No. 672,142.

Patented Apr. 16, 1901.

F. L. WHITMORE.

GOVERNOR.

(Application filed Mar. 13, 1900.)

(No Model.)

Fig. 4.

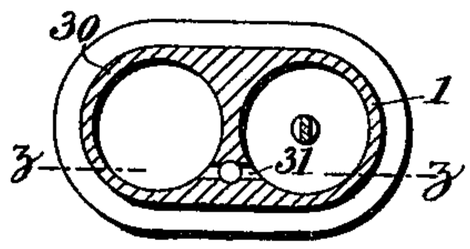


Fig. 5.

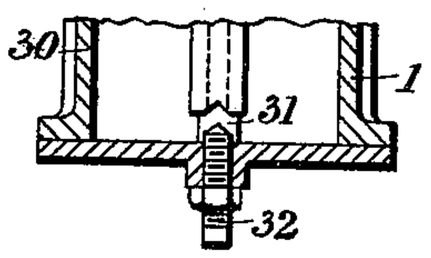


Fig. 2.

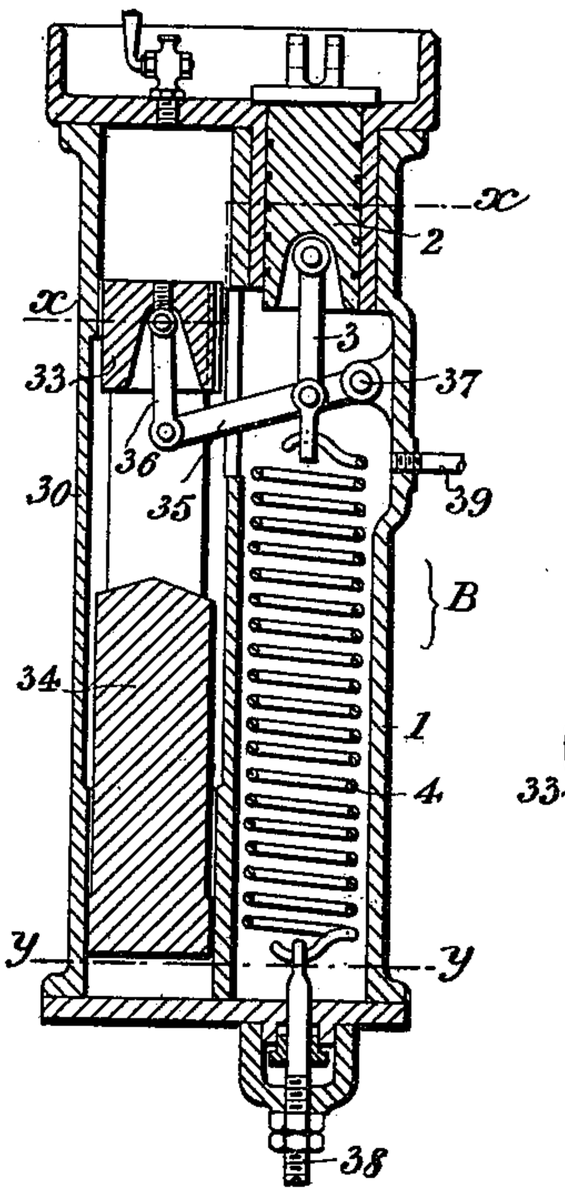


Fig. 6.

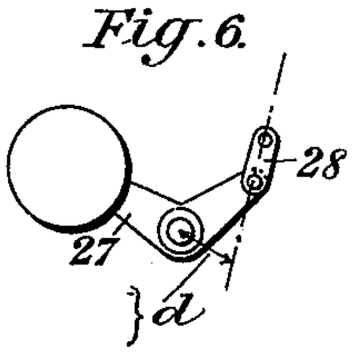


Fig. 3.

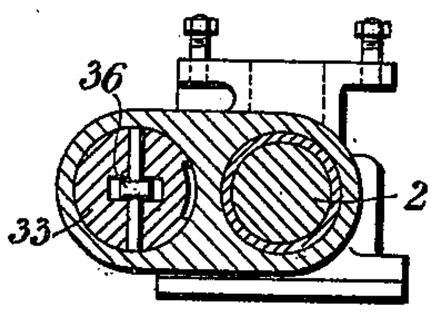
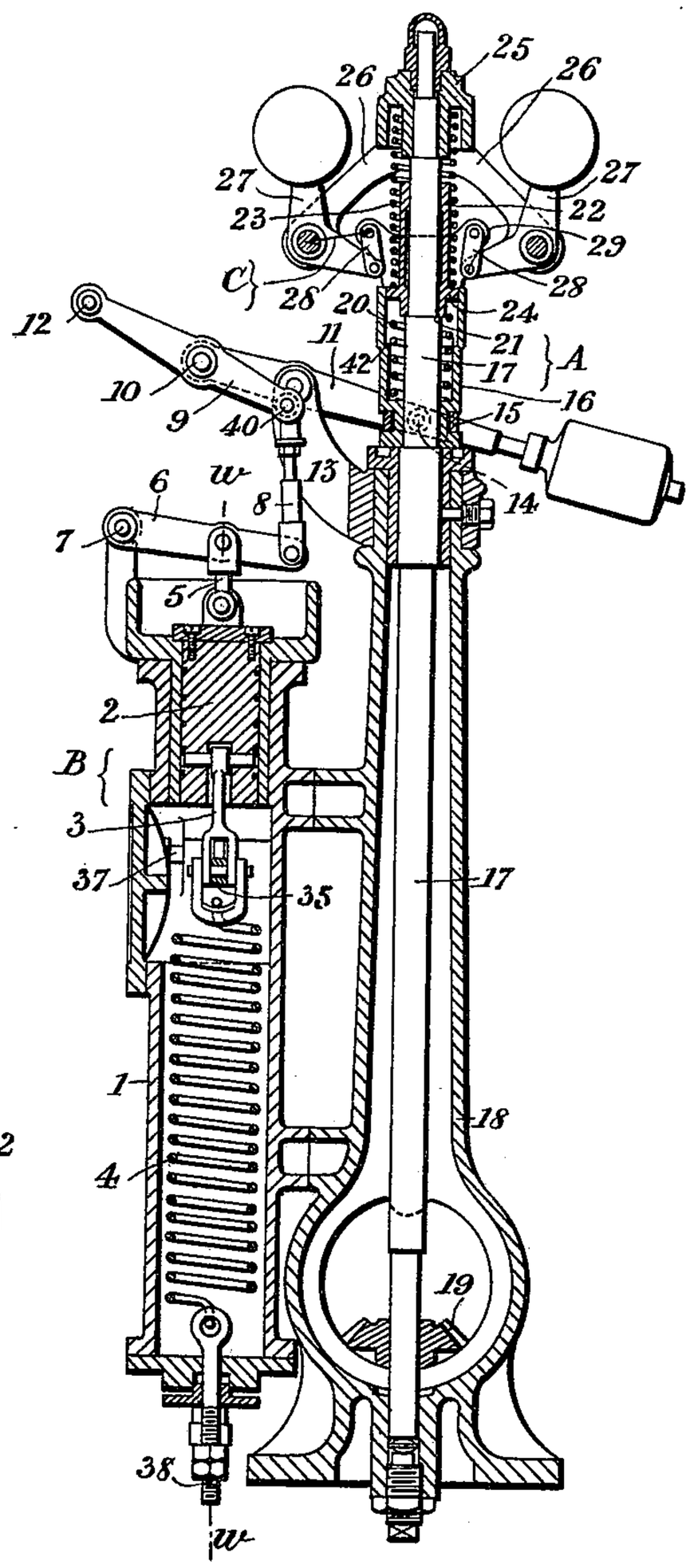


Fig. 1.



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GOVERNOR.

SPECIFICATION forming part of Letters Patent No. 672,142, dated April 16, 1901.

Application filed March 13, 1900. Serial No. 8,530. (No model.)

To all whom it may concern:

Be it known that I, FRANK LEONARD WHITMORE, a subject of the Queen of Great Britain, residing at Belvedere, in the county of Kent, England, have invented a certain new and useful Improvement in Governors for Regulating the Speed of Gas or Air Compressors or Pumps, of which the following is a specification.

The invention relates to an improvement in governors for regulating the speed of gas or air compressors or machines for pumping water or other liquids, the object of same being to provide an apparatus which will regulate with certainty the speed of the compressing-engine by the varying pressure of the compressed gas or air, or in the case of pumping-engines by the varying head of liquid to be pumped. The apparatus is adapted to act directly upon the steam-supply in the case of a steam-engine or to regulate the water-supply in a water-motor, such as is frequently used to drive a compressor or pump or to regulate the switch of an electric motor for the same purpose.

The invention is illustrated in the accompanying drawings, in which—

Figure 1 is a sectional elevation of the apparatus. Fig. 2 is a section at right angles on line *w w*, Fig. 1. Fig. 3 is a sectional plan on line *x x*, Fig. 2. Fig. 4 is a sectional plan on line *y y*, Fig. 2. Fig. 5 is a sectional elevation on line *z z*, Fig. 4; and Fig. 6 is a view of one of the fly-ball arms of the governor detached.

The apparatus consists of two main portions—a speed-governor A of the fly-ball type and a gas or air pressure governor B. This latter consists of a cylinder 1, having a plunger 2 connected by a pivotally-hung link 3 to a spring 4, secured in the cylinder. The upper part of the plunger is connected by a link 5 to a lever 6, pivoted at 7 and carrying at its free end an adjustable link 8, connected to one end of a floating lever 9, pivotally hung at 10 to an adjustable weighted lever 11, the free end 12 of lever 9 being adapted to be attached direct or by suitable connections to the cut-off or switch mechanism of the engine or motor driving the compressor or pump, so that any movement of this end of the floating lever 9 will regulate the speed of the engine or motor. The lever 11 is pivoted to a bracket 13 on the governor A and is connected at 14 to a collar 15 on a spring-box 16, surrounding a spindle 17, supported in the casing 18 of the governor A, and which spindle is driven by a gear 19 or in some suitable way from the engine or motor. In the box 16, or it may be a part serving the same function, and therefore equivalent thereto, is a spring 20, surrounding the spindle 17, which at this point has a shoulder 21, on which is supported a sleeve 22, on the outside of which is carried a spring 23, resting on a collar 24 of the sleeve, which collar moves and is guided in the box 16. The spring is further retained in position by a head 25, secured to shaft 17, said head carrying bracket-arms 26, on which are pivotally mounted the weighted arms 27, forming the fly-balls of the governor. The arms are bell-cranked in shape and are connected to links 28, pivotally connected in turn to lugs 29, cast on the box 16. The use of this link between the ball-arm and the spring-box is an important feature, as the effect is to increase the effective leverage of the governor-balls the further they fly out. The effect of this link on the leverage of the ball can be seen by comparing the distances marked *c* in Fig. 1, and *d* in Fig. 6, which show the ball at the extreme inner and outer positions, respectively. The same result may be obtained by the use of a roller on the governor-ball arm working on an inclined or curved plane on the spring-box, which in this case is the equivalent of the link.

Returning to the pressure-governor B, the cylinder 1, it will be seen in Figs. 4 and 5, communicates with a cylinder 30 by a passage 31, which may be closed or fully apertured by a screw 32. Such cylinder 30 contains a plunger 33, carrying a weight 34, which plunger is connected by a pivotally-hung arm 36 and link 35, which is pivoted at 37 with the arm 3 of plunger 2, so that the spring 4 may also operate on plunger 33. The action of the spring 4 may be regulated by adjusting the tension on the spring by means of the screwed rod 38.

The two cylinders 1 and 30 are kept full of oil from a supply-tank, the surface of the oil

in which is acted on by the air or gas pressure, 39 being the pipe through which the oil is forced.

The weight 34 moving in its cylinder acts as a cataract-piston, the flow of oil from one piston to the other being regulated by the screw 32, so that the speed movement of the plunger 2 can be controlled. The weight may be arranged, as shown, so that its leverage helps the spring by balancing a portion of the load due to the gas or air pressure acting on the plunger, or it may be arranged so as to increase the load on the spring.

Instead of the arrangement shown the pivot-point 37 might be formed as a spindle operated by a short arm from arm 3, such spindle passing through a gland in the side of cylinder 1 to the cataract-cylinder 30, which, with its weight, might be separated from cylinder 30.

It will be seen that the floating lever 9 has two centers 10 and 40, on which it can move. When the point 40 acts as the fulcrum, the movement of the lever is controlled by the gas or air pressure only. For example: Suppose that the gear that drives the speed-governor were to fail, the lever 11 would fall to its lowest position and remain there. The point 10 would then act as the fulcrum, and the gas or air pressure rising, due to the increased speed of the engine, would force the plunger 2 up, and with it the inner end of the floating lever 9, thus reducing the supply of steam and preventing the engine from running too fast; or, again, suppose any of the gas or air mains or receiver were to fail, causing the gas or air pressure to drop, the plunger 2 would then drop to its lowest point, the point 40 would act as the fulcrum, and the speed of the engine would be controlled entirely by the speed-governor.

Turning to the speed-governor it will be seen that the centrifugal force of the revolving balls is made to lift the box 16 and sleeve 22 against a load made by compressing one or both of the springs 20 and 23, the spring 20 being compressed against the under side of collar 24 and the spring 23 against the head 25. The collar 24 is held down by the spring 23 on to the shoulder 21 of the spindle 17. The spring-box 16 is made with an internal shoulder 42, so that in the lift of the governor this shoulder comes in contact with the under face of collar 24 and prevents spring 20 being compressed any further, so that after this takes place the remainder of the governor lift is accomplished against the action of the upper spring 23. This latter spring is adjusted, so that the initial force exerted by it is equal to or slightly greater than the force exerted by the lower spring when the shoulder 42 comes in contact with the collar 24.

The free length of the lower spring is made less than the distance apart of the two faces between which it is compressed when the governor is in its lowest position, so that until the governor has lifted the amount of this difference the lower spring does not begin to be compressed and the centrifugal force of the governor-balls has simply to overcome the dead-weight of the spring-box and spring and also that due to the counterweight and unbalanced weight of lever 11. This amount of dead-weight can be adjusted so that at a very low speed of the governor the centrifugal force of the balls will be sufficient to balance it and keep the top of the lower spring just up against the collar 24, which speed necessary to do this we may call the "minimum working speed" of the governor. This last point is one of great importance, as it prevents the nuisance of the engine continually stopping when only a small quantity of gas or air is required to be used. For example: Take the case of an air-compressor for driving rock-drills in which the air is compressed into a receiver from which the rock-drills draw their supply. Suppose the compressor to be running at its maximum speed—say seventy-five revolutions per minute—with the air in the receiver at its normal working pressure—say eighty pounds per square inch. Now suppose all the rock-drills are shut off. The air-pressure in the receiver will rise, force out the plunger 2, and the compressor will run at a gradually-diminishing speed until it reaches its minimum working speed, as above. The small quantity of air now being compressed will escape through the usual relief-valves on the air-receiver, which are set to blow off a few pounds above the working pressure, and the compressor will be prevented from stopping, owing to the fact that directly it slows down below its minimum working speed the speed-governor will drop quickly to its lowest position, thus considerably increasing the supply of steam to the compressor.

The advantage gained by having the arrangement of two separate springs, as described above, can also be probably best understood from an actual example. Take the case of an air-compressor working as described above—*i. e.*, its maximum working speed seventy-five revolutions per minute. The speed-governor will then be set, so that at this speed the internal shoulder 42 on the spring-box 16 will be just touching the collar 24, so that for any speed less than seventy-five revolutions the balls will be acting against the lower spring only. Now suppose the air-main burst, the compressor would want to race away; but by the time the speed had increased to about eighty-two revolutions the governor would have risen to its highest position against the resistance of the upper spring 23, thus shutting off the supply of steam and maintaining a safe speed. In the governor fitted with one spring only the speed of the engine would have to increase to about one hundred revolutions before the governor could have risen to its highest point and shut off the supply of steam. It might be supposed that a result could be obtained by the

use of one long spring, which would be practically as good as that obtained by the combination of two springs, as described above. This, however, is not so, as two points are essential for correct governing: first, the spring must be at its free length when the governor is at or near to its lowest position; second, a large spring-load is required when the governor is at its highest position, so as to obtain a great range of spring load throughout the working lift of the governor.

The principal feature in the action of this air-governor is the result obtained by the speed and pressure governors working in combination with each other, their combined actions overcoming the difficulty of governor hunting that has been existent in governors of other design up to the present.

A compressor varies in speed according to the amount of air required or rock-drills in use and may therefore be at any time from zero to the maximum capacity. When steam is employed, the mean steam-pressure is practically constant, whether running at twenty or seventy revolutions. The only difference in the steam-pressure would be due to the higher velocity of steam and air through the ports, which is trifling. The point of cut-off is, however, not constant, as the boiler-pressure may drop at any time, and in case of a trip-gear engine the closing of the steam-valves after they are tripped takes time. This latter being the case, the point of cut-off must be later when running at a slow speed than when at a high speed in order to produce the same mean pressure. Suppose a compressor fitted with a governor which has not this feature is running at twenty revolutions and the tripping-point in the steam-cylinder is at twenty-five per cent. of the stroke, the actual cut-off point would be almost directly after—say twenty-six per cent. In other words, there would be a sharp corner in the diagram, owing to the compressor running slowly. Now supposing six rock-drills are put on, the pressure will begin to drop in the air-receiver, and consequently the plunger in the air-governor. This produces a later cut-off and higher mean pressure. The engine at once increases in speed, and as it increases in speed the mean pressure is still more increased, owing to the actual cut-off point being extended, due to the higher speed. In other words, the sharp corner becomes a curve, starting from where the sharp corner was. It will be therefore seen that the mean pressure is doubly increased, and is consequently more than required, which will drive the air-pressure higher than is necessary in the receiver or to a height above the required pressure sufficient to extend the air-governor plunger and produce a cut-off point that will give less mean pressure. As soon as the mean pressure drops the engine slows down, this time to a speed slower than is necessary, due to same reason of double decreasing the mean pressure. Thus the compressor keeps hunting. The fact that this governor has a different position for every speed of the engine entirely overcomes this difficulty.

In the case of a machine for pumping water or other liquid the pressure-governor would be in communication with an air vessel placed close to the pump-cylinder. As the pressure of air in this vessel would vary directly according to the head of water being pumped, the engine or motor driving the pump would be regulated by the head against which the pump was working.

What I claim is—

1. In combination a gas or air pressure governor, a plunger carried thereby, a floating lever connected to a speed-regulating device of a motor and controlled by said plunger, a speed-regulating governor driven from said motor, and a lever operated by said speed-governor and carrying said floating lever so that the speed-regulating device of the motor may be controlled either by the speed-governor or the gas or air governor or by the two working together substantially as described.

2. The combination with the arms of a governing device of a part carried by same, a spring supported by said part and a part against which the spring may be compressed, the free length of such spring being less than the distance apart of the two parts so that until the governor has lifted the amount of this difference against the weight of the parts the spring does not begin to be compressed substantially as described.

3. The combination with a gas or air pressure governor of a speed-governor, a box carried by the latter a spring in said box, a sleeve means for supporting same, a spring carried by said sleeve compressible only after the first has been compressed, ball-arms controlling the lift of the box, a lever connected to the box and adapted to operate the speed-regulating device of a motor and means for controlling said lever from the gas or air pressure governor substantially as described.

4. The combination in a gas or air pressure governor of a cylinder for containing oil or liquid, a weight adapted to work in same, a further cylinder a plunger in the latter, a connection between the plunger and this weight said plunger being moved by the gas or air pressure so that the weight acts as a cataract-piston controlling the speed of movement of the plunger substantially as and for the purpose described.

5. The combination with a plunger of a gas or air compressor governor of a floating lever one end of which is operated on by said plunger while the other end controls the speed-regulating device of a motor, a pivoted lever, one end of which carries said floating lever, a spring-box of a speed-governor to which the other end of the pivoted lever is connected and governor-arms by which the movement of the spring-box is controlled, the arrangement enabling a slight increase in the

speed of the governor over its maximum working speed to raise the spring-box to its highest or cut-off position substantially as described.

6. The combination with a gas or air pressure governor and a speed-governor of a lever controlled by the latter, and a floating lever pivoted about centrally to the first lever, one end of the floating lever being controlled by the gas or air pressure governor and the other controlling the speed-regulating device of the motor substantially as and for the purpose described.

In testimony whereof I have hereunto set my hand in the presence of two subscribing witnesses.

FRANK LEONARD WHITMORE.

Witnesses:

WALTER J. SKERTEN,

JOSEPH LAKE.