(No Model.) 3 Sheets—Sheet 1.

W. L. CROUCH.

GAS ENGINE.

No. 575,502. Patented Jan. 19, 1897.

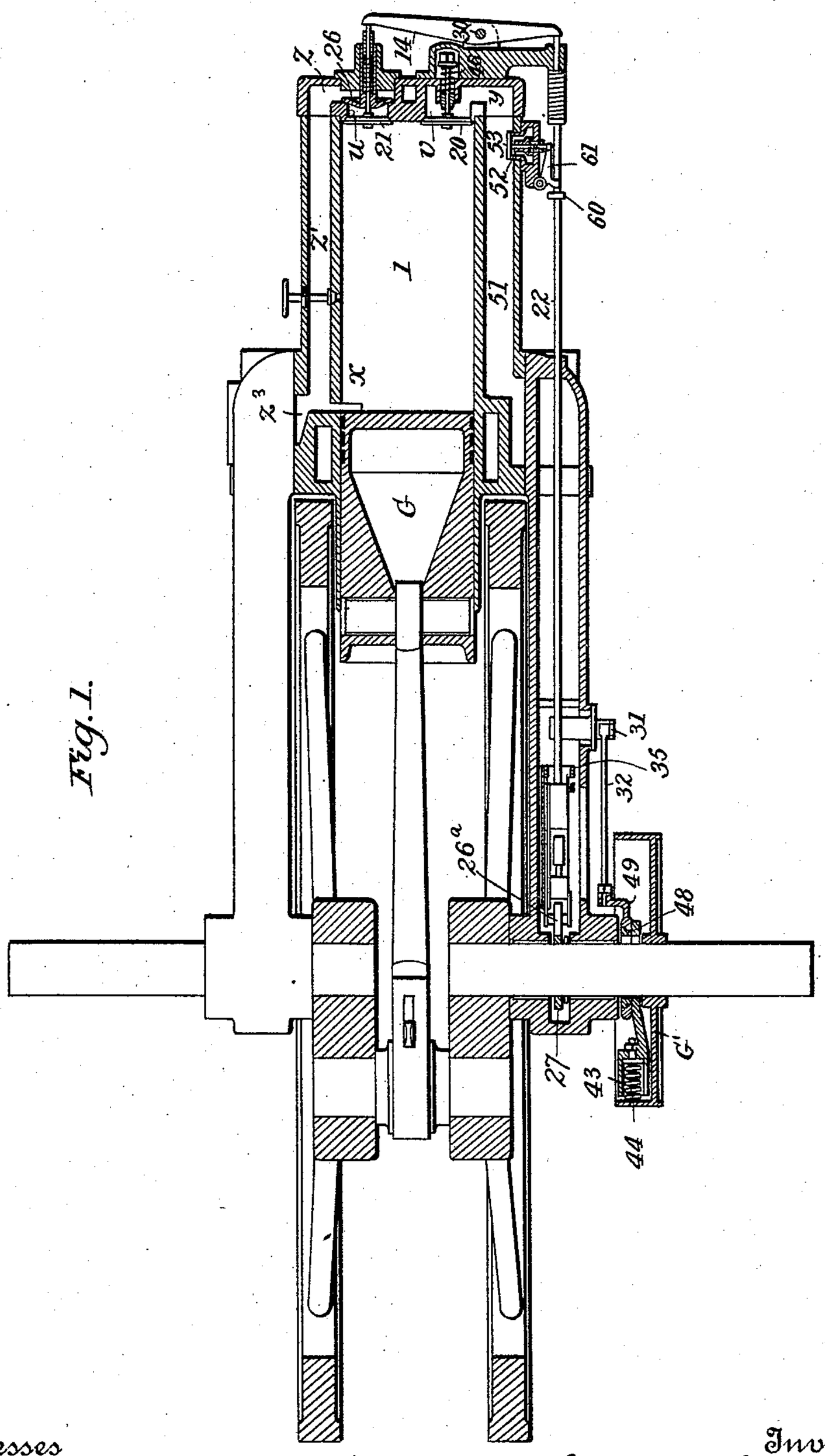


Fig. 1.

Witnesses
Jno. G. Hinkel
E. Everett Ellis

Inventor
Parker Lee Crouch
by Foster Freeman
Attorneys

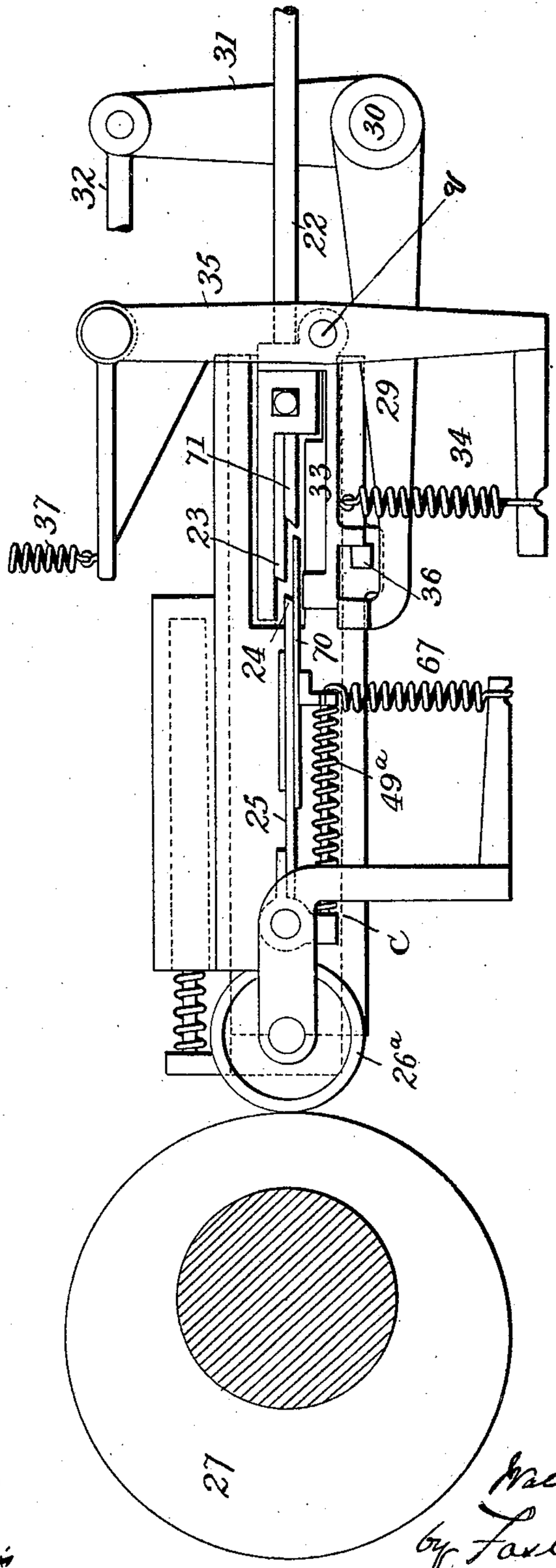
(No Model.) 3 Sheets—Sheet 2.

W. L. CROUCH.

GAS ENGINE.

No. 575,502. Patented Jan. 19, 1897.

Fig. 2.



Witnesses
Jno. G. Hinkel
E. Everett Ellis

Inventor
Walter Lee Crouch
by Foster Freeman
Attorneys

(No Model.)

3 Sheets—Sheet 3.

W. L. CROUCH.

GAS ENGINE.

No. 575,502. Patented Jan. 19, 1897.

Fig. 3

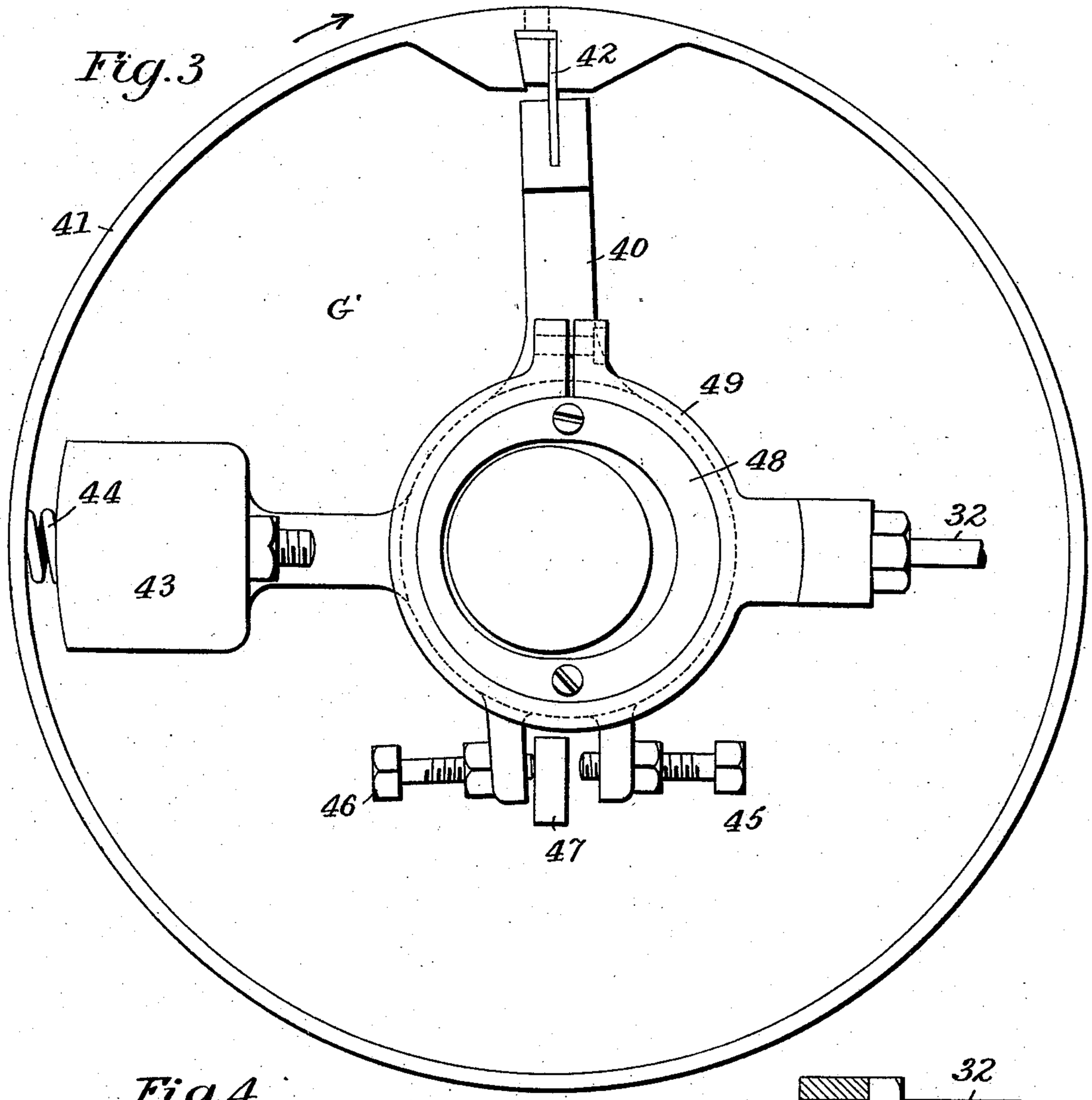
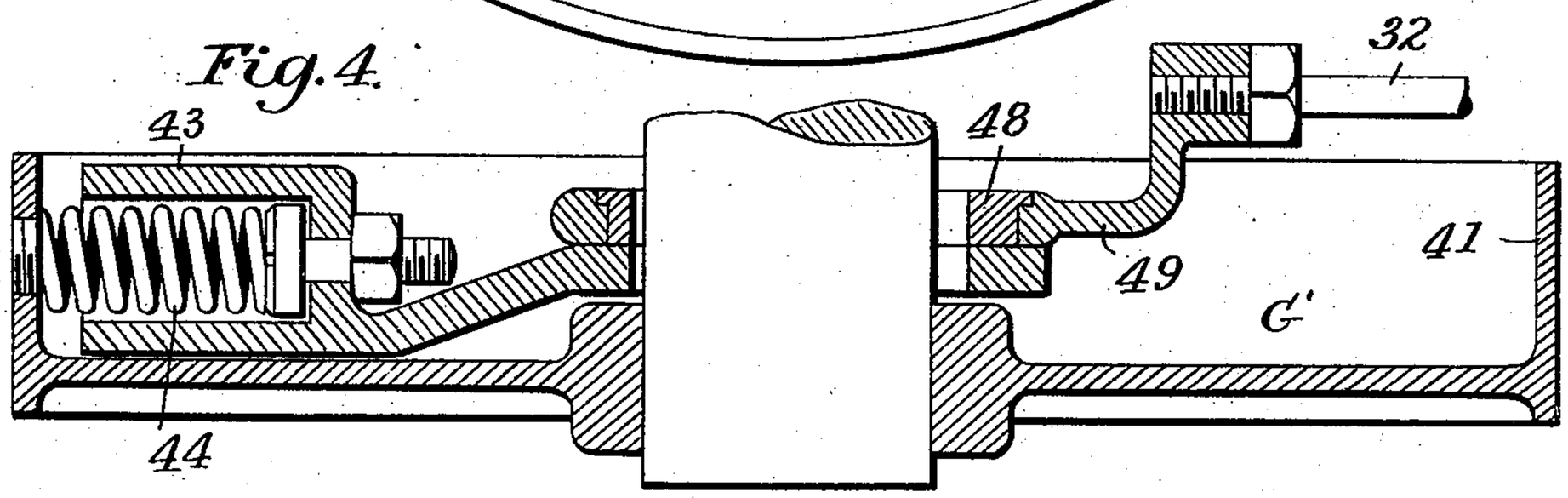


Fig. 4.



Witnesses
Jno. G. Hinkel
E. Everett Ellis

Inventor
Tracken Lee Crouch
by Foster Freeman
Attorneys

UNITED STATES PATENT OFFICE.

WALKER LEE CROUCH, OF NEW BRIGHTON, PENNSYLVANIA, ASSIGNOR TO THE PIERCE-CROUCH ENGINE COMPANY, OF SAME PLACE.

GAS-ENGINE.

SPECIFICATION forming part of Letters Patent No. 575,502, dated January 19, 1897.

Application filed November 22, 1895. Serial No. 569,829. (No model.)

To all whom it may concern:

Be it known that I, WALKER LEE CROUCH, a citizen of the United States, residing at New Brighton, in the county of Beaver and State of Pennsylvania, have invented certain new and useful Improvements in Gas-Engines, of which the following is a specification.

My invention relates to that class of gas-engines in which an explosive charge is the means of driving forward the piston; and my invention consists in certain combinations of parts, hereinafter fully set forth, whereby to insure the proper movements of the engine without taking in charges when the engine is at an excessive speed, and whereby to prevent the speed from unduly decreasing after the supply of charges has ceased, as fully set forth hereinafter and as illustrated in the accompanying drawings, in which—

Figure 1 is a longitudinal sectional plan of an engine embodying the improvements. Fig. 2 is a side view, enlarged, showing the parts connected with the governor. Fig. 3 is a face view of the governor, and Fig. 4 a transverse section of the governor.

The cylinder 1 of the engine is provided when required with the usual water-jacket and with an exhaust-port x, at the forward end arranged to be uncovered when the piston G is at the limit or approaches the limit of its forward movement, and at the rear end or head it has a passage y, through which the mixture of air and gas can flow to the port v, affording ingress to the cylinder-chamber, and another passage z, through which the contents of the cylinder may be discharged, the said passage z, as shown, communicating through a passage z' with the exhaust-passage z^3, which communicates with the exhaust-port z. As shown, the passages y z communicate with two ports v u, to which are adapted valves 20 21, although in some instances a single port with a single valve properly operated may take the place of the two ports and valves, in which case both passages y z will communicate or may be made to communicate at proper intervals with the said single port, as in the engine constituting the subject of my application, Serial No. 569,830.

In the construction shown, where there are two ports and two valves, the valve 20 is a self-acting or check valve, which is kept in its seat by a coiled spring 46, and the valve 21 is self-acting but also is opened positively by a governor, as will be described hereinafter, and a check-valve 26 is in the port leading from the valve 21 to the exhaust and so arranged as to open under pressure from the inside of the cylinder but to close against back pressure from the exhaust.

Before referring further to the details of construction I would refer to the fact that gas-engines as ordinarily constructed act through a regular cycle of operations. That is, one forward movement of the piston will draw in a gas and air supply or charge, the backward movement will compress it, the next forward movement will be under explosive pressure, and the next backward movement will expel the spent gases. In other instances the forward movement will draw in a charge as the gases are expelled to a forward port, and the return movement condenses the gases, and the explosion then drives the piston forward and the gases are expelled and the new charge drawn in. In all such cases, whatever the sequence may be, it is regularly followed out in all the operations. One object of my invention is to so construct the engine that these operations may be varied according to the speed of the engine, to regulate its speed, and maintain its operations at any desired efficiency, and to this end I have adopted the arrangement of parts which I have already partly described and the operation of which I will now set forth.

In the regular operation of the engine in doing its work the forward motion of the piston under explosion carries it past the port x when the gases exhaust from the said port, except those which remain in the cylinder 1 under atmospheric pressure. These of course will not exhaust because there is nothing to force them from the chamber. On the backward motion of the piston these gases are compressed and therefore they are practically inert, except to the extent that by expansion after compression they tend to aid

the piston in its forward motion, and this alternate compression and expansion will be carried on without the generation of any force or energy in the engine until the latter has slowed down to a certain predetermined degree of speed. When this occurs, the governor or regulator opens the valve 21 when the piston is at its forward position, or before it reaches its backward position, and then the gases in the cylinder 1 will be expelled, the valve 26 opening to permit them to pass to the exhaust until the piston reaches the limit of its backward movement. The valve 26 will then take its seat, and as the piston moves forward it will tend to exhaust the chamber in the cylinder and lift the valve 20, take in a new charge, which is compressed on the next backward movement and then ignited and exploded, forcing the piston forward.

It will be seen that by providing an exhaust at each end it is possible to keep the cylinder filled with such a body of spent gases as to prevent any exhausting action of the piston to draw in a new charge, and that thereby the engine can be allowed to run free without any additional introduction of explosive charges so long as the speed is in excess of the normal speed, and then by opening the exhaust at one end of the cylinder, so as to permit the gases to be completely expelled, the succeeding movement of the piston exerts a suction or exhausting effect that draws in a new charge; and that by regulating the movement of the exhaust-valve at the rear end of the cylinder according to the speed of the engine, the admission of charges by the forward action of the piston may be regulated, according to the speed of the engine, automatically.

Any suitable governing device may be employed, but I prefer to employ governing mechanism that will operate positively to open the exhaust-valve at the rear end of the cylinder at regular intervals when the speed of the engine decreases below the normal, that will maintain said valve closed during the time the engine is running at excessive speed, and that will open the exhaust-valve at the next backward stroke of the piston succeeding that at which the engine regains its normal speed.

One construction of governor device is illustrated in the drawings and operates in connection with a lever 14, pivoted at 30 to the rear head of the engine and bearing at one end upon the stem of the valve 21 and at the other end upon the rod 22. The rod 22 is provided at one end with a shoulder 23, which is adapted under certain circumstances to engage a shoulder 24 upon a rod 25, carried by a slide C, a friction-wheel 26^a, which bears against a cam 27 upon the crank-shaft of the engine, so that the slide and its rod 27 are moved backward with each backward movement of the piston, and if the shoulders 23 24 are in contact the rod 22 will also be moved backward, and the exhaust-valve 21 at the rear head of the engine will be opened at each alternate back stroke, and a charge will be taken into the cylinder at the succeeding stroke. This is the operation of the parts normally when the engine is operating at any speed below the maximum normal speed. If, however, this speed is exceeded, so that it is not desirable to further introduce charges into the engine and increase the speed or uselessly waste the power, the lateral position of the rod 25 will be changed, so that the shoulders 23 and 24 will not be brought into contact so long as this excessive speed is maintained, and no charges will be admitted.

When the engine is operating at the proper high speed, the rod 25 will reciprocate below the rod 22, so that the shoulders 23 24 will not come in contact; but when the speed decreases the rod 25 will be lifted up at each alternate reciprocation, so that the rod 22 will be pushed forward and the valves opened on alternate strokes, as is required. This movement of the rod 25 is effected by means of a lifter (shown as an arm) 29 upon a rock-shaft 30, having an arm 31, connected by a governor-rod 32 with the governor. The action of the governor is such that when the speed is normal or above the normal speed the arm 29 will remain in its lowest position and the shoulders 23 and 24 will not be brought in contact; but when the speed decreases to the proper extent or becomes less than it should be, then the shaft 30 is rocked at each rotation of the main shaft, so that the arm 29 rises with each backward movement of the piston. It is not desired that the rod 25 should be lifted at each upward movement of the arm 29, and to secure the alternate lifting a dog 33 is pivoted to a lever 35 swinging on a fixed pivot q, and connected with a spring 34, attached to said lever 35, so that the backward movement of the lever will bring a tension on the spring 34. Below the dog 33 is a stop 36. These parts are so arranged that upon one upward movement of the end of the arm 29 it will strike the under side of the dog 33 and lift the latter, so that at the next forward movement the shoulder 24 of the rod 25 will come in contact with the shoulder 23. As the rod 22, together with the lever 35, is carried back by this contact of the shoulders, the dog 33 is carried over the end of the arm 29, and then drops downward onto the stop 36, so that at the next forward movement of the parts the end of the dog 33 will strike the side of the upturned end of the arm 29, and when the latter is elevated the dog 33 will not be carried up so as to lift the rod 25, and the latter will therefore move backward without any contact of the shoulders 23 24.

The dog 33 is drawn down toward the stop 36 by the spring 34, attached to one arm of the lever 35, to which the dog is pivoted, and when

the arm 29 descends to carry its upturned end below the dog 33 this lever 35 is swung on its pivot *q* to throw the dog forward by the action of a spring 37, when the end of the dog will be brought above the end of the arm, so that on the next movement of the latter the dog will be lifted and with it the end of the rod 25, so that the shoulders will then on the forward movement of the rod 25 be brought in contact. These movements will be repeated so long as the engine is running at a normal or below the normal speed, so that then a charge is introduced at each alternate forward movement of the piston.

It will be evident that, as the engine may have its speed reduced at any moment so as to cause the arm 29 to be lifted on any one of the backward strokes of the piston, the rod 22 may be thrown backward and the exhaust-valve 21 opened at any backward movement of the piston. In this respect this engine differs from any others because in ordinary gas-engines, as before stated, the exhaust-valve can be opened only in its regular order in the complete cycle of movements. It is therefore possible to recover the speed with less loss of time by the operation above described than in the ordinary regular cycle of operations in the ordinary engine.

A blade 70, having an inclined end, projects beyond the shoulder 24, and back of the shoulder 23 is a deep inclined shoulder 71, so arranged that the end of the blade and shoulder 71 will engage as the blade moves back, thus causing the blade and rod 25 to rise and insuring the contact of the shoulders 23 24.

The governor may be constructed in any suitable manner so as to maintain the arm or lifter 29 in position not to raise the rod 25 when the speed is excessive, and yet reciprocate it when the speed is normal or below normal.

As shown in the drawings, the governor G consists of an L-shaped pendulum 40, suspended from the rim of a wheel 41 upon the crank-shaft by means of a flexible blade 42, secured to one arm of the pendulum, the other arm having a weight 43, between which and the rim of the wheel 41 is a spring 44, which tends to throw the pendulum in the direction of the arrow.

The body of the pendulum is cut away, forming an opening through which passes the crank-shaft, thereby permitting the pendulum to play to an extent limited by two set-screws 45 46 upon opposite sides of the stud 47. Upon the pendulum is annular rib 48, around which passes a strap 49, which is connected with the rod 32, and the parts are so arranged that when the engine is moving at a low rate of speed with the screw 46 in contact with the stud 47 the rib 48 will be eccentric to the driving-shaft, so that the rib 48 will constitute practically an eccentric revolving with the driving-shaft and imparting reciprocating motion to the rod 32 and causing the valve-operating parts to operate, as before described, to open the exhaust-port at alternate strokes. When, however, the speed increases, the pendulum of the governor will swing to a position to bring the annular rib 48 concentric to the crank-shaft, when no motion will be imparted to the strap 49 or to the rod 32, and consequently the arm 29 will be held in its lowest position and the shoulders 23 and 24 will not be brought into contact, and the cylinder will not be exhausted of its spent gases and no fresh charge will be drawn into the cylinder while the parts are in these positions.

It will be evident that, although I have described the arm 29 and the dog 33 as the means of shifting the rod 25 at proper intervals or on a change of the position of the governor, different devices may be employed for this purpose, provided they are so constructed and arranged that when the governor is in one position resulting from a high rate of speed the parts will be held out of operation and the shoulders 23 and 24 will not be brought in contact, while upon a shifting of the position consequent upon a decrease of speed the shoulders will be caused to contact at each second revolution of the crank-shaft.

In the construction shown there is a spring 49^a, connected with the rod 25, which tends to draw it in a direction to maintain the wheel or roller 26^a in contact with the cam 27, and a spring 67 tends to normally throw down the rod 25.

In order that the gas mixture may be made just prior to the outward movement of the piston that is to take it in, I provide that the gas shall be admitted to the space back of the port *v* only after the valve 21 has been lifted from its seat during the backward motion of the piston. To this end the inlet-valve 53, which closes the port 52, that communicates with the air-channel 51, is controlled in its action by the rod 22, that opens the valve 21. This rod 22 is provided with a stop 60, which makes contact with the lever 61, that bears upon the stem of the spring-seated valve 53. The rod 22 moves forward far enough to lift the valve 21 when the piston moves toward the rear, but not sufficiently far to open the valve 53. When the piston begins its forward movement, the rod 22 is moved by a projection on the cam slightly farther, so as to bring the stop 60 in contact with the lever 61 and open the gas or inlet valve and keep it open until the piston G has moved forward for a portion of the stroke, say about two-thirds. The mixture of gas and air will thus be drawn into the cylinder, after which the air will be drawn through the port *v* to such an extent as to completely exhaust all the gas from the passage 51 and absolutely prevent any danger of back explosion. During this time, of course, the valve 21 is lifted from its seat, but as the action of the piston is an exhausting action the valve 26 is kept upon its

seat, and there is no communication with the exhaust.

Without limiting myself to the precise construction and arrangements of parts shown and described, I claim as my invention and desire to secure by Letters Patent—

1. The combination with a valve of a gas-engine and with a rod for operating the same, of devices for actuating said rod, and a governor controlling such devices to prevent movement of the valve-rod during the time the engine is running above normal speed and to actuate the rod to open the valve at the next backward stroke succeeding the stroke at which the engine attains its normal speed, substantially as described.

2. The combination with a valve of a gas-engine and with a rod for operating the same having a shoulder, of a reciprocating slide provided with a shoulder adapted to be moved into and out of contacting position with the shoulder of the rod, a governor, and devices operated thereby for shifting one of the parts to bring said shoulders into contacting position on the next backward stroke of the piston succeeding the stroke at which the engine regains its normal speed, substantially as described.

3. In a gas-engine, the combination with the cylinder and piston, of an inlet and an exhaust port and valves therefor, a governor, and means controlled by the governor for holding the exhaust-valve closed when the engine reaches a predetermined speed and for opening the exhaust-valve upon a back stroke of the piston to permit the expulsion of the gases from the cylinder when the speed of the engine decreases below a predetermined speed, and means for supplying the cylinder with a new charge upon the next forward movement of the piston succeeding the stroke at which the engine attains its normal speed, substantially as described.

4. In a gas-engine, the combination with the cylinder and piston, of inlet and exhaust ports, and valves therefor, of a governor and connections for actuating the exhaust-valve to open the same at regular intervals during the normal operation of the engine, to maintain the same closed when the speed of the engine is in excess of the normal, and to open the same upon the next backward stroke succeeding the stroke at which the engine regains its normal speed, substantially as described.

5. In a gas-engine, the combination with the cylinder and piston, of inlet and exhaust ports and valves therefor, connections intermediate the exhaust and inlet valves for operating the same, and a governor controlling said connections for holding the exhaust-valve closed when the engine reaches a predetermined speed and for opening the inlet and exhaust valves upon the next backward stroke succeeding that at which the engine regains its normal speed, substantially as described.

6. In a gas-engine, the combination with the cylinder and piston, of inlet and exhaust ports and valves therefor, a check-valve intermediate the inlet-valve and cylinder, connections intermediate the exhaust and inlet valves for operating the same, and a governor controlling said connections to cause them to open the inlet and exhaust valves at regular intervals during the normal operation of the engine, to maintain said valves in their closed positions when the speed of the engine is excessive and to open said valves at the next backward stroke of the piston succeeding that at which it regains its normal speed, substantially as described.

7. In a gas-engine, the combination with a valve and a rod for actuating the same provided with a shoulder, a reciprocating part provided with a shoulder for engaging that of the valve-rod, means for carrying the reciprocating part laterally to different positions to insure or prevent the contact of the two shoulders, and a governor for controlling said means arranged to prevent the contact of the shoulders when the speed of the engine is excessive and to insure the contact of the shoulders at the next backward stroke of the piston succeeding that at which the engine regains its normal speed, substantially as described.

8. In a gas-engine, the combination with a valve and a rod for actuating the same provided with a shoulder, a reciprocating part provided with a shoulder, said part being capable of lateral movement to insure or prevent the contact of the two shoulders, a lifter adapted to shift the reciprocating part laterally, a governor adapted to actuate the lifter, and a dog, and means for operating the same to bring it alternately intermediate the lifter and reciprocating part and to one side of the lifter, substantially as described.

9. The combination with a valve and its operating-rod, devices for actuating said rod, a governor, and mechanism intermediate the governor and the devices for actuating the valve-rod for throwing them into and out of operative position, said governor comprising a wheel and its shaft, an angular pendulum provided with an elongated opening for reception of the shaft, and having one of its arms flexibly connected to the wheel and the other provided with a weight, and a spring adapted to move the pendulum in one direction, substantially as described.

10. The combination of the sliding rod 25, valve-rod 22, and shoulders 23, 24 adapted to make contact, lifter 29 controlled by a governor, and dog 33, and means for bringing the said dog alternately first above and then to one side of the lifter during the vibrations of the latter, substantially as and for the purpose set forth.

11. The combination with the valve-rod 22, reciprocating rod 25, and shoulders adapted to engage each other, of a lifter and intermediate devices, and a governor, and connections between the governor and the lifter, the

governor provided with an annular rib, a strap upon the said rib connected with the lifter connections, all arranged to throw the rib and strap out of center as the speed decreases and into center as the speed increases, substantially as set forth.

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

WALKER LEE CROUCH.

Witnesses:
E. H. THOMAS,
IRVIN K. CAMPBELL.