J. E. Gillespie,

Hydraulic Engine,

No. 57,630. Patented Aug. 28, 1866.

Fig: 1.

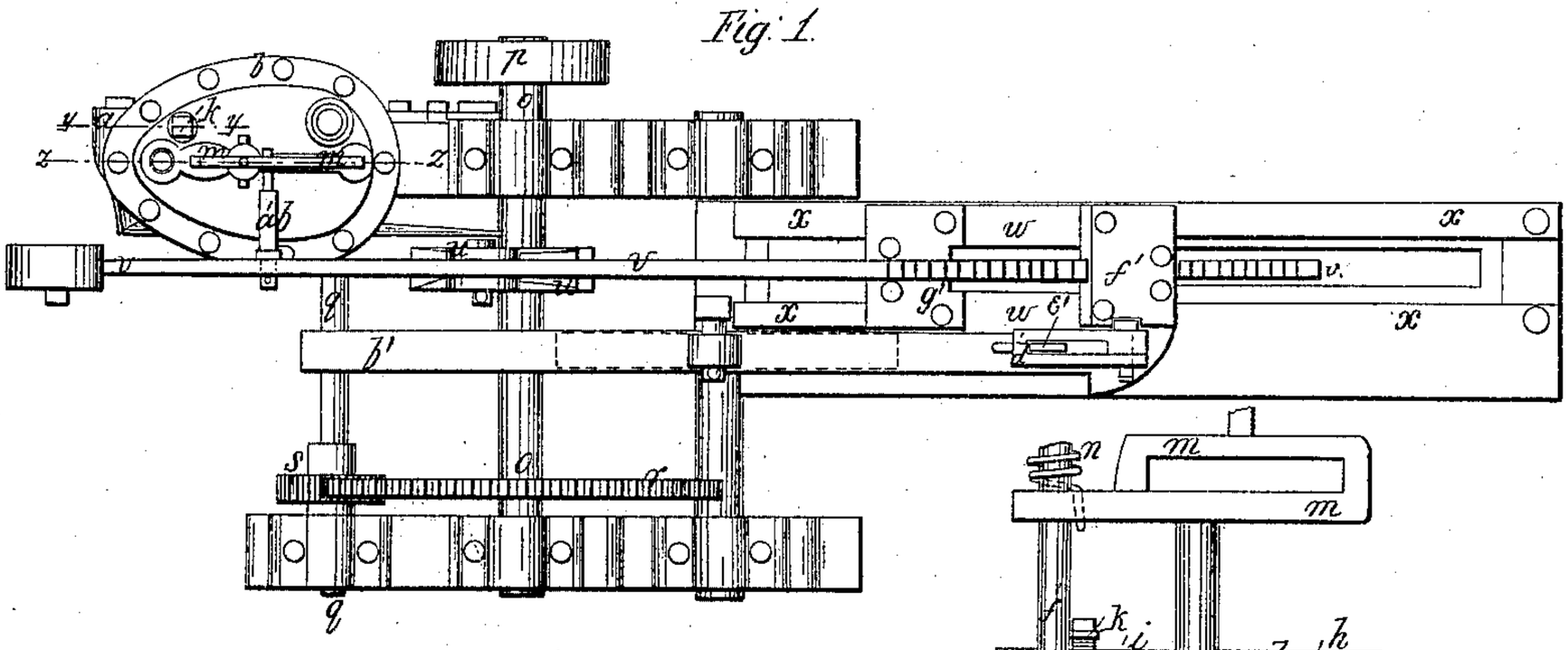


Fig: 3.

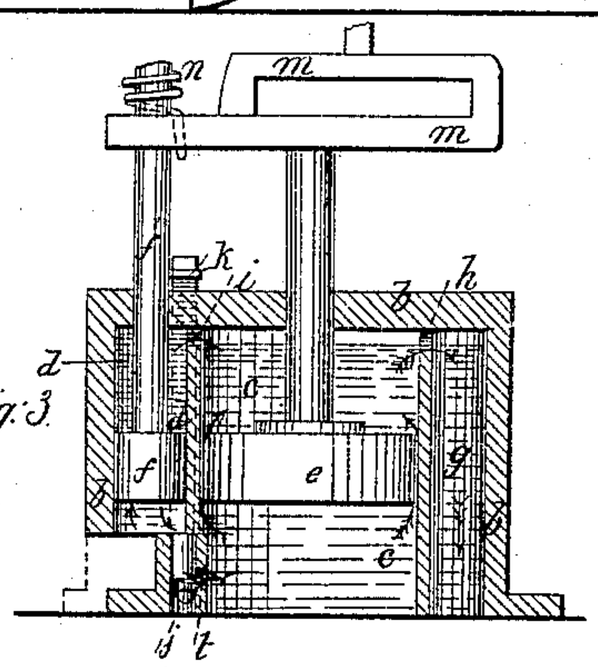
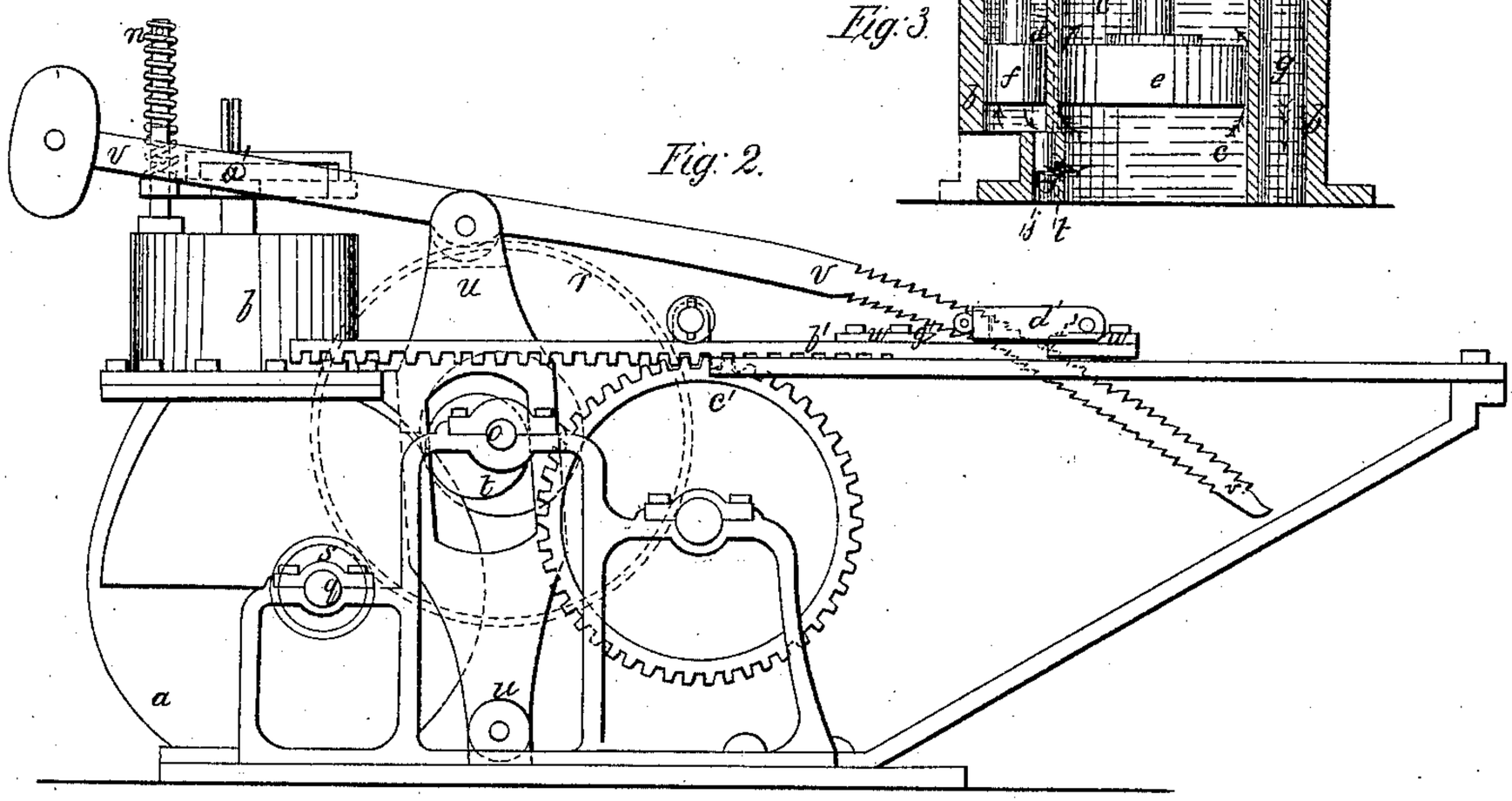


Fig: 2.



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UNITED STATES PATENT OFFICE.

JAMES E. GILLESPIE, OF BOSTON, MASSACHUSETTS, ASSIGNOR TO GILLESPIE GOVERNOR COMPANY, OF SAME PLACE.

IMPROVEMENT IN HYDRAULIC GOVERNORS.

Specification forming part of Letters Patent No. **57,630,** dated August 28, 1866.

To all whom it may concern:

Be it known that I, JAMES E. GILLESPIE, of Boston, in the county of Suffolk and State of Massachusetts, have invented certain new and useful Improvements in Hydraulic Regulating-Governors; and I do hereby declare that the following, taken in connection with the drawings which accompany and form part of this specification, is a description of my invention sufficient to enable those skilled in the art to practice it.

This invention relates to certain improvements upon and modifications in the hydraulic governor which, under the number 34,055, was patented to me in the United States, January 7, 1862.

While the construction shown and described in my said patent would govern the speed of the mechanism therewith connected so as to confine the speed within fixed maximum and minimum limits, yet within those limits the velocity of the mechanism was not well regulated, as slight changes in the amount of work to be performed would cause the governor so to operate as to allow a considerable change in the speed of the connected mechanism within the maximum and minimum limits.

To economize the expenditure of the force applied—as, for example, pressure of steam or a head of water—and to regulate the velocity of the mechanism thereby driven to an almost constant speed, instead of merely governing the same by confining it within certain limits, but allowing the speed to vary or change within such limits, is the object of part of my invention.

Another object of another part of my invention is to so connect the governing and regulating apparatus with the gate or valve or other object operated thereby that, while the parts may be disconnected at pleasure to prevent opening such gate or valve, they will always be in gear to close it, so that the automatic action of the governor as a safety apparatus, in preventing too high a rate of speed in the connected machinery, will not be affected when the connection by which the gate or valve is opened is broken.

Before stating in what my invention consists, I will first describe the construction of an apparatus embodying it, as illustrated in the accompanying drawings, of which—

Figure 1 is a plan of said apparatus. Fig. 2 is a side elevation; and Fig. 3 is a sectional view of the part containing the cylinders and their pistons, the section being taken in the plane of the line *z z*, seen in Fig. 1, except the lower left-hand corner, where the section is taken on the line *y y*, seen in said figure.

a is a case suited for containing an ordinary centrifugal pump, said case being surmounted with another, marked *b*, this containing a reservoir for fluid, as well as two cylinders, one, *c*, larger than the other, *d*, both being fitted with pistons marked, respectively, *e* and *f*, the piston *e* fitting loosely in its cylinder, and the piston *f* fitting closely, but so as to slide freely, in its cylinder. The pump-case *a* is provided with an inlet at the center, by which fluid is supplied, to be acted on by the pump; also, with an outlet for discharge of the supplied fluid. All this, however, being as is common in centrifugal pumps, is not shown in detail in the drawings. The inlet of the pump connects with the reservoir part *g* of the case *b*, and the discharge-outlet of the pump connects with the open lower end of cylinder *c*, so that, as will be evident, the pump constantly circulates the fluid through the parts before described. At the upper part of cylinder *c* is an opening communicating with the fluid-reservoir *g*, and between the cylinders *c* and *d*, at the upper part thereof, is an opening, *i*. In the case *b*, and between the cylinders *c* and *d*, is drilled a hole, *j*, this receiving a screw-spindle, *k*, the end of which controls by its adjustment the aperture *l*, and a small passage (not seen in the drawings) connects *j* with the cylinder *d*. The cylinder *d* and hole *j* are supplied with bottoms by fitting down upon a flange on the inside of the top of case *a*, so that the only communication of fluid therewith must be had through the passages described. The rod of the piston *e* passes up through the head of cylinder *c*, and carries a slotted cross-head or yoke, *m*, one portion of which surrounds the rod *f'* of piston *f*, which is made with a considerable extension above the case *b*, the yoke *m* being fitted to slide freely upon the rod *f'*, to which

it is so connected by the spiral spring *n* that piston *e* may move either up or down without immediate movement of piston *f*, compressing or extending the spring *n*, which then, acting to regain its normal condition, moves the pistons *f* and *e* to regain their normal position relative to each other.

It is in the combination of the pistons *e* and *f* with the spring *n*, so as to operate in the manner as hereinafter described, that the chief part of the invention herein described consists.

The shaft *o*, rotated from the machinery to be regulated through the belt-wheel *p*, drives the shaft *q* of the centrifugal pump by means of the spur-gear *r* and its pinion *s*, and on shaft *o* is an eccentric, *t*, which, rotating in the slot or opening made in lever or rocker *u*, vibrates it and the balanced notched bar *v*, which is pivoted thereto.

One end of the bar *v* is notched on its upper and lower edges (see Fig. 2) with teeth somewhat like the teeth of a ratchet-wheel, so that while bar *v* is reciprocating it will, if its notched end is raised, engage with the teeth on its upper edge the slide *w*, which is arranged to move on ways *x*, and will push the slide *w* away from the lever *u*. If said end of bar *v* is depressed, then the teeth on its lower edge, engaging with slide *w*, will, in the reciprocations of *v*, pull the slide *w* toward the lever *u*.

The pin *a'* in the bar *v*, extending into the slot in *m*, is the means by which the notched end of *v* is raised and lowered, the slot in *m* being made long enough to permit the vibrations of pin *a'*, caused by the operation of the eccentric *t*.

The slide *w* abuts against the end of a rack marked *b'*, which is fitted so as to slide freely, and in sliding to turn a spur-gear, *e'*, the shaft of which, by suitable connections, works the valve of a steam-engine, the gate of a water-wheel, or the controlling device of any mechanism the speed of which it is desirable to regulate.

On the slide *w* is hinged a latch, *d'*, which, when placed over a projection, *e'*, from the rack *b'*, draws the rack in the same direction in which the slide *w* is pushed by bar *v*. And it may be here observed that the shaft of *c'* is connected in a manner such that, supposing the gate of a water-wheel to be the object controlled thereby, it would be shut by the pulling of rod *v* on the slide *w*, and opened by the pushing of the same, so that, in case latch *d'* should be disconnected from the projection *e'*, in order that the water-gate might be closed by hand, the regulator would, by the abutment of slide *w* against the rack *b'*, still be in condition to prevent increase of speed, though not in such condition as to be able to maintain the normal speed. It is in this arrangement of parts, which operates to free the governor from its controlling action in one direction, while its control is maintained in the opposite direction that another part of my invention consists.

The pump-case and the passages leading thereto, and the case *b*, the cylinders, and passages therein, being filled with oil or other suitable fluid, and the mechanism the speed of which is to be controlled being connected with the governor by belting onto the pulley *p*, it is evident that the fluid in the cases *a* and *b* will be circulated with a velocity corresponding to the speed given to the pump, the fluid-current, impinging against the bottom of piston *e* and passing its sides, or through openings through it, will overcome its gravity when the velocity of the current is sufficient for that purpose, and will cause the piston *e* to rise in its cylinder, the fluid above the piston and that moving beyond it passing through the opening *h* into *g*, and thence to the inlet of the pump.

Rotation of shaft *o* reciprocates the bar *v*, which is nicely counterbalanced, as shown, the notched end of the bar being so curved that it will reciprocate freely in the opening in the cross-head *w* between the plates *f'* and *g'*, in whatever position the bar *v* is made to assume by its connection with the piston *e*, so long as in that position the mechanism runs at its normal speed; but when the speed is increased the piston *e*, ascending, depresses the notched end of bar *v* till it engages with *g'*, moving the rack *b'*, this operating to shut the water-gate or steam-valve with which it is connected. Decrease of the normal speed causes descent of piston *e*, this elevating the notched end of bar *v* till it engages with *f'* and pushes the rack *b'* in a direction away from the cases, this operating to open the said gate or valve.

Such is the general operation of the machine, it being substantially, so far as described, that of the apparatus shown in my patent before referred to, except that the main cylinder is not perforated, as therein described, other and better means being herein supplied for effecting all and more than was effected by the perforations of the cylinder in my said patent.

In the construction shown in my aforesaid patent the governing action was defective in the same manner that the action of the common ball or centrifugal governors is defective—that is to say, that it requires not only an increase of speed to close the valve or gate connected therewith, but to hold it closed, and a decrease of speed to open and hold open such valve or gate, the consequence being the continued vibration or change of speed above and below the normal rate.

But by the addition of the spring *m*, acting to resist change of position in either direction, together with the gradually-yielding spring-holder, the operation of increase of speed of the mechanism is first to raise the main piston compressing the spring, the result being the closing of a valve or gate; but to maintain the main piston at the elevation required to keep the gate closed does not call for the maintenance of the speed required to raise

the main piston, for the reason that the spring *m*, asserting its force to return to its normal position, raises the gradually-yielding piston *f*, and, all the parts being then in equilibrium, the normal speed will be maintained till some change in the condition of the applied force or of the work to be done occurs to change the position of the main piston. Supposing the force of the motor to be decreased, or the amount of work to be increased, causing a retardation of speed and a consequent lowering of the main piston, this elongating the spring *n*, the piston *f*, by the pull of the spring in its effort to assume its normal condition, will quickly assume its normal position, and, the parts being then all in equilibrium, the gate will remain in the position required to run the mechanism at its normal speed till changes in the power applied or in the work done cause another change in the position of the main piston. Thus it will be seen that a uniform speed may be maintained with the valve or gate partly opened or closed, while with any centrifugal or ball governor, or with my hydraulic governor, as shown in my aforesaid patent, the speed has to be constantly kept above thenormal rate to keep the gate or valve closed, or below the normal rate to keep it open.

Referring again to the drawings, more particularly to Fig. 3, for a description of the operation of the piston *f* and the spring *n* upon the main piston *e*, it will be seen that the piston *f* cannot be moved freely upward any faster than the fluid can enter cylinder *d* to supply the space left by such movement. Therefore the yoke *m* compresses spring *n* between it and the place where it is attached to the piston-rod *f'*; or if the piston *e* descends, it will be seen that the piston *f* cannot descend faster than the fluid can be forced out of the cylinder *d*, and that the spring *n* will be elongated between the yoke *m* and the place where it is fastened to *f'*. But in either case the spring *m* will cause the piston *f* to move after the movement of piston *e* till *f* assumes its normal position relative to *e*, and the time which it takes to accomplish this is regulated by the position of the screw-plug *k* relative to the aperture *l*.

The aperture *i* serves merely to let any fluid which may leak past the piston *f* escape into the main cylinder *c* when *f* moves upward. But the operation of spring *n* is exerted not alone on piston *f*; it acts at the same time on piston *e*, its function being, primarily, to restore the position of the pistons *f* and *e* relative to each other after each disturbance or change of the position of piston *e*, and when said relation between the pistons is obtained the mechanism regulated in speed thereby will move at the normal rate of speed to which it is adjusted, without regard to whether the pistons *e* and *f* are at the top, middle, or bottom of their cylinders.

In some cases it may be desirable to impart to the slide *w* the regular reciprocating movement from the mechanism driven by the motive power, instead of giving such regular movement to the lever *u* and bar *v*. In such cases the gate or valve will be connected with the lever *u*, or its substitute, instead of with the slide *w*, as herein shown.

In my invention the position of the governor or the main piston *e* always bears a definite relation to the position of the gate or valve ultimately operated thereby, though the work of opening or closing such gate or valve is not performed by the governor itself, this merely indicating when the work of opening and closing should be performed and causing it to be done. For example, if the governor-piston *e* is midway between the top and bottom of its cylinder, the gate with which it is connected is, when properly adjusted, half opened, and, as the piston *e* is raised or lowered, so respectively is the gate lowered or raised, it being fully closed when the piston *e* is at the top of its stroke and fully opened when it is at the bottom of its stroke; and this change of the gate is very quickly accomplished. Any variation from the normal speed of the machinery to be regulated, operating to change the speed of the pump, causes at once a change in the position of the piston *e*, either compressing or elongating the spring *n*, according as the piston *e* is raised or lowered, which spring, being attached to a support which is practically for a moment unyielding, prevents extreme movements of piston *e*. Said support, then yielding under the influence of the spring, gradually, as fast as the fluid can pass the graduated opening controlling the rate of its movement, brings all the parts of the governor into equilibrium, the spring *n* returning to its normal condition as it moves its yielding support *f f'*.

The first operation of any change of speed from the normal one acting through the pump-driving mechanism is to quickly change the position of the gate to a close approximation of the position required to maintain the normal speed, and the spring and its yielding support afterward operate to adjust or correct the position of the main piston, so as to make the slight changes needed in the position of the gate to maintain the correct normal speed. By adjustment of the piece *j* the flow of the fluid consequent upon movements of the piston *f* can make the rate of speed of such movements whatever may be desirable.

The cylinder *d* might be entirely closed and an opening made in or on one side of the piston, so that the spring *n*, when not in its normal condition of freedom from stress, would move the piston as fast as the fluid could pass such opening, and the graduations of such opening might be made in various ways more or less convenient.

It is known that the ordinary ball-governor, when controlling a valve, does not keep it unusually closed unless the normal speed is not only increased, but is kept at such increase. So, too, the valve is not kept thereby unusually

open unless the speed not only falls below the normal rate, but remains below such rate, and the work of operating the valve has to be performed by the governor itself. Where such governors have had appliances combined therewith by which they were relieved from the labor of working the valve, and merely indicated when the labor should be done and caused it to be done, then there has been no relation between the position of the valve and the position of the governor.

I claim—

1. The combination of a governing device with the cylinder *d*, its piston *f*, and the spring *n*, or the equivalents of these, when arranged to operate together substantially as specified.

2. In combination with the foregoing, a passage capable of variation, when so arranged as that by such variation the rate of speed of the movement of the piston under influence of its spring may be changed.

3. Combining a governor and the object governed thereby in such a manner that, while the connection between the governor and the governed object can be broken to prevent movement of the latter in one direction, the connection causing movement of the governed object in the reverse direction remains operative, substantially as shown and described.

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