No. 628,518.

Patented July 11, 1899.

C. W. BOGART.

GAS ENGINE.

(Application filed Jan. 5, 1899.)

(No Model.)

3 Sheets—Sheet 1.

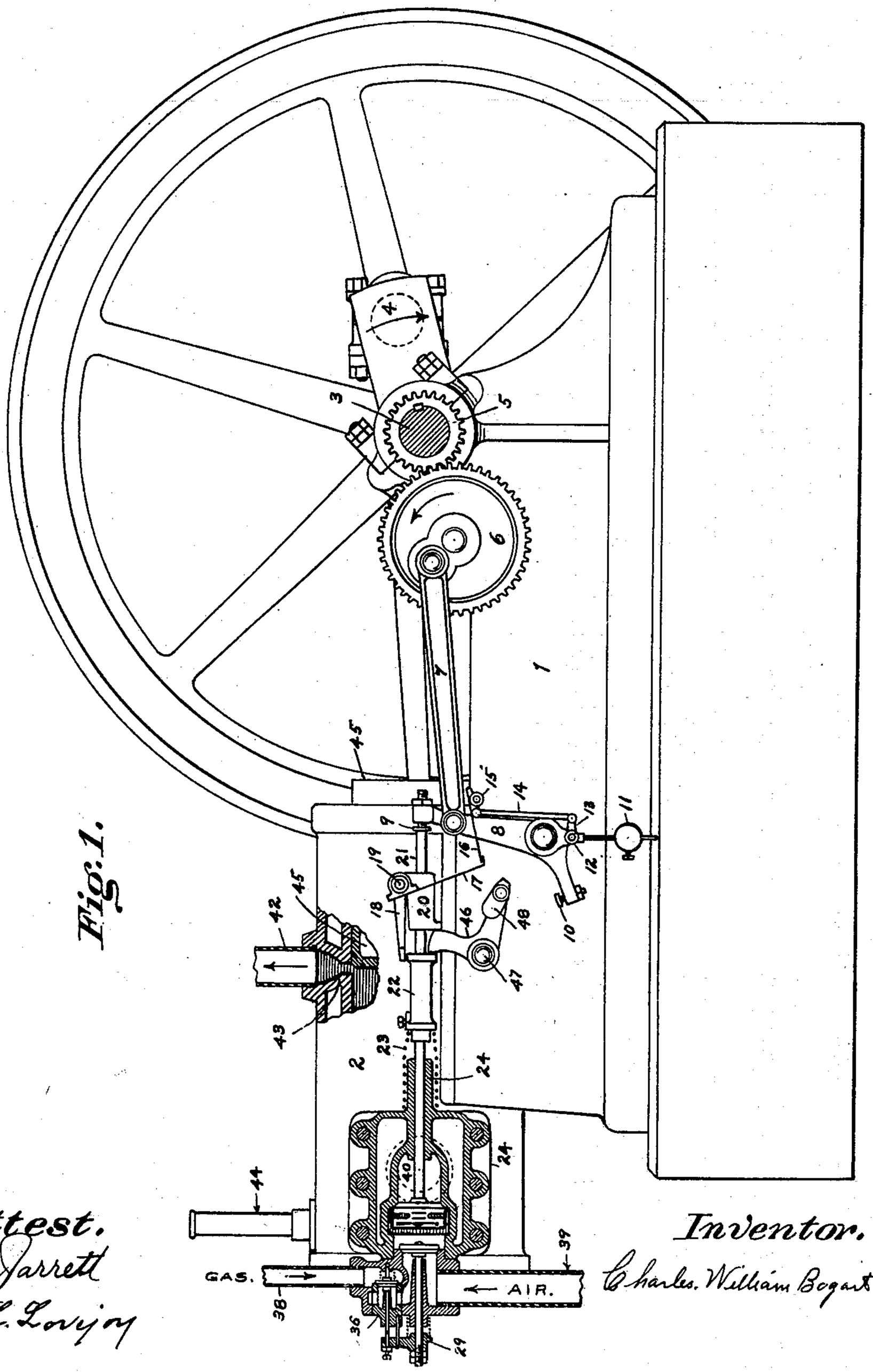


Fig: 1.

Attest.
G. Jarrett
G. L. Lovejoy

Inventor.
Charles. William Bogart.

No. 628,518.

Patented July 11, 1899.

C. W. BOGART.

GAS ENGINE.

(Application filed Jan. 5, 1899.)

(No Model.)

3 Sheets—Sheet 2.

Fig. 2.

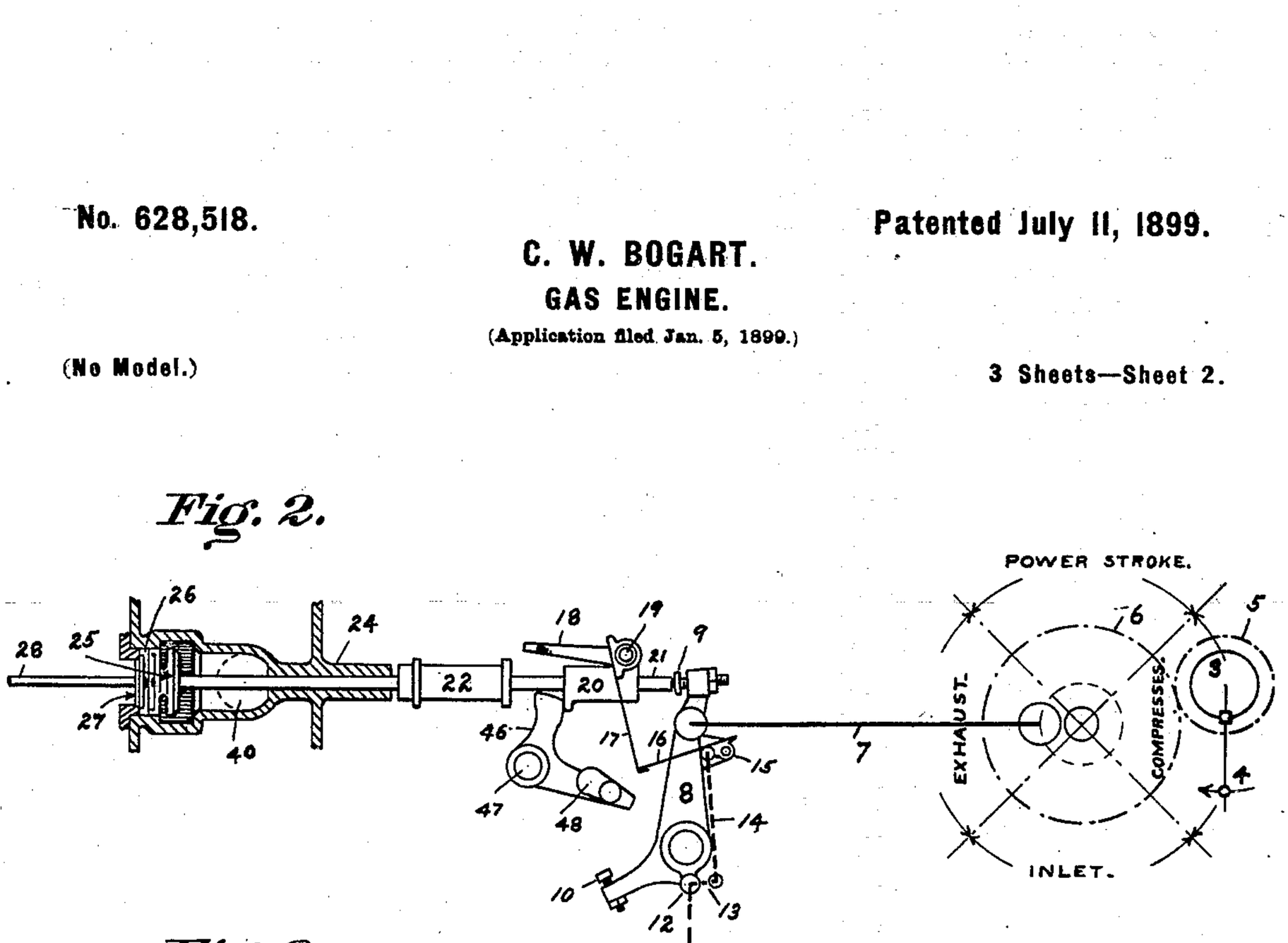


Fig. 3.

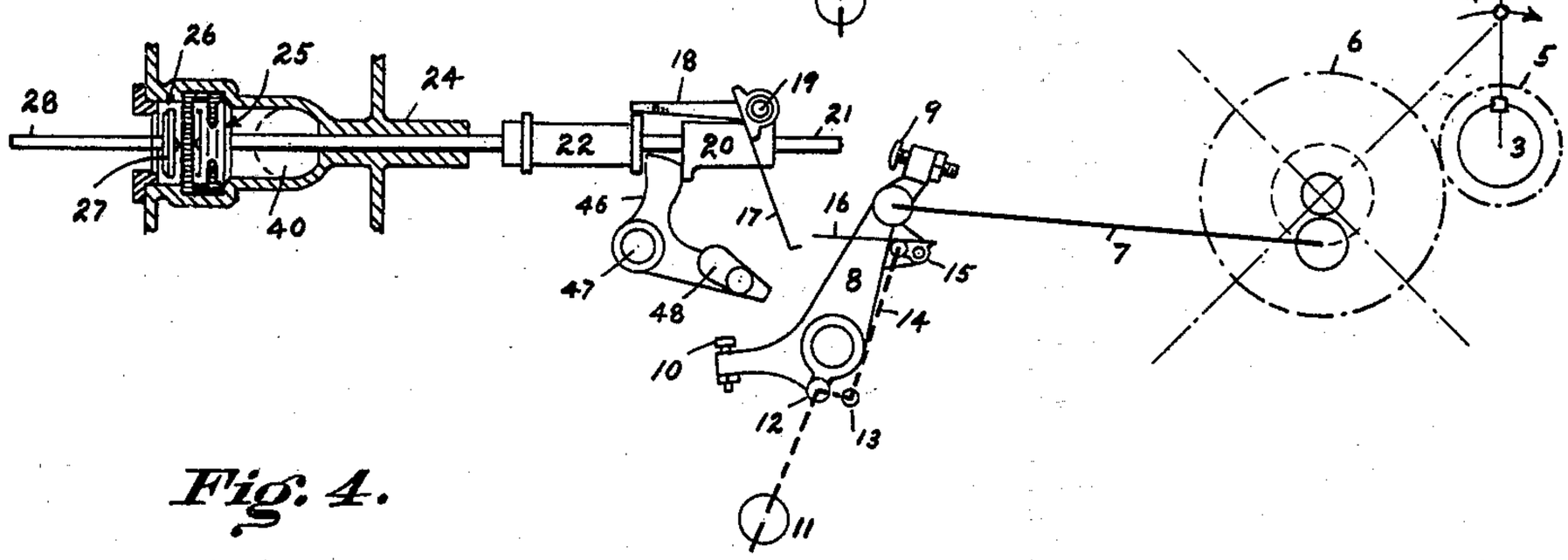


Fig. 4.

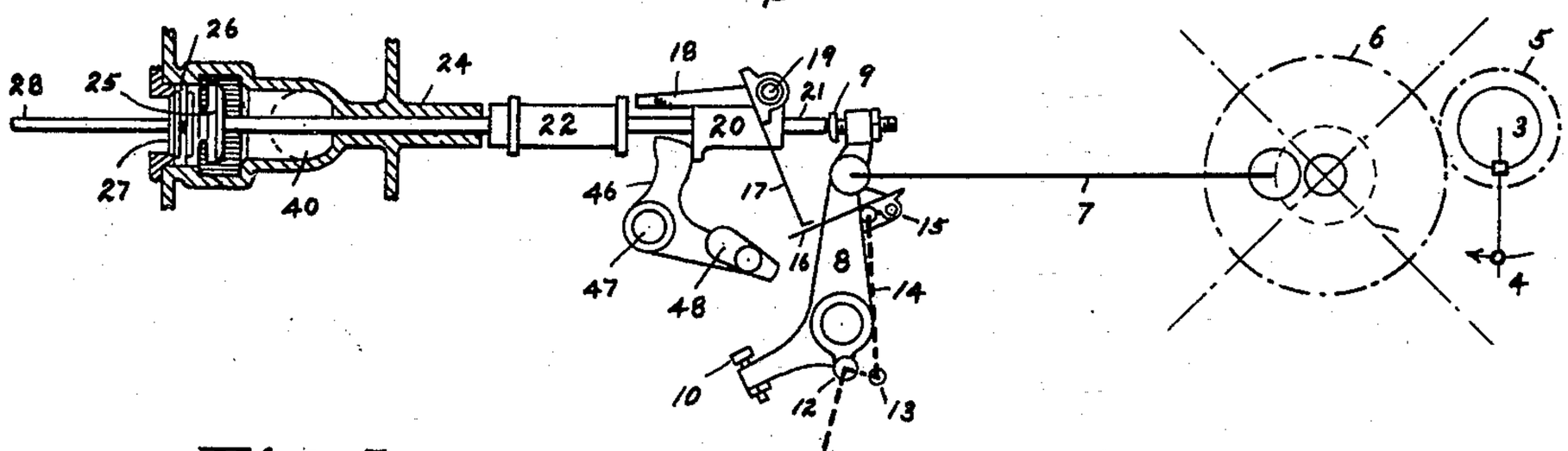


Fig. 5.

Attest.
S. Jarrett
G. L. Lovejoy

Inventor.
Charles. William. Bogart.

No. 628,518. Patented July 11, 1899.

C. W. BOGART.

GAS ENGINE.

(Application filed Jan. 5, 1899.)

(No Model.) 3 Sheets—Sheet 3.

Fig. 6.

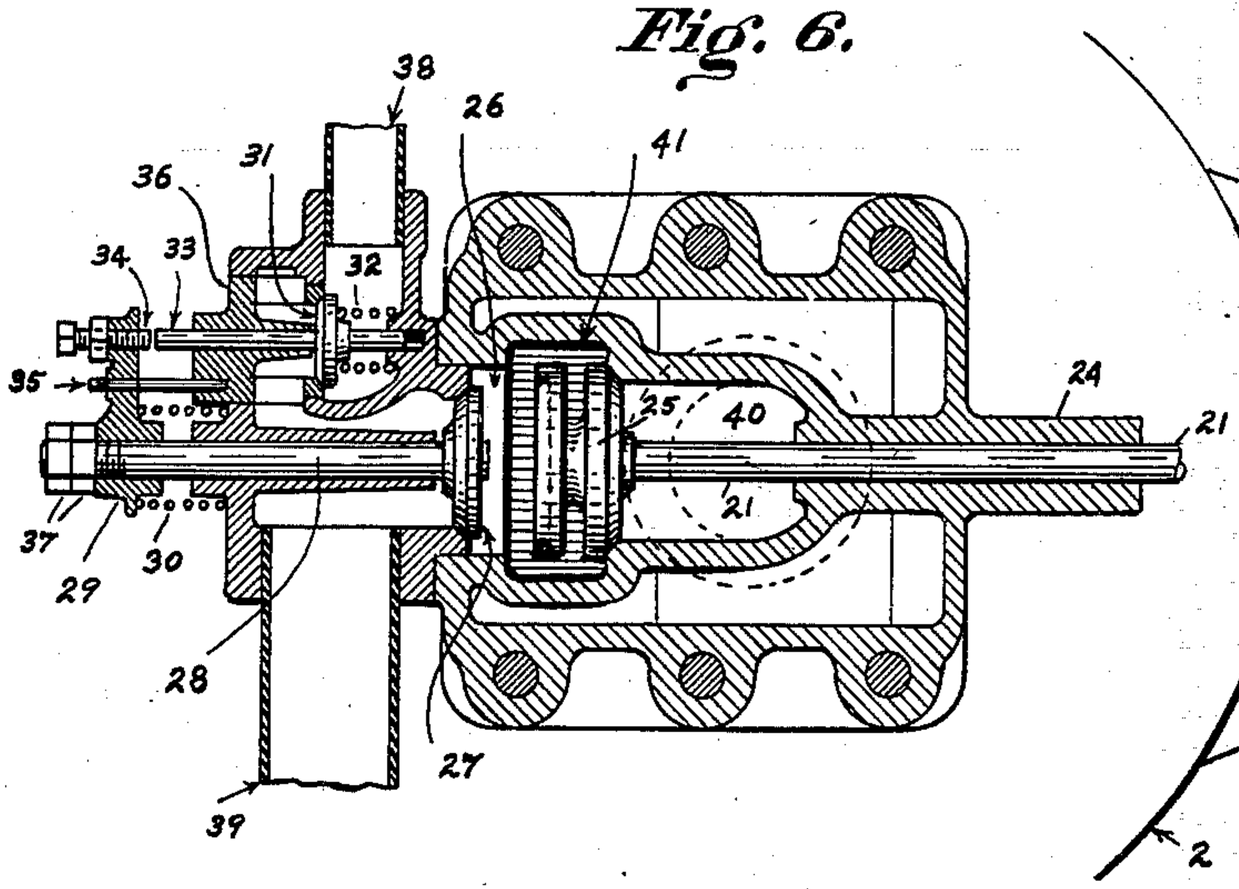


Fig. 7.

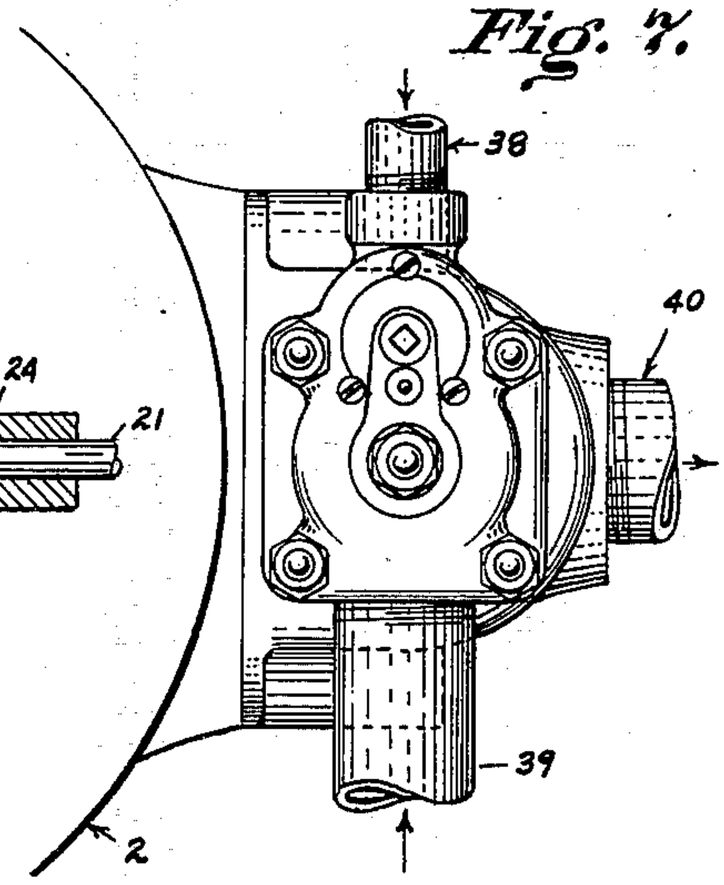
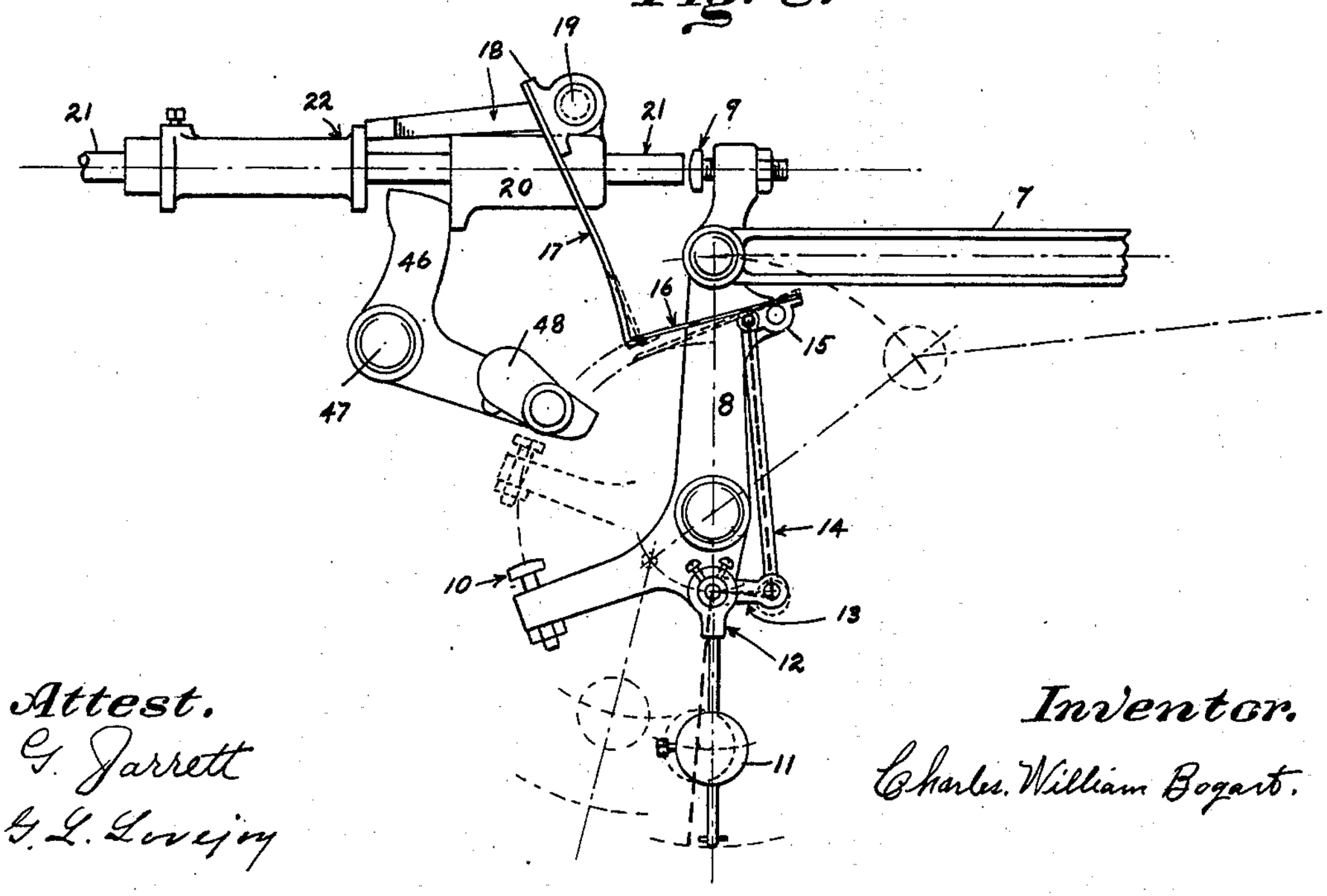


Fig. 8.



Attest.
G. Jarrett
G. L. Lovejoy

Inventor.
Charles William Bogart.

UNITED STATES PATENT OFFICE.

CHARLES WILLIAM BOGART, OF BUFFALO, NEW YORK.

GAS-ENGINE.

SPECIFICATION forming part of Letters Patent No. 628,518, dated July 11, 1899.

Application filed January 5, 1899. Serial No. 701,216. (No model.)

To all whom it may concern:

Be it known that I, CHARLES WILLIAM BOGART, a citizen of the United States, and a resident of the city of Buffalo, in the county of Erie and State of New York, have invented certain new and useful Improvements in Gas-Engines, of which the following is a specification.

My invention relates to that type of gas-engines operated upon the well-known "Otto" cycle and wherein a charge of gas and air is drawn into the cylinder upon the first outward stroke of the piston, compressed by the first inward stroke, ignited and exploded on the second outward stroke, and exhausted on the second inward stroke.

The objects of my improvement are to provide an efficient engine for service in the oil country and elsewhere that will make long runs with least possible care and attention, to provide such form of construction and assemblage of parts as will sustain the severe duty and bear the rough usage to which it may be subjected, to obtain the greatest steadiness in running, to prevent the speed from exceeding a predetermined limit, and to provide inexpensive mechanism that is readily accessible, quickly and easily adjusted to compensate for the usual wear and tear, and that will maintain itself in adjusted position. These objects are attained in the following-described manner, as illustrated in the accompanying drawings, in which—

Figure 1 is a side elevation of an engine embodying my improvements, showing the valves and part of the cylinder in section with other parts of the valve-gear and governing mechanism in outline. The parts are shown in the position that they will assume after the piston has been impelled outward and just previous to its return to make the exhaust-stroke. Fig. 2 is a diagram showing the position of the valve and governing mechanism when the crank has half-completed its exhaust-stroke. Fig. 3 shows the position of the valve and governing mechanism when the crank has half-completed the inlet-stroke. Fig. 4 shows all the parts in the same position as in Fig. 2, except that the engine has reached a speed where the governor swings in position to prevent the exhaust-valve from seating and the inlet-valve from opening. Fig. 5 shows the position of the same parts when the crank has half-completed the compression-stroke. Fig. 6 is a longitudinal vertical section through the center of the exhaust-valve, air-valve, and gas-valve. Fig. 7 is an end view of the parts shown in section in Fig. 6 and shows the relative position of the valve-casings to the cylinder. Fig. 8 is a diagram which shows the action of the pendulum-governor and how it is affected by a change of speed of the engine.

In the drawings, 1 represents a bed-plate to which the water-jacketed cylinder 2 is suitably secured. Crank-shaft 3 revolves in appropriate bearings on the bed-plate, and the wrist-pin of said crank-shaft turns in the direction of the arrow shown at 4. The crank-shaft 3 carries a spur-gear 5, meshing with a second spur-gear 6. Connecting-rod 7, reciprocated by gear 6, oscillates lever 8. The upper extremity of the lever 8 carries an adjustable push-screw 9, and another push-screw 10 is suitably secured in its lower left-hand extension. Swinging pendulum 11 carries adjustable arm 13 and depends from stud 12 at the lower end of and below the pivotal point of lever 8. Connecting-link 14 transmits the oscillation or swinging motion of the pendulum 11 to finger 16, which finger is pivoted at 15 to said lever 8. Flexible or yielding tongue or blade 17 is rigidly attached to latch 18. Said latch is pivotally attached to stud 19 on boss 20, that projects from the side of the cylinder.

Valve-stem 21 slides freely in boss 20 and carries spring-stop 22. The valve-stem and spring-stop are impelled in the direction of the boss 20 by the action of spring 23. One end of this spring rests upon the extension of the valve-casing 24. The other end is carried by an extension of the spring-stop 22, as shown. Valve-head 25, carried by valve-stem 21, Fig. 6, seats against the sides of an opening which forms the outlet for the exhaust-port 41 and is held normally closed and against its seat by the action of spring 23. Cast integral with this valve-head 25 is a disk which is made a working fit in the opening 26. Main inlet-valve 27 is carried by valve-stem 28, which works freely through an opening in a support or guide formed by an inward extension of part of the inlet-valve

casing. Trip or tappet 29 is carried by the valve-stem 28 and is held against spring 30 by two jam-nuts 37. The action of spring 30 holds the inlet-valve 27 normally closed. Gas-valve 31 is carried by valve-stem 33 and is held normally closed by the action of spring 32. Screw 34 is threaded into trip 29 and secured in adjustment by a jam-nut, as shown in Fig. 6, or by other suitable means. Guide-pin 35, rigidly attached to the gas-valve casing 36, keeps screw 34 at all times in line with the gas-valve stem 33 and prevents the trip from turning around on the valve-stem 28. Gas-supply pipe 38 and air-pipe 39 both enter the inlet-valve casing, as shown in Figs. 1 and 6. Passage 40 communicates with the main port 41 to permit the escape of the exhaust-gases when the valve-head 25 is open.

Supplementary exhaust-pipe 42 leads outwardly from a supplementary exhaust-port 43, formed in cylinder 2 at a point just in the rear of piston 45, upon its completion of an outward stroke. Igniter 44 is located on the top of the rear portion of cylinder 2. No details of the igniter are shown, as any approved form of tube-igniter may be used. Piston 45 when nearing the extremity of its outward stroke uncovers port 43 for the escape through exhaust-pipe 42 of the terminal pressure of the explosion-stroke, thereby relieving the pressure on the head of valve 25. Bell-crank lever 46 is pivoted to the bed-plate at 47 and rests by its own gravity against a stop formed under the left-hand end of boss 20. The lower right-hand extension of lever 46 is provided with a button 48, that is arranged to rest normally as shown in Figs. 1 and 8 and which may be turned, as shown in Fig. 5, to engage push-screw 10.

In the adjustment of the parts and in practice the spring-stop 22 is secured on the rod 21 in the proper position for the action of spring 23 to hold valve 25 snugly against its seat and at the same time to provide a clearance between the faces of spring-stop 22 and lever 46 after the lever 8 is withdrawn from contact with rod 21, as shown in Figs. 3 and 5. Lever 46 should have some "shake" when idle, and valve 25 should be snugly seated. The seat should act as a stop to the movement of the valve and its stem and to the members attached to the stem.

When it is desired to start the engine, sufficient gas is turned into pipe 38 through a stop-cock, (not shown,) and button 48 is thrown into the position shown in Fig. 5. The fly-wheel of the engine may now be turned in the proper direction by hand or by other suitable means. At the beginning of the suction-stroke, which occupies one-half of the revolution of the crank, the piston 45 will be at that end of cylinder 2 nearest the port 41, and at the end of the suction-stroke the crank will have reached the position shown in Fig. 1 and piston 45 will have drawn into the cylinder an explosive mixture through the inlet-valve 27. In this position of the crank the other parts of the valve-gear, as well as the valves, are illustrated in Fig. 3. It will be noticed that the inlet-valve in this case is open. The next half-turn of the crank 4 brings the parts in position, as shown in Fig. 5. This is the compression-stroke, and without some means of allowing some of the compressed gases to escape it would be difficult to turn the wheel to the completion of this stroke. To facilitate the turning of the wheel through this compression-stroke, I allow a small portion of the gases to escape by giving the exhaust-valve a slight lift from its seat. This is accomplished by the movement of the lever 8 and connecting-rod 7 causing push-screw 10 to engage with button 48 and actuate bell-crank lever 46 against the spring-top 22 and valve-stem 21, which lifts the exhaust-valve, as shown in Fig. 5. Near the end of the compression-stroke and before the crank reaches the inner dead-center the movement of gear 6, connecting-rod 7, and lever 8 will cause push-screw 10 to recede from the end of button 48. This permits the action of spring 23 to close the valve and at such a time as to retain only sufficient compression to start the engine. The explosion now takes place by the compressed gases being driven into the igniter 44. The next half-turn of the crank outward brings all the parts in the position shown in Fig. 1. The exhaust now takes place, for the reason that the movement of gear 6, connecting-rod 7, and lever 8 causes push-screw 9 to engage with the end of rod 21 to open valve 25. In the meantime the button 48 should be thrown by the operator in the position shown in Fig. 2 and where it will be out of the reach of and will not make contact with push-screw 10.

It will be noticed in Fig. 2 that the pendulum hangs vertically, which causes the finger 16 to engage the yielding tongue 17 and raise the latch 18 in opposition to its own weight or gravity. When the exhaust-stroke is completed, latch 18 allows the exhaust-valve to close as push-screw 9 recedes, because latch 18 has been lifted by the contact of finger 16 with yielding tongue 17 before the push-screw 9 touched rod 21. After lever 8 is withdrawn from rod 21 and spring-stop 22 has reached its normal resting-place latch 18 will rest on said stop, as shown in Fig. 3. The parts are now in the position shown in Fig. 3, and the crank traveling in the direction indicated by the arrow is midway of the inlet-stroke. It will be noticed in Fig. 3 that the inlet-valve is now being drawn open. By this time the engine is impelled by the momentum, as the result of the previous power-stroke, of the fly-wheel and is turning at the rate of speed sufficient to vibrate the pendulum. Up to and including Fig. 3 the engine is supposed to be running nearly up to its normal speed. In Fig. 4 the speed of the engine has exceeded its normal or predetermined limit and causes the lever 8 to oscillate faster than the natural oscillation of the pendulum. The point

of suspension of the pendulum always reaches the vertical line at the instant that push-screw 9 comes in contact with rod 21; but the natural vibration of the pendulum in this instance has not allowed it to return at the same instant to the vertical as was shown in Fig. 2. Its tardiness in reaching this vertical line causes the finger 16 to swing clear of the tongue 17 and permit latch 18 to fall by gravity into engagement with stop 22 and intercept the closing movement of the exhaust-valve, as shown in Fig. 4.

Referring to Fig. 8, the speed of the engine is now assumed to have fallen below the normal, in which case the time of the oscillation of lever 8 coincides with and equals the time of oscillation of the pendulum, and when the pendulum and its point of suspension on lever 8 both reach the vertical line at the same instant the finger 16 will have engaged the tongue 17, as shown, and before push-screw 9 engages rod 21. It is obvious that as tongue 17 is flexible or yielding it is by the action of finger 16 laid under tension; but the latch 18 cannot rise on account of the opposing tension of the spring 23. As soon as push-screw 9 engages rod 21 the tension of spring 23 will be taken from the latch 18, and the said latch will be lifted to the position shown in Fig. 2.

To regulate the speed of the engine, it is only necessary to lengthen or shorten the pendulum and thereby change the rate of its vibration. To speed the engine faster, it is only necessary to shorten the pendulum and its rate of vibration increases of its own accord, and as the lever 8 is rocked to and fro in the same ratio as the speed of the engine, pendulum 11, having been shortened, will reach the vertical line a greater number of times to the minute, and the finger 16 will engage tongue 17 oftener. Whenever finger 16 engages tongue 17 and raises latch 18, the exhaust-valve is allowed to close, and each and every time the exhaust-valve closes the next suction-stroke of the engine draws in a fresh charge of gas and air through the inlet-valve 27; but each and every time that finger 16 does not engage tongue 17 latch 18 will invariably fall to the position shown in Fig. 4 to arrest the movement of the valve-rod and spring-stop after the manner shown in Fig. 8.

Each and every time latch 18 arrests spring-stop 22 and latches the exhaust-valve open the disk which is a part of the exhaust-valve head 25 will be caused to remain in the passage 26. As long as the disk remains in this position it will be impossible for any fresh charge to be drawn into the cylinder through the inlet-valve 27. No fresh charge can enter the cylinder while the valve and disk remain in this position, as shown in Fig. 4. The engine is thus entirely relieved of the useless task of compressing the so-called "blank" charges, and the momentum previously stored in the fly-wheel may be utilized in performing more mechanical "work" than would otherwise be the case. In order to adjust the position of finger 16 in relation to tongue 17, arm 13 is adjustably fastened to the head of pendulum 11 by two small set-screws, as shown in Fig. 8, that the angle it forms with the pendulum may be changed.

In practice the disk or valve head 25 is made to fit the passage 26 freely to prevent wear and to provide for any expansion of the disk by the heat it receives from the high temperature of the exhaust-gases, that might cause it to stick in said opening 26 and prevent the action of spring 23 from closing valve-head 25. As the disk must fit the opening loosely, there will be at each suction-stroke of the engine a slight leakage around it. The inlet-valve 27 must be drawn from its seat in the inlet-valve casing only a slight distance for the passage of the small amount of air that necessarily leaks past the disk. As this leakage occurs at a time when I do not desire any gas to pass under the gas-valve 31, I provide the screw 34, which is carried by the piece 29 on the end of the inlet-valve rod 28. A small space is left between the end of said screw 34 and the gas-valve stem 33, as shown in Fig. 6. In practice this space is not absorbed by the slight movement of the inlet-valve 27 that is necessary for the passage of the small amount of air that will leak past the edge of the disk of the valve-head 25. This construction prevents any gas entering the cylinder until the pendulum causes the latch 18 to rise, and which takes place only when the speed of the engine falls below the normal and it is required to take a full explosive charge into the cylinder. In order to prevent the chattering of the inlet-valve 27 when the air is drawn past the disk, I provide a spring of such weak tension that it is only capable of overcoming the friction of the inlet-valve stem 28 in the opening through the guide in the inlet-valve casing, and whereby the slightest suction produced in the port of the engine will draw the valve clear off its seat. To prevent the chattering of the gas-valve, it is arranged to be opened by the movement of the inlet-valve 27 and against the action of the suction produced in the air-pipe 39 and whereby the inlet-valve becomes partially "balanced." While the inlet-valve is opened by suction, it in turn opens the gas-valve against a slight gas-pressure and against the pressure of the weak spring 32. The action of the gases tends to steady the two valves when the mechanical action of the inlet-valve is communicated to the gas-valve by means of the piece 29 and screw 34. One valve opposes the other, both oppose springs and the suction, and "mechanical" action serves to steady them.

It is important that the tongue 17 should be yielding, for otherwise the latch 18 would have to be withdrawn upwardly and away from the spring-stop 22, while it resists the severe tension of spring 23. It is obvious that this would throw an undue amount of

wear where the end of latch 18 engages spring-stop 22. By making the tongue flexible and yielding the finger 16 lays this yielding tongue under flexion until the pressure of spring 23 has been overcome by push-screw 9 impinging against rod 21. It will also be observed that by providing a yielding tongue instead of a rigid one I do not impose as severe duty upon the finger 16 and its pivot 15 as would otherwise be the case. It is highly essential that members 12, 13, 14, 15, and 16 be made as light as possible in order to be free and sensitive, for they are at all times under control and are constantly vibrated by the pendulum 11.

To maintain close regulation of the speed of the engine, the pendulum must at all times be free to assume the normal rate of vibration that corresponds to its length. It is also important that the push-screw 9 be adjustable in the upper extremity of lever 8 in order to adjust the time of opening and closing of the inlet-valve. It is obvious from Fig. 8 that the push-screw 10 be also made adjustable to regulate the amount of compression to be released from the engine and to insure uniform results in starting the engine.

The lever 8 of course is always caused to rock or oscillate through a fixed arc. One of its extreme positions is shown in Fig. 8 by dotted lines immediately below the button 48 on bell-crank lever 46. Said button is shown in the raised position to avoid contact with push-screw 10, that no motion will be imparted to lever 46. When button 48 is turned down in the position shown in Fig. 5, lever 46 will receive as much of the motion of rocking lever 8 as the adjustment of push-screw 10 therein may predetermine.

In whatever position the parts may come to a state of rest while the engine is being turned slowly by hand or otherwise the pendulum will by gravitation hang "plumb" or vertically from its point of suspension at 12. As the point of suspension from which the pendulum depends describes a fixed arc, an increase in the speed of the engine causes the pendulum to assume an independent movement of its own, its speed depending always upon its length. It will be seen that as the distance moved by the pendulum is in proportion or bears a certain ratio to the radial velocity of the arc of suspension its time of coincidence with the vertical line through lever 8 will remain constant as long as the radial velocity of the angle of oscillation of lever 8 coincides with the "beat" or swing of the pendulum. In other words, the time of the vibration of the pendulum is constant for a given length, and until the time of oscillation of lever 8 is slower than the swing of the pendulum the finger 16 will engage tongue 17. When the time of oscillation of lever 8 becomes quicker than the swing of the pendulum, the lever 8 reaches the vertical ahead of the pendulum, and this difference causes the center line of lever 8 to form an angle with the line of pendulum 11, which angle determines whether or not the valve is allowed to close and cause the engine to take another charge or whether the valve is prevented from closing and thereby prevents the admission of gas and air through inlet-valve 27.

Having fully described my improvement, what I claim as my invention, and desire to sscure by Letters Patent of the United States, is—

1. The combination with an exhaust-valve closed by the action of a spring, an oscillatory lever arranged to open the valve and a latch to hold the valve open, of a movable finger carried by the lever and controlled by a governor to open the latch and permit the valve to close.

2. The combination with an exhaust-valve provided with a movable stem a stop carried by the stem and a spring arranged to close the valve of an oscillatory lever adapted to intermittently impinge against the stem and open the valve of a latch adapted to detachably engage with the stop to prevent the valve from being closed and means actuated by the lever and controlled by a governor to occasionally disengage the latch from the stop and permit the valve to close.

3. The combination with an exhaust-valve an oscillatory lever arranged to intermittently open the valve, of a latch to hold the valve in the open position, a flexible tongue on the latch and a finger carried by the lever and directed by a governor against the tongue to disengage the latch and permit the valve to close.

4. The combination with an exhaust-valve, an oscillatory lever adapted to open the valve and a latch to hold the valve open of a movable finger carried by the lever and pendulum mechanism also carried by the lever to control the movement of the finger to occasionally engage with and open the latch.

5. The combination with a lever and means to oscillate the lever in time with the engine of an exhaust-valve opened by the lever, a latch to hold the valve open, a finger carried by the lever and a pendulum depending from the lever and arranged to actuate the finger to disengage the latch and permit the exhaust-valve to close.

6. The combination with a lever arranged to oscillate in time with an engine, and a pendulum carried by the lever and arranged to swing independently thereof in time proportioned to its length of a finger mounted on the lever and moved by the pendulum into engagement with valve-controlling mechanism whereby the retardation in the movement of the lever in relation to the uniform swing of the pendulum causes a charge to be admitted to the engine.

7. The combination with a lever, means to oscillate the lever in time with the variable speed of an engine, of a pendulum depending from the lever and arranged to swing inde-

pendently thereof and in uniform time proportioned to its length and valve-controlling mechanism actuated by the pendulum only when the oscillation of the lever differs in time from the swinging of the pendulum in uniform time.

8. The combination, an exhaust-valve carried by a stem, a stop on the stem, a lever pivotally mounted at a fixed point, means to oscillate the lever in variable time with the speed of an engine, an adjustable push-screw carried by the lever to intermittently engage with the end of the stem and open the valve, a gravity-latch provided with a flexible tongue and adapted to engage with the stop, a finger carried by the lever into contact with the tongue to disengage the latch from the stop and a pendulum mechanism mounted on the lever and arranged to move the finger in position to engage with the tongue only when the oscillation of the lever becomes slower than the swing of the pendulum.

9. The combination with a lever arranged to be oscillated by and in time with the variable speed of an engine, of an adjustable pendulum mechanism carried by the lever and arranged to swing independently of the lever and at a uniform velocity proportionate with the length of the pendulum and a valve mechanism controlled by the lever and pendulum mechanism in a manner to regulate movements of the engine to synchronize with the swing of the pendulum.

10. The combination with a lever pivoted at a fixed point and oscillated in a vertical plane by an engine, a finger movably secured to the lever above the fixed point, of a pendulum depending from a pivot on the lever below the said fixed point, an arm carried by the pendulum and adjustable in different angles thereto and a rod connecting the arm with the finger, whereby the position of the pendulum in relation to the lever controls the position of the finger.

11. The combination with a bell-crank arranged to partially open an exhaust-valve a lever formed with a projecting arm and oscillated in time with the movements of an engine an adjusting-screw in said arm and a button movable on the bell-crank in and out of position to be engaged by the screw as desired.

12. The combination with an exhaust-valve and an inlet-valve each being arranged to open toward the other, and in the same line of an inlet-valve chamber and a disk carried by the exhaust-valve and adapted to close the inlet-valve chamber when the exhaust-valve opens.

13. The combination with an exhaust-valve and an inlet-valve each being arranged to open toward the other and in the same line, of an inlet-valve chamber a disk carried by the exhaust-valve and arranged to close the inlet-valve chamber when the exhaust-valve opens and a gravity-latch mechanism to hold the exhaust-valve open.

14. The combination with an exhaust-valve and an inlet-valve each being arranged to open toward the other and in the same line of a passage leading from the inlet-valve to the main port and means carried by the exhaust-valve to close the passage when the exhaust-valve is open.

15. The combination with an exhaust-valve closed by a spring, an oscillatory lever arranged to open the valve and pendulum mechanism arranged to control the time of closing the valve of a mixing-chamber, a gas-valve leading therein, an inlet-valve leading from the chamber to an inlet-port, springs arranged to close the gas and inlet valves and means actuated by the inlet-valve to open the gas-valve only after the initial opening movement of the inlet-valve has transpired.

16. The combination with an exhaust-valve provided with a stem and closed by the action of a spring and a stop on the stem of a latch pivoted at a fixed point and adapted to engage with the stop to hold the valve open, a pendulum arranged to swing in uniform time and hit-and-miss mechanism controlled thereby and adapted to open the latch and permit the valve to close.

17. The combination with an exhaust-valve closed by the action of a spring, a stop carried by the valve and a gravity-latch adapted to engage with the stop and hold the valve open of a flexible tongue on the latch an oscillatory lever a movable finger thereon and pendulum mechanism attached to the lever and adapted to control the position of the finger, in relation to the tongue to disengage the latch from the stop.

18. The combination with a lever pivoted at a fixed point and oscillated by the movement of an engine, an exhaust-valve intermittently opened by the lever and closed by a spring and a latch adapted to engage with a stop and prevent the valve from being closed of a pendulum-controlled mechanism carried by the lever to engage with the latch and release the valve.

19. The combination with an inlet-valve, a gas-valve actuated thereby, a supplementary exhaust-port opened by the piston in terminating its stroke of an exhaust-valve, a lever adapted to open said valve and pendulum mechanism carried by the lever and arranged to control the time of closing the exhaust-valve according to the predetermined relative position of the lever to the pendulum.

CHARLES WILLIAM BOGART.

Witnesses:
WM. BENNET WRIGHT,
MEREDITH POTTER.