centrifugal and the centripetal forces of a governor are precisely balanced in all positions. This sacrifice has been considered necessary for purposes of stability, that is to say, for the purpose of preventing the so-called racing, hunting or floating of the centrifugal weights. The present invention, proceeding upon the view that no such sacrifice is necessary for that purpose, aims to impart to the weights all necessary stability by other means. For the purpose of accomplishing this object, my invention balances the centrifugal and the centripetal forces of the governor in such a manner as to produce theoretically correct regulation isochronism, and at the same time subjects the weights to the action of a special device, which may appropriately be termed an air dash-pot.

The best manner in which I have contemplated applying the principle of my invention, is shown in said drawings; in which—

Figure 1 is a side elevation of a shifting-eccentric governor, which is constructed in accordance with my invention, the weights being shown in their positions of nearest approach to the shaft. Fig. 2 is a detail side view of a portion of the same governor with parts cut in section to show the construction, the weights being shown in positions of greatest departure from the shaft. Fig. 3 is an edge view on Fig. 1, with parts broken away.

In these views the numerals 1, 2 and 3 denote respectively the central hub, the radial arms and the peripheral rim of a wheel or pulley, which is secured to a crank-shaft 4. On shaft 4, and contiguous to hub 1, is an eccentric 5, which has a slot or opening 6, through which shaft 4 is inserted. An eccentric strap, which is not shown in the drawings, is applied to eccentric 5, and is connected with a valve-rod, in the usual manner. The centrifugal weights, 9 and 10, whose form may be observed in the drawings, are pivoted by steel pins 11 to arms 2 at points which are equidistant from the center of the wheel. Said pivots are preferably separated from each other by an angle of one hundred and thirty-four degrees, more or less, formed at the center of said wheel. Weights 9 and 10 have terminal lever arms 12 and 26 respectively, which approach each other beyond pins 11. These weights are connected with rim 3 by helical springs 13 and 15, which are preferably arranged in approximately radial positions in the wheel. Arm 26 of weight 10 is deflected from the path of spring 13, as seen in Figs. 1 and 3. Springs 13 and 15 are set at such a degree of tension as to produce isochronous regulation, that is to say, they are preferably adjusted at full theoretic tension; if adjusted at any other tension, not producing stability, they fall nevertheless within the scope of my invention, which is designed, as already stated, to render an adjustable governor stable by means of an air dash-pot. Eccentric 5 is provided with two spreading arms 7 and 8, which are cast integrally therewith. These arms are respectively pivoted to weights 9 and 10 by pins 14, one of which is located near the extremity of arm 12, while the other is located on the body of weight 10. Pivots 11 and 14 are laid out in such positions, as shown in the drawings, that the situation of the valve is undisturbed and its lead is constant, when the eccentric is thrown across the shaft. Two stop pins 16 are set in arms 2 to limit the separation of the weights.

The numeral 17 denotes the air dash-pot which is the special device above mentioned as an essential element of my invention. The cylinder of the dash-pot, being exhibited in longitudinal section in Fig. 2, is denoted by the same numeral 17. One end of cylinder 17 is provided with a screw cap 18, having a tongue 19. By means of a pin 20, passing through tongue 19, the cylinder is pivoted to a bracket 21, which is attached to rim 3. The other end of the cylinder is provided with a screw cap 22, which has a hole in the middle

to serve as a guide and also as a stuffing-box, for stem 23 of the piston. The piston-head 24 is made to fit nearly air-tight within cylinder 17, and for that purpose is provided with grooves 25, which contain oil. The outer end of stem 23 is pivotally attached to the extreme portion of arm 26 by means of a pin 28. Thus the dash-pot constitutes an elastic link between rim 3 and the centrifugal weights, and occupies at all times an approximately radial position relative to the wheel.

The remaining particulars of construction of my invention, as applied to a shifting-eccentric governor, will sufficiently appear from the drawings, and from the mode of operation which now remains to be described. When the piston in cylinder 17 is at rest, or remains for a short time unmoved by the action of the centrifugal weights, the piston-head occupies a position of equilibrium between equal atmospheric pressures upon its opposite sides. But whenever the piston is moved in either direction by the action of the weights, that equilibrium is for the time being disturbed to a greater or less extent, varying with the extent and speed of the movement. The disturbance, however is not of long duration; for equilibrium is soon restored, either by the leakage of air from one side of the piston-head to the other, or by a return movement of the piston, or by both methods together. Until such restoration of equilibrium is complete, the piston, seeking to execute such return movement, exerts upon the weights a force which is derived from the elasticity and pressure of the air in cylinder 17. The force which is thus exerted upon the weights produces two effects. On the one hand it checks the centrifugal or centripetal movement, whereby the disturbance of equilibrium was produced; acting in this manner it counteracts the inertia of the weights, and diminishes or prevents that continuance of movement which would otherwise result from their centrifugal or centripetal momentum. On the other hand, as soon as any movement of the centrifugal weights in either direction is ended, the same force, being still exerted upon the weights, impels them in the opposite direction, namely, toward that position which is necessary, under existing conditions, to produce the normal speed. Under this impulse, and under the influence of changing speed, the weights, in returning toward their normal position, start more promptly, proceed by a more slow and gradual movement, and reach their destination more quickly, than would be possible under the influence of changing speed alone. In other words, the piston, either drawing the weights, or pushing them, as the case may be, helps them slowly back toward their proper positions, in advance of the time when they would be moved to the same position under the sole influence of changing centrifugal force. By reason of this function of the dash-pot, therefore, less change of speed is requisite, than would otherwise be necessary in order to produce the proper return movement of the weights: and as that movement is executed in a slow and gradual manner, the weights acquire little momentum, and are sooner brought to rest in their normal position. This mode of operation occurs in connection with each successive excursion and return of the weights, in passing from one normal position to another in the presence of variable conditions. This may be illustrated concretely. Suppose an engine, which is provided with this governor, to be running at normal speed, say four hundred revolutions per minute, under normal conditions in respect of load, boiler pressure and all other particulars. Then suppose a large part of the load, or the whole of it, to be suddenly thrown off, while all other conditions remain unchanged. The speed is in consequence increased immediately. But the weights, being hindered by their inertia, and by the resistance of the dash-pot, cannot immediately fly out to shut off steam. Hence the increase of speed, resulting from the supposed diminution of load, may amount to as much as four or five per cent., that is to say, the engine may run at the rate of four hundred and sixteen or four hundred and twenty revolutions per minute, before any regulations occurs. Presently, however, under the influence of increased centrifugal force, the weights move out to their extreme position, shown in Fig. 2, and completely shut off the steam in the usual manner. The speed in consequence begins to fall, while the weights are in that position. Now without the aid of some centripetal force, other than the springs, the weights would remain in their extreme position, until the speed had fallen below its above-mentioned normal rate; and the speed of the engine would be reduced, say four or five per cent., or to the rate of three hundred and eighty-four or three hundred and eighty revolutions per minute, more or less, before sufficient steam would again be admitted, to the engine to maintain the normal speed. And in that case the inward movement of the weights, when it occurred, and the consequent increase of speed, would be excessive; so that the engine would again be running faster then its normal rate of four hundred revolutions per minute. After that it would again run too slow; and so on, in the usual manner of racing. But in the present instance, being urged inward by the combined pull of the springs and also of the dash-pot, the centrifugal weights, instead of lingering in their extreme outer position, as in the case last supposed, now commence their inward movement immediately after reaching that position and before the speed has fallen to the normal rate. During this return movement of the weights, the pull of the dash-pot diminishes gradually to nothing, the diminution being due to leakage and to change of position. The rate of leakage, being pre-determined experimentally in construction, is such that the

energy, which is stored in the dash-pot by reason of any typical or usual change of conditions, is completely exhausted precisely when the returning weights reach the position which is necessary to produce the normal speed of the engine under those changed conditions. By this mode of operation the engine while falling back to her normal speed, is supplied with a continually increasing quantity of steam; the normal speed and the normal supply of steam for the diminished load, are reached simultaneously; and the stability of the governor is preserved without the sacrifice of theoretically correct regulation isochronism. The illustration need not be extended to the similar case in which the load is increased. In that case, the described movements are reversed, and the same result is secured.

It is not intended in this specification to describe those modifications of structure or arrangement, which may be necessary or desirable for the purpose of applying my invention either to non-centrifugal governors, or to those centrifugal governors, which are not embraced in the class of shifting-eccentric governors. All modifications will retain the air dash-pot and in all centrifugal governors the air dash-pot will act in conjunction with the weights. But it is not necessary to the operation or identity of the invention that the dash-pot should be closed at both ends, as by caps 18 and 22, nor that the centrifugal weights should be two in number.

Such being the construction and operation of my invention, I claim—

1. In an isochronous governor for steam engines, one or more centrifugal weights, and regulating mechanism, actuated thereby, in combination with an air dash-pot which has a low rate of leakage, and is adapted to preserve contained air for limited times in states of compression and of rarefication, and thereby to act elastically upon said weights during those times, substantially as and for the purpose specified.

2. In a centrifugal governor, one or more weights in equilibrium between the centrifugal and the centripetal forces of the governor, and regulating mechanism, actuated by said weight or weights, in combination with an air dash-pot, which has a close-fitting piston, and is adapted to the storage of energy in the form of compressed air and of rarefied air, substantially as and for the purpose specified.

3. In a steam-engine governing device, wherein the regulating parts are adjusted so as to give substantially an equilibrium to the opposing forces, the combination with said regulating parts, of an air dash-pot, applied to co-operate therewith, and provided with a close-fitting piston, whereby the elastic contents of the dash-pot may be preserved for limited times in states of compression and of rarefication, substantially as and for the purpose specified.

4. In an isochronous centrifugal governor, a wheel upon the engine-shaft, centrifugally movable weights, adjusted in said wheel, and springs connected with said wheel and with said weights, in combination with an air dash-pot, applied as an elastic link between said wheel and weights, and provided with a close-fitting piston, whereby the air of the dash-pot may be rarefied, and also compressed, for the purpose of storing energy, substantially as and for the purpose specified.

In testimony whereof I hereunto set my name in the presence of two witnesses.

RICHARD H. MATHER.

Witnesses:

WILLARD EDDY,

D. S. FLETCHER.