No. 777,914. PATENTED DEC. 20, 1904.

# T. OFFICER.

## ENGINE.

APPLICATION FILED APR. 13, 1904.

NO MODEL.

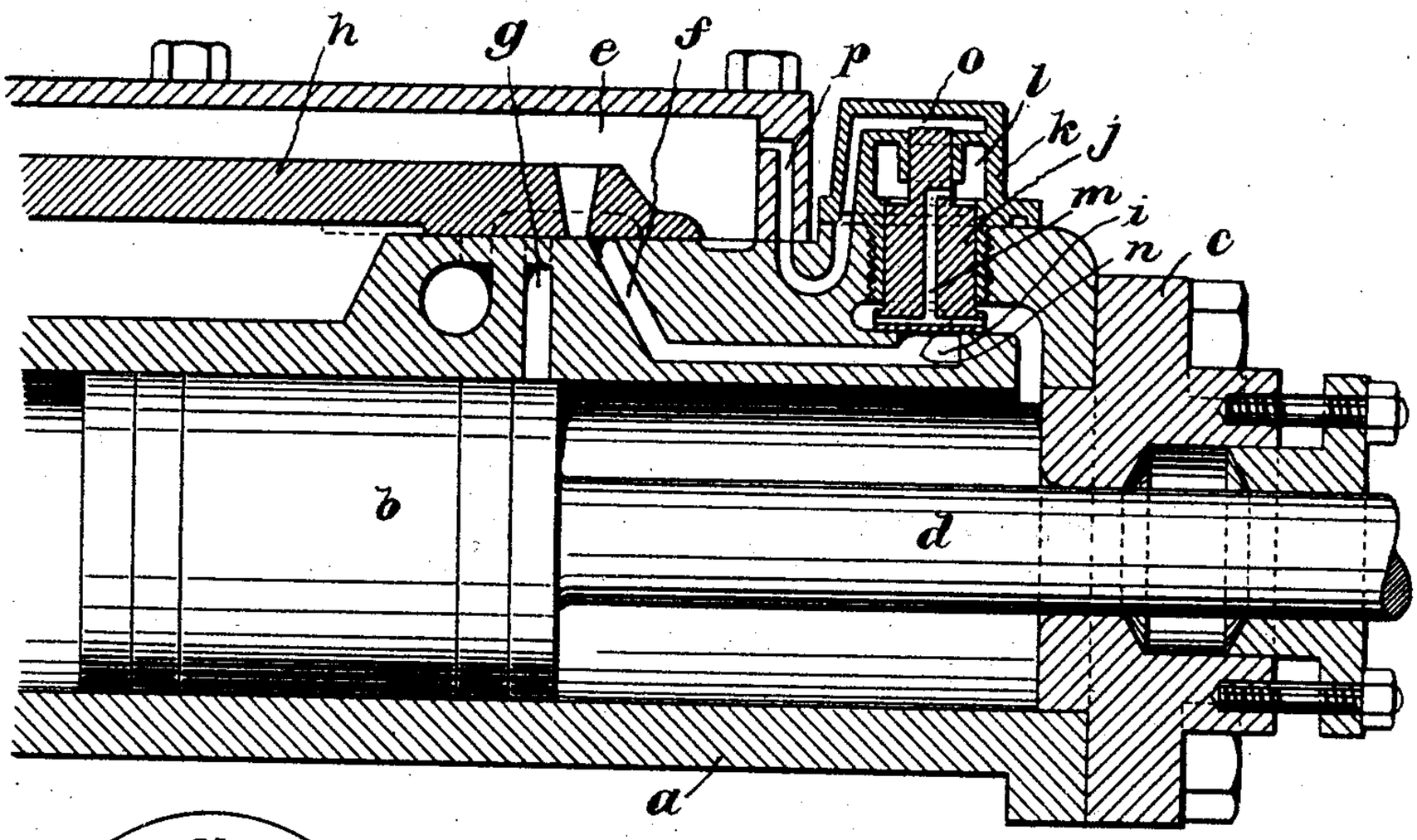


Fig. 1

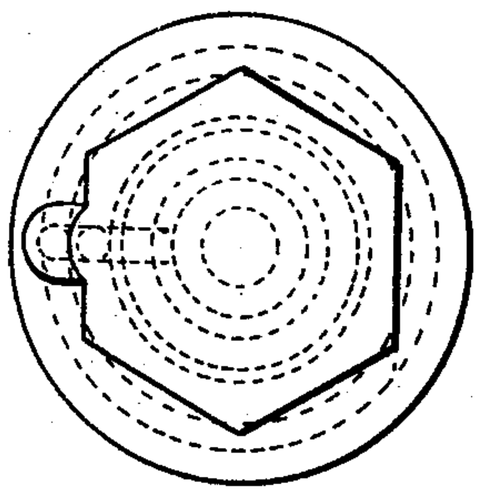

Fig 3

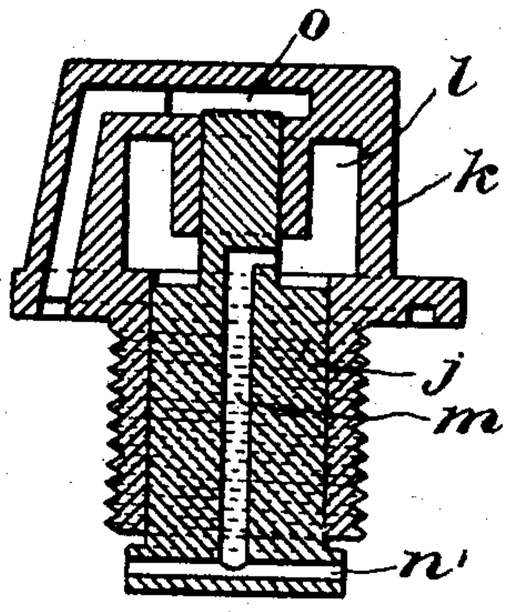


Fig 2

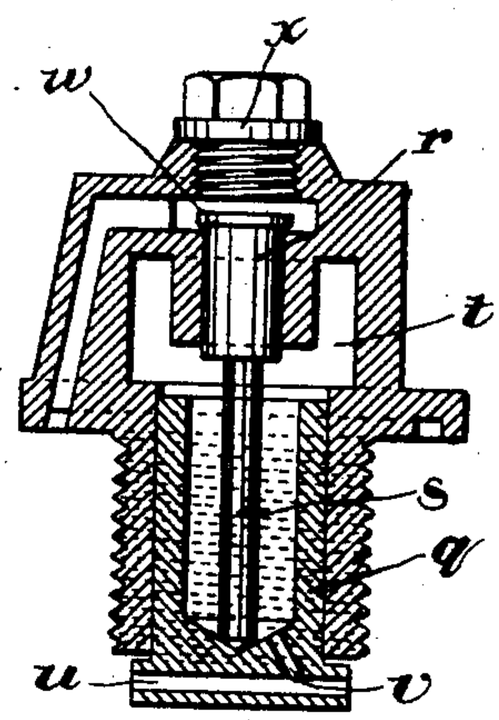


Fig 4

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No. 777,914. Patented December 20, 1904.

# UNITED STATES PATENT OFFICE.

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## ENGINE.

SPECIFICATION forming part of Letters Patent No. 777,914, dated December 20, 1904.

Application filed April 13, 1904. Serial No. 202,976.

*To all whom it may concern:*

Be it known that I, THOMAS OFFICER, a citizen of the United States, residing at Claremont, in the county of Sullivan and State of New Hampshire, have invented an Improvement in Engines, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

My invention consists in improvements in direct-acting engines, being more particularly, though not exclusively, concerned with the governing or control of engines employed in connection with reciprocating tools upon rock or coal cutting machines. During the operation of this class of machines frequent occasions arise where, with the engine in operation, the tool fails to strike the work, as when the machine is undergoing adjustment or being shifted on the runner-board, and it becomes desirable to make suitable provision both for cushioning the blow of the reciprocating parts and for opposing the resultant increase in speed which follows from the tool missing its work in the manner described. It is customary to cushion the blow of the piston by compressing the air in the head or tool end of the cylinder, and United States Patent issued to Ball, No. 603,358, dated May 3, 1898, discloses a means for regulating the movement of the piston when the machine is running, but not doing work.

This patent specifically discloses an auxiliary valve controlling the admission of air or other working fluid to one end of the engine-cylinder, such valve being controlled by the compressed or cushioning air at the head end of the cylinder, so that the effect of the compression of that air resulting from the movement of the machine without opposition is to enforce the seating of the auxiliary valve and the interruption of the incoming working fluid to the cylinder, thereby to control the speed of the engine and prevent the racing which would otherwise follow. The closing of the auxiliary valve in the specific embodiment disclosed depends upon the preponderating effect over the upwardly-acting fluid-supply pressure of a downwardly-acting pressure varying with the pressure of the air in the head end of the cylinder combined with the further opposing pressure exerted by a spiral spring. This system of regulation has been found to work satisfactorily where the pressure of the working fluid supplied to the cylinder undergoes no substantial variation. Where there are material variations in the pressure of the fluid supplied, which is the case in mine and tunnel work, where the machines are usually run under compressed air in connection with numerous other devices supplied from the same source or sources, the closing movement of the auxiliary valve, assisted, as it is, by the substantially constant pressure of the spring, is later at high than at relatively low pressures. This results in great irregularity of the governing action of the valve, the machine under conditions of no work running at much greater speeds under high pressures than under low pressures. My invention provides a system of control for this class of engines whereby this difficulty heretofore experienced is overcome and a uniform speed is maintained by the engine when the tool is reciprocating freely irrespective of variations in the supplied pressure.

My invention will be best understood by the following description when taken in connection with the accompanying illustration of one specific embodiment thereof, while its scope will be more particularly pointed out in the appended claims.

In the drawings, Figure 1 is a sectional view of the front part of the cylinder and air-chest of a direct-acting compressed-air engine to which one form of my invention is applied. Fig. 2 is an enlarged detail in section of the auxiliary governing-valve shown in Fig. 1, together with its holder or bonnet. Fig. 3 is a plan view of the valve and holder shown in Fig. 2. Fig. 4 is an enlarged detail in section of a modified form of governing-valve.

Referring to the drawings, *a* represents the cylinder, *b* the piston, and *c* the cylinder-head, of a direct-acting compressed-air engine having the piston-rod *d*, the opposite end of which

may be assumed to carry the reciprocating cutter-bar of a coal-cutting machine, although it is to be understood that my invention is not limited to any particular type of machine or engine and that while I have referred to the engine as operated by compressed air the same may be driven by any fluid under pressure. During the operation of the engine air is admitted from the air-chamber *e* to the front or head end of the cylinder through the admission-passage *f* leading thereto, this serving to cause backward movement of the piston *b*, at the close of which the air is exhausted through the exhaust-port *g*, a suitable and usual valve *h* being shown in the air-chest to control the admission and exhaust ports in the customary manner. On its passage from the air-chest to the cylinder the incoming air is obliged to pass through a port *i* in the admission-passage *f*, controlled by the check-valve *j*, slidably mounted in the holder or bonnet *k*, the latter being screwed into the walls of the engine-cylinder. A tendency to upward or opening movement of the check-valve *j* is caused by the pressure of the incoming air on its passage from the air-chest to the cylinder, such pressure acting against the area of the valve-face exposed by the port *i*. In order to oppose the opening of the check-valve and to force the same against its seat when the tool misses its work, there is provided in the valve-holder an air-governing chamber *l*, connected with the cylinder side of the check-valve by the downwardly-extending longitudinal passage *m* and the connecting cross-passage *n*, through the medium of which the chamber *l* is at all times in communication with the air in the cylinder, and the air therein tends to assume the pressure of the air in the cylinder. To further assist in closing the valve *j* under the conditions stated, the end of the valve-stem is exposed to the pressure in the differential chamber *o* in the crown of the valve-holder. This chamber is connected by the passage *p* with the air-chest *e* and is therefore maintained at a pressure varying with the pressure in the inlet-passage *f* and substantially equal to the latter. The pressure within the chamber therefore assists in closing the valve and counterbalances a portion of the pressure, acting to open the same in the passage *f*. By making the exposed end of the valve-stem in chamber *o* of lesser cross-sectional area than the port *n* the opening effect of the pressure in the passage *f* when air is admitted thereto exceeds somewhat the closing effect upon the valve of the pressure in the differential chamber *o*, even when the valve is upon its seat and exposed only to the opening pressure acting upon a valve area equal to the area of the port. During the operation of the engine and while the machine is meeting with the opposition incidental to its work there is no compression of the air at the head end of cylinder, and the pressure in the governing-chamber *l* before the opening of the valve being less than that of the incoming air in the passage *f* there is little resistance to the passage of the high-pressure air through the auxiliary valve and into the cylinder to effect the return movement of the piston. When resistance to the tool is withdrawn, as by the latter missing the work, the blow is cushioned by the air in the front end of the cylinder, causing the inward rush of the then highly-compressed air into the governing-chamber *l* through the passages *m* and *n*, raising the pressure therein and so overbalancing the normal excess opening effort of the incoming air over the downward effort due to the air in the differential chamber as to maintain the auxiliary valve closed and prevent the admission of the propelling fluid to the cylinder until the piston has traveled backwardly sufficiently far to reduce the cylinder-pressure below the pressure in the admission-passage *f*, and to thus reduce the pressure in the governing-chamber *l* to the point where it is no longer sufficient to maintain the valve closed. The differential chamber *o* supplies a large factor of the effort tending to close or maintain closed the auxiliary valve, the pressure in this chamber being subject to variations similar to the variations of the supplied pressure. This factor therefore varies with the valve-opening effort due to the pressure in passage *f*, thus tending to maintain a uniform action of the valve irrespective of variations in supplied pressure. It will be obvious that after compression of the cylinder-air by the piston the auxiliary valve cannot open until the pressure in the governing-chamber falls to an amount less than the difference between the opening effort due to the incoming air and the closing effort due to the pressure in the differential chamber. In the prior constructions the closing effort being effected partly by a spiral spring this difference was subjeet to very wide variations on ordinary changes in supplied pressure, and the time of opening the auxiliary valve was therefore also subject to wide variations Through the use of my invention the difference between the opening and the closing efforts due to the two similarly-varying pressures undergoes or may be made by appropriate design to undergo for all practical purposes very slight variations, so that the action of the valve and the consequent reduced speed of the engine is substantially independent of variations in the supplied pressure.

The passage leading to the governor-chamber *l* from the longitudinal passage *m* is preferably somewhat reduced in order to retard the passage of air and prolong somewhat the period of high pressure in the governing-chamber after the drop of pressure in the engine-cylinder, the actual size of the reduced connecting-passages being, of course, select-

ed according to the speed which it is desired to give the piston *b* when operating as described. Thus in practice the speed of the machine may be reduced, for example, from a normal speed of two hundred strokes per minute to a speed of sixty strokes per minute under conditions of no tool resistance, and this reduction may be widely varied by varying the area of the passage connecting the governing-chamber *l* with the engine-cylinder.

Through the use of the herein-described embodiment of my invention the reduced speed of the machine is substantially constant under all conditions of pressure-supply, variations in the latter causing no material difference, as heretofore, in the operation of the regulator, and consequently no material variation in the reduced speed of the engine.

In Fig. 4 I have shown a modified form of governing-valve, the governor-valve *q* therein being separate from the differential valve *r*, the latter, however, being provided with a stem *s*, contacting and engaging with the valve *q* to assist in closing the same. The governor-chamber *t* in the modified form of valve is connected with the cross-passage *u* by means of the regulating-port *v*, the size of which will be selected according to the desired speed of the engine. The differential valve *r* is provided with a flange *w* to prevent the withdrawal of the same excepting through an opening in the top of the bonnet, which is closed by means of the screw-plug *x*.

It is to be understood that the specific embodiment of my invention herein shown is submitted wholly for illustrative purposes and that my invention is not to be limited to the details of construction or the form or arrangement of parts herein shown, but that the same may be modified within wide limits without departing from the spirit thereof.

I ciaim—

1. In a direct-acting engine the combination with a cylinder having inlet and exhaust ports, of a main valve controlling the same, a piston working in said cylinder, an auxiliary valve located so as to control the inflowing fluid to the front end of said cylinder, means for regulating the movement of said auxiliary valve by the cushioned fluid and means for rendering the action of the valve substantially independent of variations in the pressure of the supplied fluid.

2. In a direct-acting engine the combination with a cylinder and piston of governing means responsive to the pressure of the fluid in the cylinder for controlling the inflowing fluid, and means for rendering the action of said governing means substantially independent of variations in the pressure of the supplied fluid.

3. In a direct-acting engine the combination with a cylinder and piston of governing means for controlling the inflowing fluid, means for causing the same to act on the compression of the fluid within the cylinder, and means to render said governing means substantially independent of variations in the pressure of the supplied fluid.

4. In an apparatus of the class described the combination with an engine-cylinder, piston and a reciprocating tool-carrying piston-rod, of governing means for controlling the inflowing fluid, means for causing the same to act when the tool misses its work, and means for rendering the action of said governing means substantially independent of variations in the pressure of the supplied fluid.

5. In an apparatus of the class described the combination of an engine-cylinder, piston and reciprocating tool-carrying piston-rod, of means for controlling the admission and exhaust of fluid to and from the cylinder during the normal operation of the engine, additional means controlled by the tool missing its work for further controlling the inflowing fluid, and means for rendering said additional regulating means substantially independent of variations in the pressure of the supplied fluid.

6. In a direct-acting engine the combination of an engine-cylinder and piston, means for normally controlling the admission to and exhaust from the cylinder, additional means controlled by the compressed fluid in the cylinder for controlling the inflowing fluid, and means for applying to said additional controlling means oppositely-acting and similarly-varying pressures.

7. In a direct-acting engine the combination of a cylinder having inlet and exhaust ports of a main valve controlling the same, a piston working in said cylinder, an auxiliary valve so located as to control the inflowing fluid, means for exerting an opening pressure upon said valve varying proportionately to the pressure of the incoming fluid, and means acting to close said valve with pressures varying respectively according to the pressure of the incoming fluid and the pressure of the fluid within the cylinder.

8. In a direct-acting engine the combination of a cylinder having inlet and exhaust ports of a main valve controlling the same, a piston working in said cylinder, an auxiliary valve located so as to control the inflowing fluid, said valve being controlled by a fluid-chamber connecting with the cylinder and a second fluid-chamber connecting with the fluid-supply.

9. In a direct-acting engine the combination with a cylinder and piston of a check-valve controlling the inlet-port of said cylinder, said valve having surfaces exposed to two opposing, similarly-varying pressures.

10. In a direct-acting engine the combination with a cylinder and piston working therein of a check-valve controlling the inlet-port of said cylinder, the opposite walls of said valve being exposed in part to the pressure of a chamber connecting with the cylinder

and in part to a pressure varying with the pressure of the incoming fluid.

11. The combination with an engine of a check-valve controlling the inlet-port of the engine-cylinder, the opposite walls of said valve being exposed in part to the pressure of a chamber connecting with the engine-cylinder and in part to a pressure varying with the pressure of the incoming fluid.

12. The combination with an engine of a check-valve controlling the inlet-port of the engine-cylinder, said valve being provided at its back with a chamber connecting therethrough with the cylinder side of the inlet-port, a portion of the walls of said valve being exposed to the pressure within said chamber, and a second chamber behind said valve to the pressure within which also a portion of the valve-walls is exposed, said second chamber connecting with the fluid-supply chest of said engine.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

THOMAS OFFICER.

Witnesses:
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P. B. COLNON.