No. 799,459. PATENTED SEPT. 12, 1905.

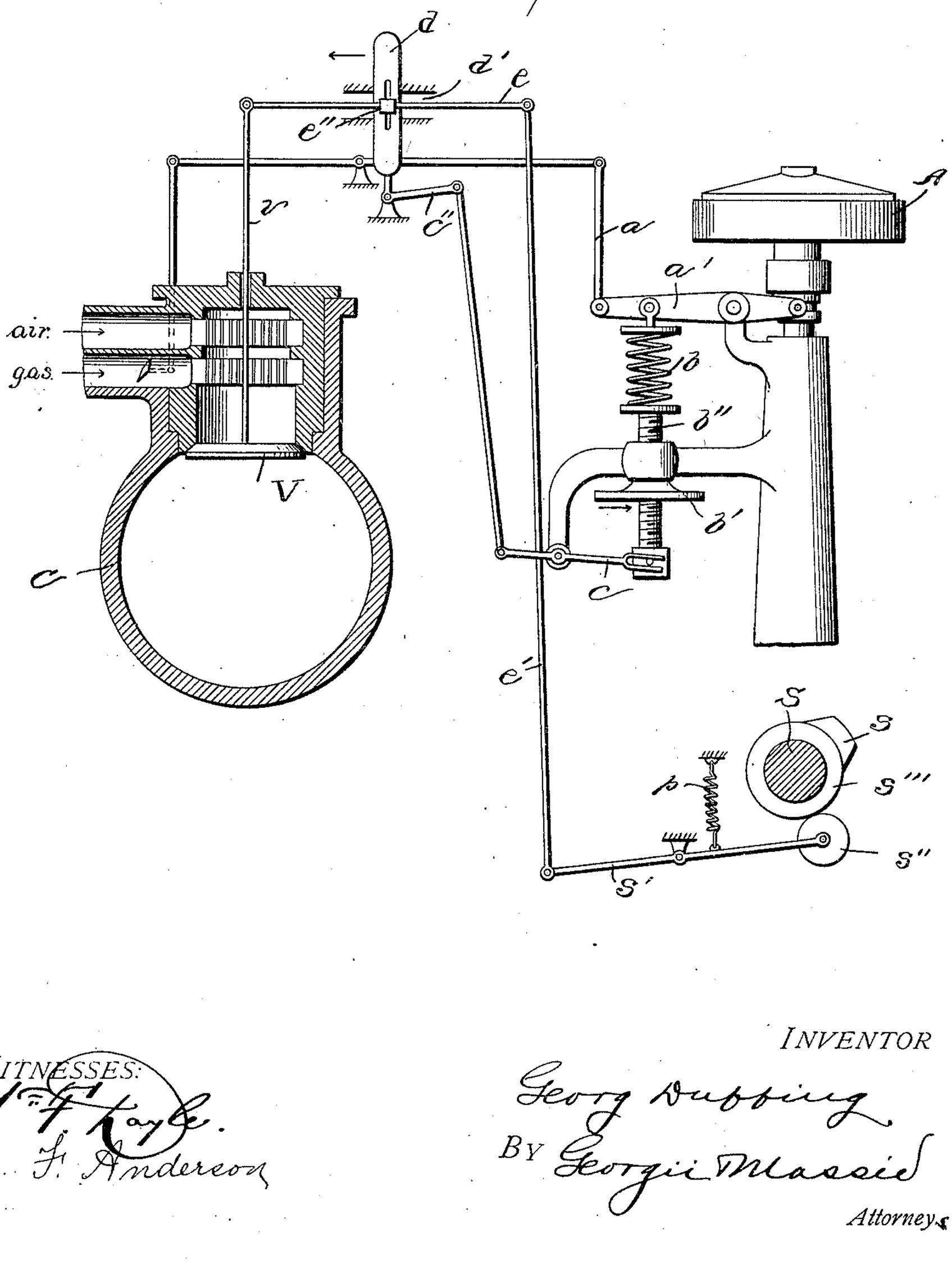
G. DUFFING.

# SPEED REGULATOR FOR EXPLOSION ENGINES.

APPLICATION FILED JUNE 1, 1903.

2 SHEETS—SHEET 1.

FIG. 1.

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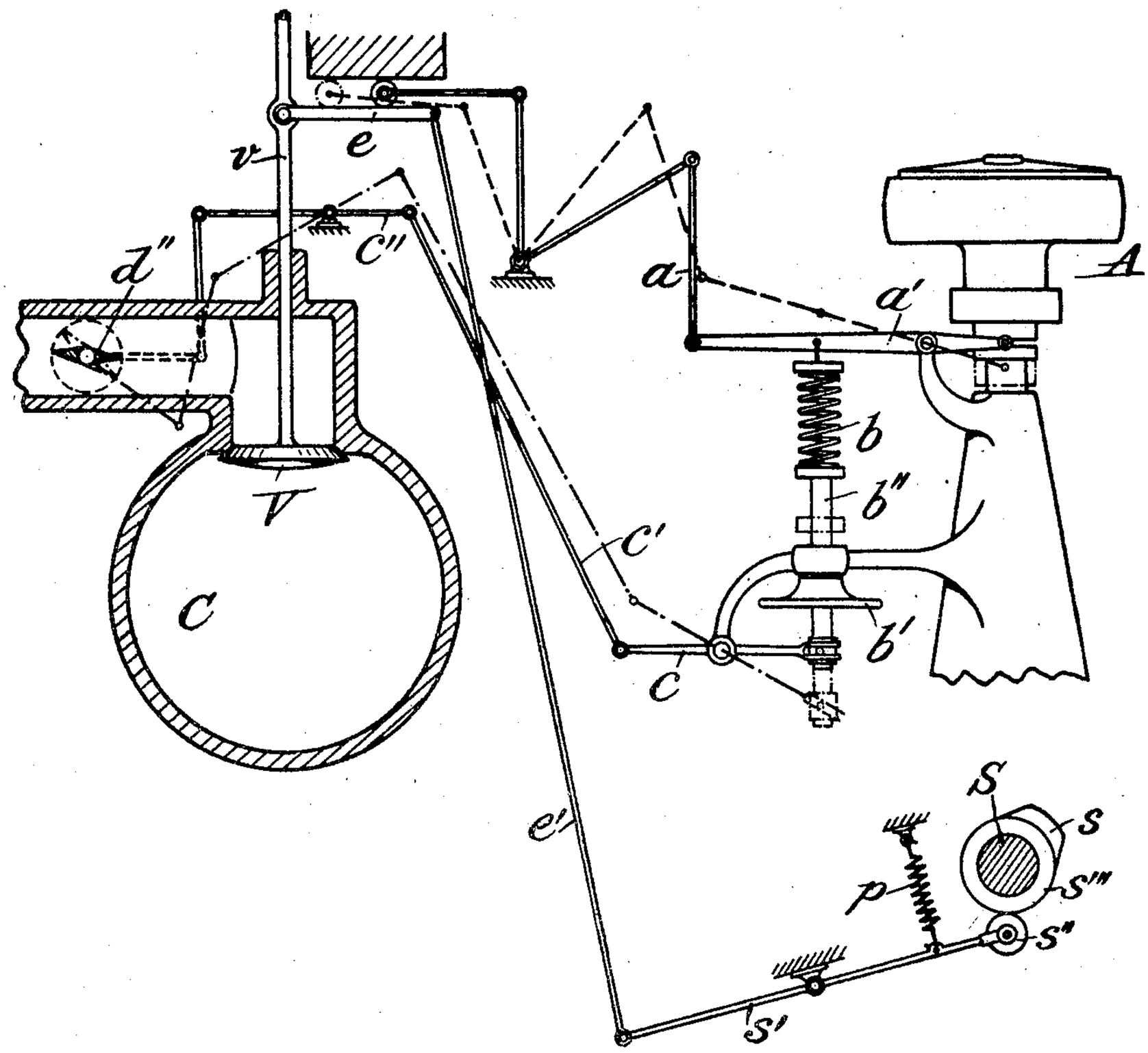
2 SHEETS—SHEET 2.

*Fig. 2.*

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# UNITED STATES PATENT OFFICE.

GEORG DUFFING, OF MÜLHEIM-ON-THE-RHINE, GERMANY.

## SPEED-REGULATOR FOR EXPLOSION-ENGINES.

No. 799,459. Specification of Letters Patent. Patented Sept. 12, 1905.

Application filed June 1, 1903. Serial No. 159,700.

*To all whom it may concern:*

Be it known that I, GEORG DUFFING, engineer, a subject of the German Emperor, residing at 93 Deutzerstrasse, Mülheim-on-the-Rhine, Germany, have invented certain new and useful Improvements in Speed-Regulators for Explosion-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.

My invention relates to gas-engines, and more especially to those parts of such engines by which the admission of the explosive mixture to the cylinder is controlled.

The invention has for its object to obtain an equally intimate mixture of explosive gas for all speeds of the engine.

In the regulation of explosive-engines the difficulty has been encountered that as the speed of the engine has been increased the valve admitting the explosive fluid was opened by means of the governor connection in order to admit a greater amount of the explosive mixture. This resulted in a corresponding increase of the cross-section of the entrance, and consequently reduced the throttling action of the valve and resulted in a less perfect mixture of the gases. In other words, if under the old arrangement by a change in the load-adjustment of the regulator the mean speed of the engine is reduced and at this reduced mean speed the full power of the engine is called for, then the regulator brings into service the entire cross-section of the gas and air inlet, the same as at a higher speed of the engine. Since, however, the speed of the engine has become less, the air and gas now flows through the same cross-section at a reduced velocity, and the consequence is that the thoroughness of the mixture is impaired. This invention is an improvement upon the old, whereby the cross-section of the entrance is reduced as the mean speed of the engine is lowered, so that a more perfect mixture and increased efficiency is attained when the engine is operating at a lower speed.

The invention consists in providing means for effecting a throttling action in the channel by which the explosive mixture is admitted to the cylinder and in making such arrangements that the said throttling action can be increased or diminished, according and in proper relation to the mean speed at which the engine is to be run.

In the accompanying drawings, Figure 1 is a diagrammatical illustration of the parts of a gas-engine which form the subject of the following description, other well-known parts being omitted; and Fig. 2 is a similar illustration of a modification.

In the figures, A is a centrifugal governor of the usual description, which, by means of the lever $a'$ and the rod $a$, acts upon the valves controlling the composition of the explosive mixture in the usual known way, so as to automatically retain constant at all loads the speed for which the governor is once adjusted. In order to adjust the governor A for different speeds, the tension of the spring $b$ can be varied, and for this purpose the spindle $b''$ is attached to the lower end of the spring $b$ and is provided with a hand-wheel $b'$, forming an adjusting-nut. By means of a lever $c$ and a link $c'$ the spindle $b''$ is connected to the one arm $c''$ of a bell-crank lever whose other arm $d$ is provided with a slot in which an adjustable bearing $e''$ can slide up and down. This bearing is mounted in guides $d'$ and forms the pivot of a lever $e$, one arm of which is connected by a link $e'$ to a lever $s'$ and the other by a link $v$ to the valve V, controlling the admission of the explosive mixture to the cylinder C. The free end of lever $s'$ is provided with a roller $s''$, held in contact with a sleeve $s'''$ by a spring $p$. The sleeve $s'''$ is mounted upon a shaft S, to which the revolution of the main engine-shaft is transmitted by the usual intermediate mechanism. (Not shown in the drawings.) On the sleeve $s'''$ is fixed a cam projection $s$, which causes an oscillation of the lever $s'$ every time it passes under the roller $s''$, thereby opening the valve V for the admission of the explosive mixture to the cylinder.

It will be seen that if the pivot $e''$ of the lever $e$ is shifted either to the right or left the valve will offer a larger or smaller outlet for the mixture when opened.

The operation of this device is as follows: It is found that in order to obtain an intimate mixture of the gases composing the charge of the cylinder, it is in most cases sufficient to provide in the channel by which the mixture is admitted to the cylinder a portion having a comparatively small section. On being forced through this portion of the channel the speed of the gases is considerably increased. By this means whirls are formed in the stream of gases, and intimate mixture is the consequence. It has been found, however, that this throttling action cannot be in-

creased beyond a certain limit dictated by experience, because otherwise too much resistance would be offered and a corresponding increase of the time consumed in charging the cylinder would follow, and thus a diminution of the power of the engine. Therefore it will be seen that for every speed of the engine a definite amount of throttling action will render the best results, and, if the same engine is to be run at different speeds, the throttling action adapted to the highest speed will not be sufficient to cause a satisfactory mixing of the gases when the engine is run at low speeds, and vice versa. It is the object of my present invention to obviate this difficulty not only by making the throttling-section of the admission-channel variable, so that it can be adapted to different speeds of the engine, but also to make the variations of the throttling-section dependent upon the adjustment of the governor. The different parts are so dimensioned that when the engine is running at its highest speed the opening movement of the valve V is just sufficient to cause an amount of throttling action in the stream of gases which gives the most favorable results. When the speed of the engine is to be diminished, the hand-wheel $b'$ is turned so as to retract the spindle $b''$, and thereby increase the tension of the spring $b$. Lever $c$ and link $c'$ will then act upon the bell-crank lever $c''$ $d$ so as to rock it to the left, and the opening movement of the valve V will be correspondingly reduced. Thus the throttling action of the valve will remain practically constant though the charge of gas admitted to the cylinder at each opening of the valve is reduced. To illustrate, we will suppose that the governor (see Fig. 1) is adjusted to maintain approximately two hundred revolutions per minute. The actual speed will vary between one hundred and ninety-six at full load and two hundred and four without load. As the speed of the engine falls below or rises above these limits the connection between the governor and the inlet-valve will operate to increase or diminish the quantity of explosive mixture fed to the cylinder in such manner as to maintain this approximate speed. If it is desired to reduce the mean number of revolutions to, say, one hundred, then by adjusting the governor by means of a spring or any other well-known medium a condition may be attained whereby the governor will operate, through its connections, to maintain a speed within the limits of about ninety-seven under full load and one hundred and three without load. Thus far the arrangement is well known. However, under the ordinary arrangement the inlet-valve at the lowest position of the regulator would open just as far whether the regulator were set to maintain a speed of two hundred or one hundred revolutions. Since in the latter case the number of revolutions is but one-half as large, then the velocity of the explosive gases in the valve-entrance would also be reduced one-half, and the mixture would consequently not be so thorough. To overcome this difficulty, the rods $c$ $c'$ $c''$ are so connected with the spindle $b''$ that when by means of the wheel $b'$ the governor is so adjusted as to maintain a lower mean speed the fulcrum of the lever-rod is shifted and the extent to which the valve V is opened is simultaneously reduced. The effect is that as the mean speed is reduced one-half the cross-section of the entrance is also reduced one-half, and the constant velocity of the gases is maintained, resulting in an efficient mixture under varying circumstances. In the embodiment of my invention described with reference to Fig. 1 the opening offered by the admission-valve V is itself the throttling-section, and, as has been already explained, this section is varied accordingly as the governor is adjusted for higher or lower speeds by turning the hand-wheel $b'$. However, I wish it to be understood that I consider any other device by which the adjustment of the governor likewise causes a corresponding adjustment of the throttling-section in the admission-channel as included in my invention. Thus, for instance, in some cases I prefer to use separate appliances for the admission and for mixing purposes, an example of such an arrangement being illustrated in Fig. 2. In Fig. 2 the throttling action upon the explosive mixture is produced by a damper $d''$, arranged in the path of the mixture, the throttling action in this case being independent of the inlet-valve V. This damper $d''$ is connected by the links and levers $c$, $c'$, and $c''$ with the spindle $b''$, as before. The principle of operation in both cases is the same.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is—

1. In a gas-engine, the combination, with means for varying the mean speed of the engine, of means for maintaining a substantially uniform velocity of inflow of the explosive gases to the cylinder under different mean speeds.

2. In a gas-engine, the combination, with means for varying the mean speed of the engine, of means for reducing or enlarging the section of the channel admitting the explosive gases to the cylinder according as the mean speed of the engine is reduced or increased.

3. In a gas-engine, the combination, with means for adjusting the speed-governor to vary the mean speed of the engine, of means for reducing or enlarging the section of the channel admitting the explosive gases to the cylinder in proportion as the governor is adjusted to reduce or increase the mean speed of the engine and simultaneously therewith.

4. In a gas-engine, the combination, with means for adjusting the speed-governor to

vary the mean speed of the engine, of a valve for reducing or enlarging the section of the channel through which the explosive mixture flows to the cylinder, and a connection between the valve and the adjusting means whereby the adjustment of the governor to a reduced mean speed will result in a reduction of the section of the channel and vice versa.

5. In a gas-engine, the combination, with a centrifugal governor, a spring adapted to counteract the centrifugal force, and means for varying the tension of said spring, of a lever arranged to control the movement of the admission-valve, and means for shifting the fulcrum of said lever, said shifting means being controlled by the means for varying the tension of the governor-spring.

6. In a gas-engine, the combination, with an inlet-valve for the motive fluid, a speed-governor, a connection between the governor and the inlet-valve, and a spring tending to counteract the action of the governor, of a throttle-valve controlling the passage of the motive fluid, a lever connected with the throttle-valve, and means operating simultaneously to vary the tension of the spring and shift the fulcrum of the lever, whereby the throttling action will be increased as the mean speed of the engine is reduced.

In testimony whereof I have affixed my signature to this specification in the presence of two witnesses.

GEORG DUFFING.

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