(No Model.)

2 Sheets—Sheet 1.

W. VON OECHELHAEUSER.

GAS ENGINE.

No. 417,759. Patented Dec. 24, 1889.

FIG. I.

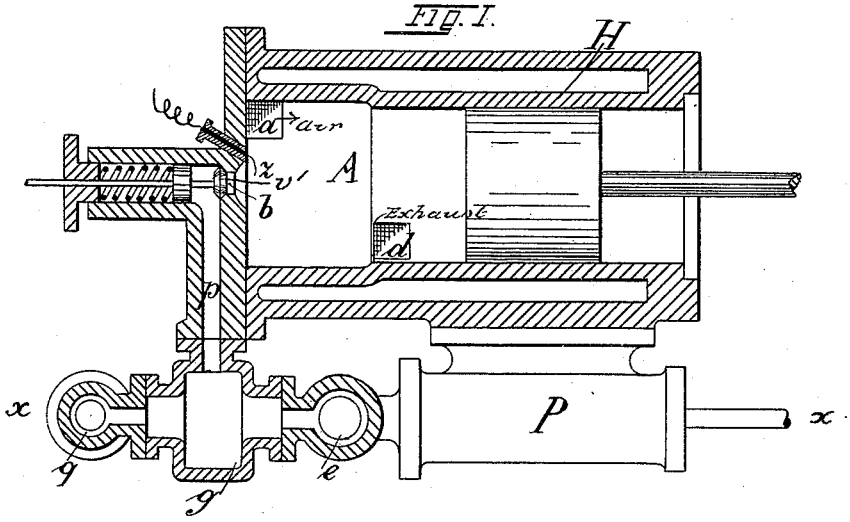
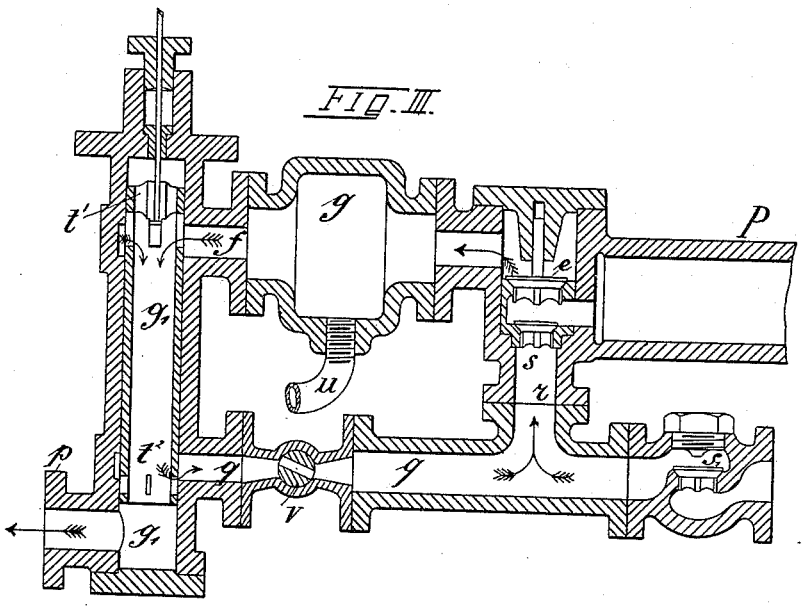


FIG. III.



Witnesses.
J. Thomson Cross
A. D. Weaver

Inventor.
Wilhelm von Oechelhaeuser
per Henry Orth
Att'y.

N. PETERS, Photo-Lithographer, Washington, D. C.

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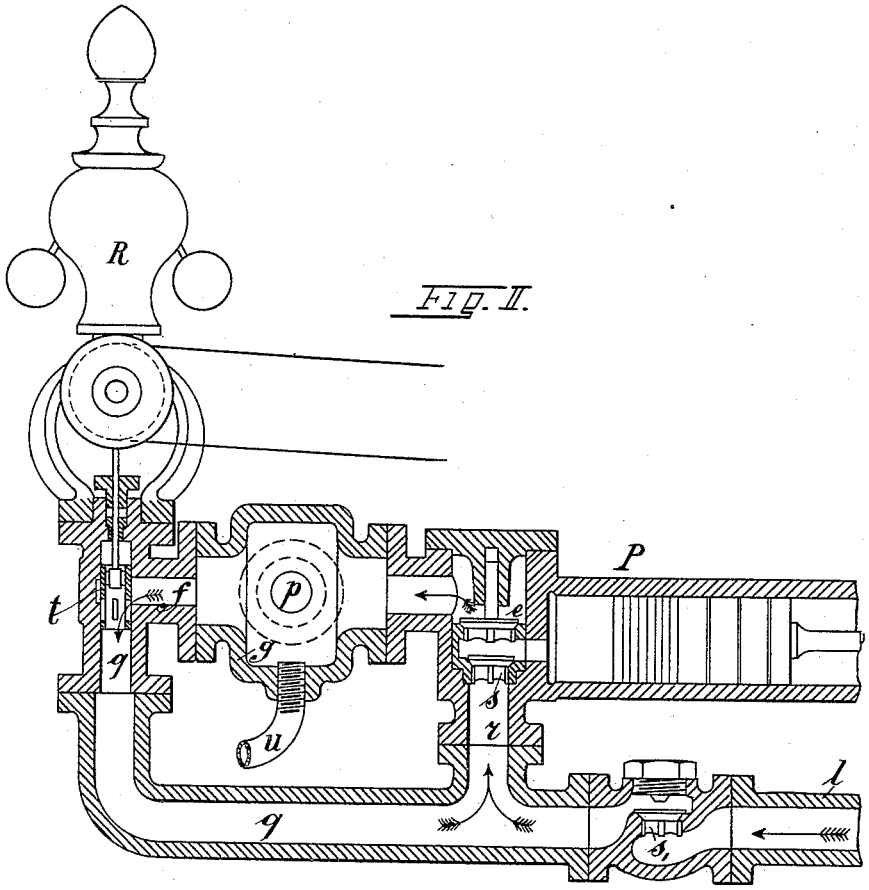

Fig. I.

Witnesses.
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per
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UNITED STATES PATENT OFFICE.

WILHELM VON OECHELHAEUSER, OF DESSAU, GERMANY.

GAS-ENGINE.

SPECIFICATION forming part of Letters Patent No. 417,759, dated December 24, 1889.

Application filed May 23, 1889. Serial No. 311,814. (No model.)

To all whom it may concern:

Be it known that I, WILHELM VON OECHELHAEUSER, engineer, a subject of the King of Prussia, residing at Dessau, 30 Cavalier Strasse, have invented certain new and useful Improvements in and Relating to Gas-Engines; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to letters of reference marked thereon, which form a part of this specification.

The invention relates more particularly to the art of regulating or governing the speed of the piston in gas-engines, or more properly the work performed by such piston; and it consists in a novel mode of and means for regulating such work, substantially as hereinafter fully described, and set forth in the claims.

I have discovered and extensive experiments have fully demonstrated that when a non-combustible gas or gaseous compound—that is to say, a gas or compound that in itself is non-combustible, but that will become combustible when another gas (as, for instance, air) is combined therewith—is admitted under pressure and within the reach of an ignitor into the working-cylinder of a gas-engine charges of gas may be burned within a body of air the relative proportions of which surpass by far the limits of the combustible compounds heretofore employed. This will be readily understood when it is borne in mind that combustion will take place as soon as a sufficient quantity of air has combined with the gas admitted to produce a combustible gas and before the incoming gas has combined with the body of air contained in the working-cylinder, or before the gas has combined with a sufficient quantity of air to so attenuate it as to render it again non-combustible. In this manner gas in any desired quantity, or gas in any desired limited or small quantities relatively to the air in the cylinder, may be ignited. Consequently any desired pressure or pressures limited to any desired degree may be obtained within the cylinder, so that the operation of the motor can be regulated, not, as heretofore, by cutting off the supply of combustible gas and interrupting the explosions, but by varying the volume of gas admitted to the working-cylinder—a mode far more simple, advantageous, and effective. That this mode of regulating gas-engines may be rendered practicable and applied economically, the admission of the charge of gas into the charge of air in the working-cylinder should be instantaneous, whatever the volume of said charge of gas and at whatever point of its stroke the piston may be at the time of admission. In this manner any desired degree of pressure is rapidly attained, and the expansion resulting from the combustion of a charge of gas or from a plurality of charges admitted during one and the same stroke of the piston made fully available. In carrying out my novel mode of regulating gas-engines it is therefore not sufficient, as in the modes heretofore in use, to simply cut off the supply of gas to the pump and force the gas from the dead-space thereof into the working-cylinder, because then the rapidity as well as the duration of admission to the cylinder will constantly depend upon the comparatively slow motion of the pump-piston or the position of the latter at the time.

According to my method I store the gas under an excess of pressure in a collector or receiver interposed between the working-cylinder and pump, a governed cut-off being provided in the communication between said collector and the combustion-chamber of the cylinder, so that the required charge of gas may be admitted thereto instantaneously and at any desired point of the stroke of the piston, a cut-off being also provided for the communication between the collector and the pump. The regulation of the charges of gas admitted does, therefore, not depend upon the throttling of the gas-supply pipe, but upon the variation in the tension or pressure of the body of stored gas. The regulation of the charges is therefore entirely or absolutely independent of the speed of the pump-piston or the position of the latter during the admission and relatively to the admission-valve. Consequently my method of regulating gas-engines is not only applicable to such en-

gines in which several charges of gas are admitted during one and the same stroke of the piston, or in which a charge is admitted after every other stroke only, but to all engines in which a charge of non-combustible gas is forced within the reach of an ignitor into a charge of air already contained in the working-cylinder. In addition to regulating the tension or pressure of the gas previous to its admission to the cylinder the duration of admission may also be regulated by controlling the organ of admission from the governor. This, however, requires complex mechanisms, and as the charges of gas are to be admitted instantaneously the duration of admission will necessarily be uncommonly short, and such regulation can therefore be dispensed with. For this reason I prefer to effect the regulation of the charges of gas solely through variations in the pressure or tension of the body of gas from which the charge is taken, and this may be effected by devices controlled by the governor and so arranged as to allow a portion of the stored gas to return to the pump, or the connection between the pump and source of supply, whenever a diminution in the pressure, or, in other words, a reduction in the charge of gas to be admitted, becomes necessary. On the other hand, the stored gas may be allowed to flow into a second collector, or a section of the first collector interposed between the latter and the pump-cylinder, and a suitable cut-off mechanism provided and controlled by the governor. Finally, both arrangements last described may be combined, and in either of them a controlling-valve, adapted to be operated by hand, may be arranged in the communications, whereby the operation of the devices or the sensitiveness thereof may be regulated without necessitating an adjustment of the governor.

Referring to the accompanying drawings, Figure 1 is a horizontal section, partly in plan, of so much of a gas-engine as will be necessary to illustrate my invention. Fig. 2 is a vertical section on line $x\ x$ of Fig. 1, showing the pressure-regulating valve as connected with the governor, the latter being shown in elevation; and Fig. 3 is a view similar to that shown in Fig. 2, illustrating a modification in that both the regulating and admission valves are controlled by the governor, and also showing other modifications.

A indicates the combustion-chamber of the cylinder H, a being the air-admission port through which air is admitted at normal or atmospheric pressures or through which air under pressure may be admitted in any usual manner, and d is the exhaust-port. The gas under pressure is admitted through the valved port b, the valve v' of which is controlled in any usual or desired manner from a moving element of the engine, and instead of the spring-actuated valve any other description of cut-off device may be employed and controlled, as described. The ignitor in this case is, as shown, an electrical ignitor z, arranged in proximity to the gas-admission port b, though any other description of ignitor may be employed and similarly arranged in proximity to port b, so that the inflowing charge of gas may be ignited as soon as sufficient air has combined therewith to form an inflammable or combustible gas. The gas reaches the valve-chamber through passage p, connected with the storage chamber or collector g, that is in communication with the pump P. These communications are more plainly shown in Fig. 2 and on a slightly larger scale, the pump shown being a single-acting pump, though a double-acting pump may be employed, and may operate in conjunction with valves, whether slide-valves or others or stop-cocks.

The pump is connected on the one hand with the source of gas-supply l through valve-casing r, in which are arranged the suction and force valves $s\ e$, respectively, the valve-chamber of which latter valve is in communication with the collector g. The collector is in communication through a pipe f with the regulating-valve t, connected with and controlled by the governor R, the valve t operating to admit a portion of the gas from g to a return-pipe q, connected with the valve-casing r and supply-pipe l, a check-valve s' being arranged in the latter for obvious purposes, and p is the connection between the collector g and the admission-valve v. It is obvious that if the regulating-valve is adjusted to a normal speed of the governor R when such speed increases the port leading from f to q will be more or less uncovered and a portion of the gas in the collector g will flow back to the suction-pipe and valve s, thereby reducing the pressure of the gas in g, so that at the next admission the volume of gas admitted will be reduced in proportion to the reduction of the pressure in g, as will be readily understood, thereby reducing the degree of pressure in the cylinder accordingly, and consequently the speed of the piston. As the piston resumes its normal speed, the valve t will again close the port leading from f to q, and the pressure of the gas in g will be restored, especially in the more powerful cylinders. It might happen, however, when the piston is moving at too great a speed, that the port leading from f to q will not be sufficiently opened by the valve t to effect the necessary or required reduction in the pressure of the gas in the collector g, and, on the other hand, several pumps would be required to restore the pressure of the gas in the collector after a rapid and great reduction thereof or by a sudden increase in the work performed by the piston. This may be avoided by constructing the collector with two chambers or by using an additional collector and interposing in the connection between the two a cut-off controlled by the regulator. This construction I have illustrated in Fig. 3, where the valve t' is constructed in the form of a long tube g', the lower end of

which is provided with valve-ports operating in conjunction with the port of the return-pipe *q*.

It will readily be seen that upon an increase in the speed of the piston the communication between the connection *f* and the tubular collector *g'* is cut off more or less, and a smaller quantity of gas will flow from *g* to *g'*. A reduction in the pressure of the gas in *g'* will at once take place without thereby reducing the pressure in *g*. As soon as the speed of the piston necessitates an increased volume of gas this will take place, since the pressure in *g* was not affected or materially affected by the prior reduction of the pressure in *g'* or in the latter and in pipe *p*, leading to the admission-valve *v'*.

To prevent any excess of pressure in the collector *g*, a safety-valve may be applied to such collector and so arranged as to conduct the gas back to the suction-valve or the feed-pipe of the pump.

This construction and mode of operating gas-engines may be combined with that described in reference to Figs. 1 and 2 by simply providing a connection between *g'* and the suction-valve of the pump. This may be effected in a very simple manner by providing the valve *g'* with a tubular extension and so constructing the lower end of the same as to perform the function of the cut-off f^2 relatively to the connection between *g'* and the suction-valve *s* of the pump, as shown in Fig. 3, so that a portion of the gas will return to the pump for the purposes hereinbefore set forth.

Both collectors may be provided with a cooling-jacket. The described method has great advantages over that heretofore in use, where a charge of air and gas is mixed prior to its admission to the working-cylinder and the pressure thereof regulated, in that in the latter case but limited or definite proportions of air and gas can be introduced into the cylinder and ignited, and which are yet ignitible after complete or thorough admixture. The limits within which the motor can be regulated are therefore narrower, the use of the motive fluid less economical, while the operation may fail entirely in case of a variation in the admixture of the gases beyond these narrow limits. On the other hand, there is danger of explosion in the collecting-chamber in case of a too-slow admission of the explosive gas into the working-cylinder, as it has been proven that the finest wire fabric will not prevent such explosion, which cannot take place when gas alone is present in the collector.

In so far as the method of regulating gas-engines by regulating the flow of gas to the pump is concerned the described method has the advantage in that the introduction and regulation of the charges are entirely independent of the operation of the pump or the position of its piston, and in that several charges of gas may be successively admitted to the working-cylinder during one and the same stroke of the pump and better regulated, so that the regulation does not take place after the pump has been working some time.

To facilitate the starting of the motor and to obtain a sufficient pressure in the collector at the start, the latter may be connected through pipe *u* with a hand-pump and suitable cut-off mechanism provided to cut off the communication after the motor has been started.

Having described my invention, what I claim is—

1. The combination, with the working-cylinder of a gas-engine, its gas-inlet port, a governed cut-off therefor, and a gas-pump, of a gas-collector respectively connected with said inlet-port and pump, a cut-off in the latter connection, and a variable cut-off in the connection between the collector and gas-inlet port, substantially as and for the purposes specified.

2. The combination, with the working-cylinder of a gas-engine, separate air and gas inlet ports therefor, a governed admission-valve for said gas-port, and a gas-pump, of a gas-collector for storing the gas under pressure, connected with the gas-inlet port and with the pump, an automatic cut-off in the connection between the pump and collector, and a regulating device interposed in the connection between said collector and gas-inlet port for regulating the flow of gas thereto, substantially as and for the purposes specified.

3. The combination, with the working-cylinder of a gas-engine, separate air and gas inlet ports therefor, a governed admission-valve for said gas-port, and a gas-pump, of a gas-collector connected with the gas-inlet port and with the pump, a cut-off device in the connection between the pump and collector, a regulating device interposed in the connection between the collector and gas-inlet port, and a connection between said port and the suction of the pump, substantially as and for the purposes specified.

4. The combination, with the working-cylinder of a gas-engine, its gas-inlet port, a governed cut-off therefor, and a gas-pump, of a gas-collector composed of two communicating chambers connected, respectively, with the forcing end of said pump and said gas-inlet port, a regulating device interposed in the connection between the two chambers, and a cut-off device interposed in the connection between one of said chambers and the pump, substantially as and for the purposes specified.

5. The combination, with the working-cylinder of a gas-engine having separate air and gas inlet ports, a governed cut-off for said gas-inlet port, a gas-pump, and a governor, of a gas-collector composed of two communicating chambers connected, respectively, with the forcing end of the pump and the said gas-inlet port, a regulating device interposed in the

connection between the two chambers and controlled by the governor, and an automatic cut-off device in the connection between the pump and one of said chambers, substantially as and for the purposes specified.

6. The combination, with the working-cylinder of a gas-engine having separate air and gas inlet ports, a governed cut-off for the gas-port, and a gas-pump, of a gas-collector composed of two communicating chambers, whereof one is connected with the forcing end of the pump and the other with the suction end of said pump and with the gas-inlet port of the cylinder, an automatic cut-off device in the connection between one of said chambers and the forcing end of the pump, and a regulating device in the connection between the other chamber and the gas-inlet port of the cylinder, substantially as and for the purposes specified.

7. The combination, with the working-cylinder of a gas-engine having separate air and gas inlet ports, a governed cut-off for said gas-inlet port, and a gas-pump, of a gas-collector composed of two communicating chambers, whereof one is connected with the forcing end of the pump and the other with the suction end of said pump and with the gas-inlet port of the cylinder, an automatic cut-off device interposed in the connection between one of said chambers and the pump, and automatic regulating devices in the connection between the other chamber and the gas-inlet port and between said port and the suction of the pump for controlling the flow of gas from the collector to the inlet-port and to the suction of the pump, substantially as and for the purposes specified.

8. The combination, with the working-cylinder of a gas-engine provided with separate air and gas admission ports, a governed cut-off for the latter port, and a gas-pump, of a gas-collector composed of two communicating chambers, a regulating device interposed in the connection between said chambers, a connection provided with an automatic cut-off between one of the chambers and the forcing end of the pump, a connection between the other chamber, the gas-inlet port of the cylinder, and the suction of the pump, a regulating device, and an adjustable cut-off interposed in said connection, substantially as and for the purposes specified.

9. The combination, with the working-cylinder of a gas-engine having separate air and gas inlet ports, a valve for said inlet-port controlled by a moving element of the engine, a gas-pump, a connection between the suction end thereof and the gas-inlet port, an adjustable cut-off device in said connection, and a governor, of a gas-collector connected, respectively, with the forcing end of the pump and with the gas-inlet port of the cylinder, a regulating device controlled by the governor and interposed in the latter connection, and a like regulating device interposed in the connection between said gas-inlet port and the suction end of the pump, substantially as and for the purposes specified.

10. The combination, with the working-cylinder of a gas-engine, its valved inlet-port, and the gas-pump, of a gas-collector in communication with said inlet-port and pump, and a cut-off device interposed in the connection between the collector and pump, and the pipe *u*, connected with the collector, for the purposes specified.

In testimony whereof I affix my signature in presence of two witnesses.

WILHELM VON OECHELHAEUSER.

Witnesses:
B. ROI,
A. DEMELIUS.