No. 863,838. PATENTED AUG. 20, 1907.

J. G. ENNIS.

GAS ENGINE.

APPLICATION FILED DEC. 31, 1906.

3 SHEETS—SHEET 1.

Fig 1.

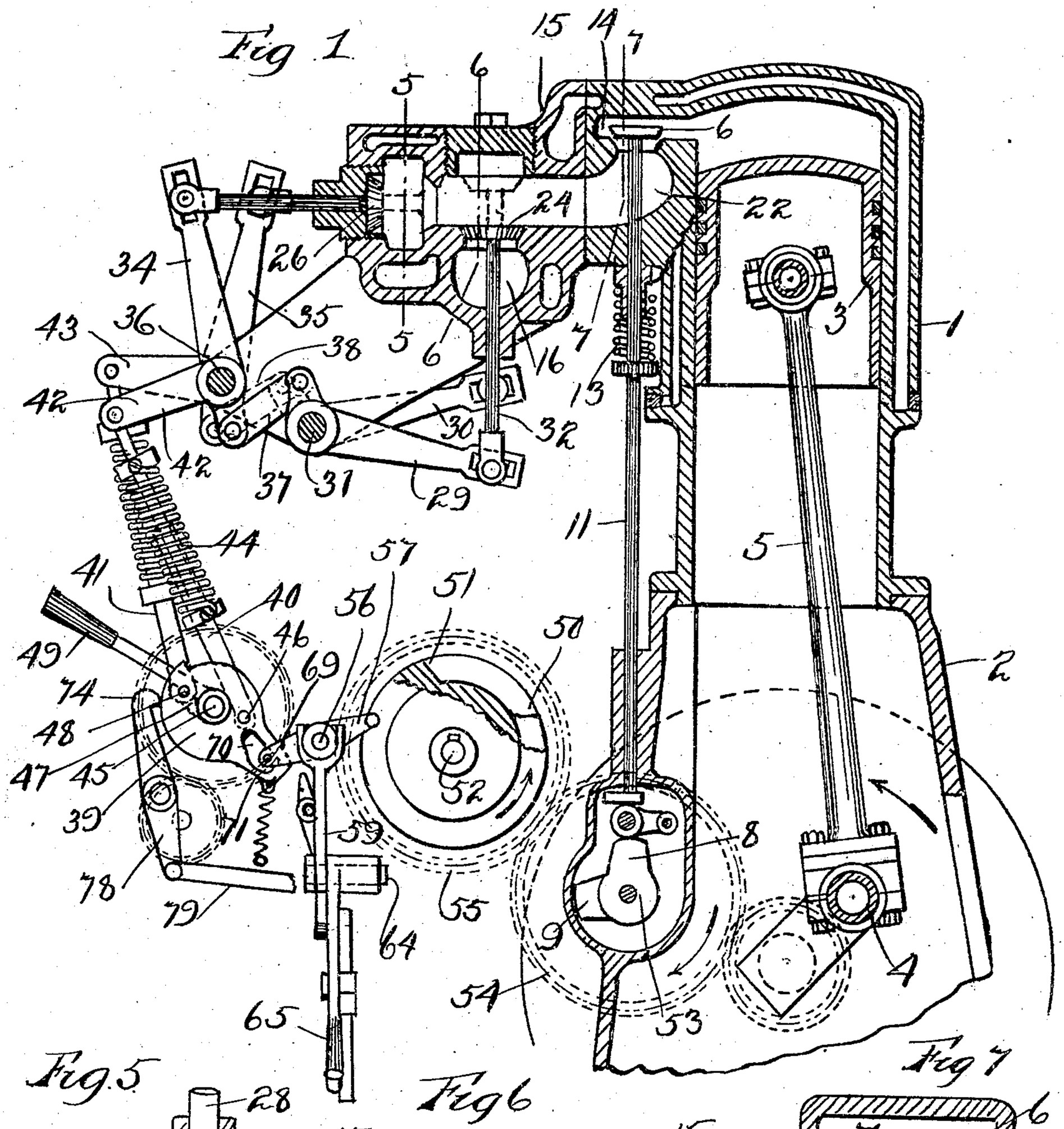


Fig. 5

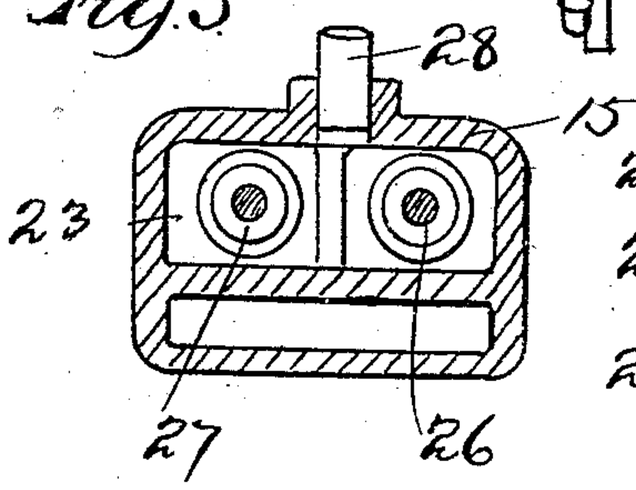


Fig 6

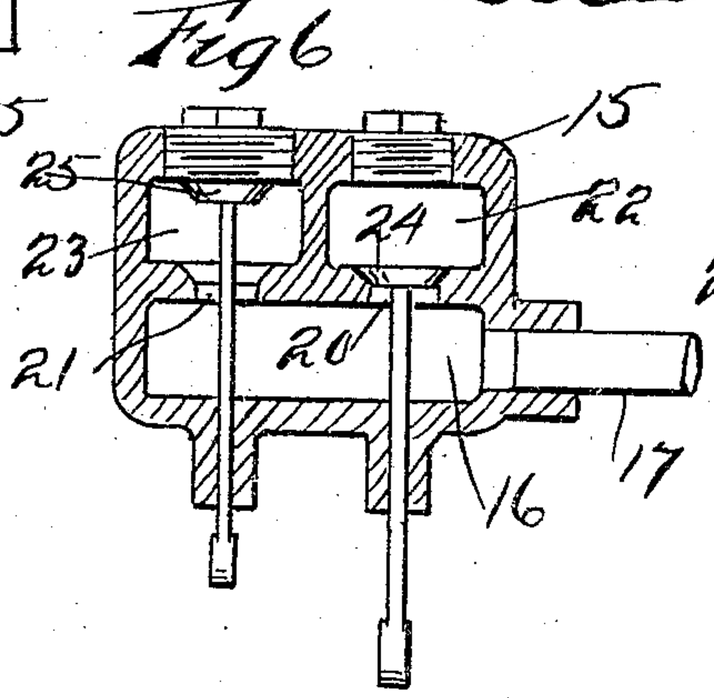
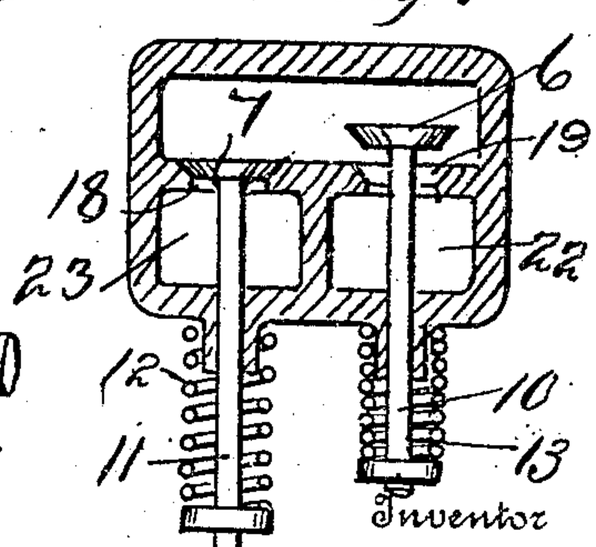


Fig 7



Witnesses
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3 SHEETS—SHEET 2.

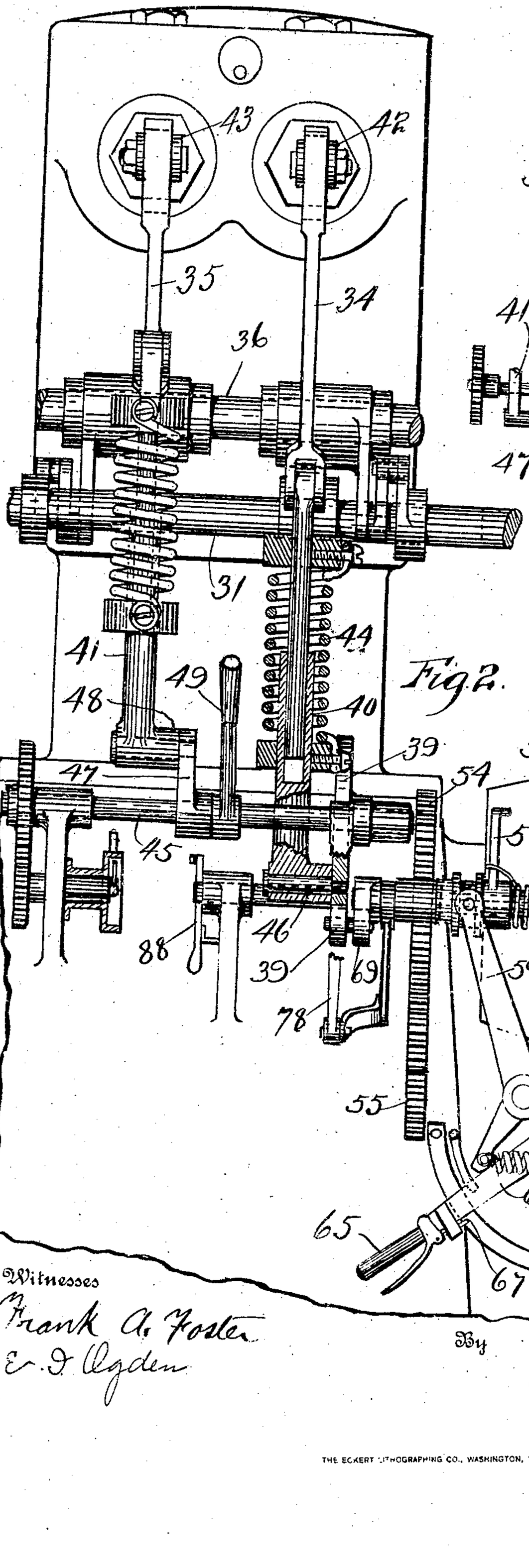

Fig. 2.

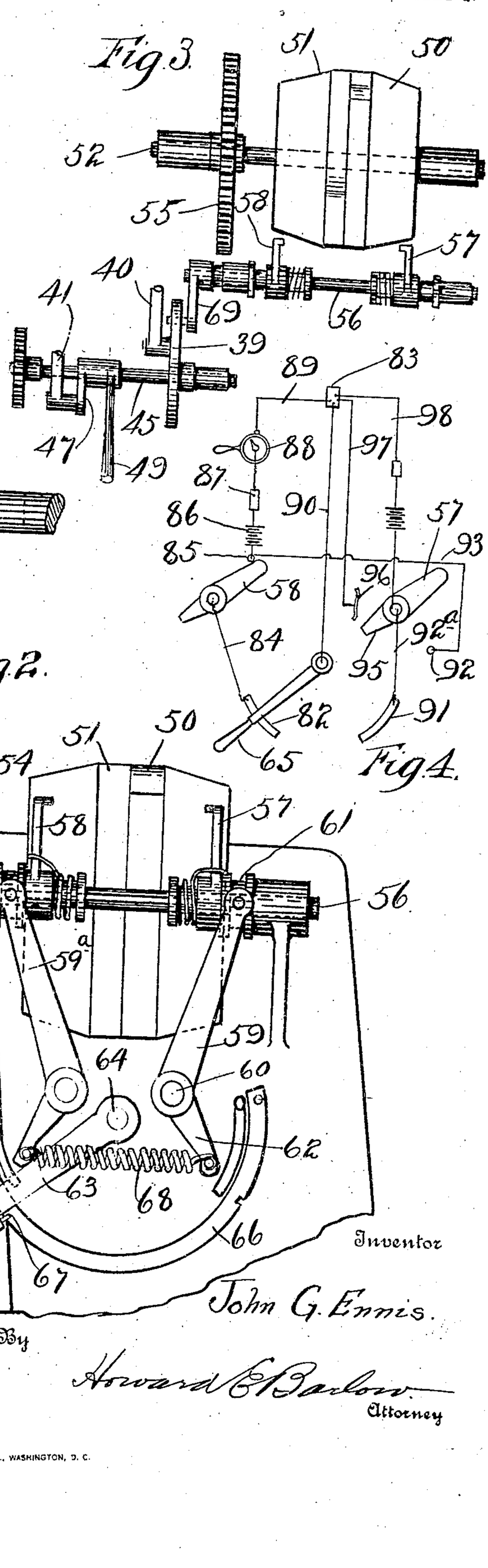

Fig. 3.

Fig. 4.

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3 SHEETS—SHEET 3.

Fig 8.

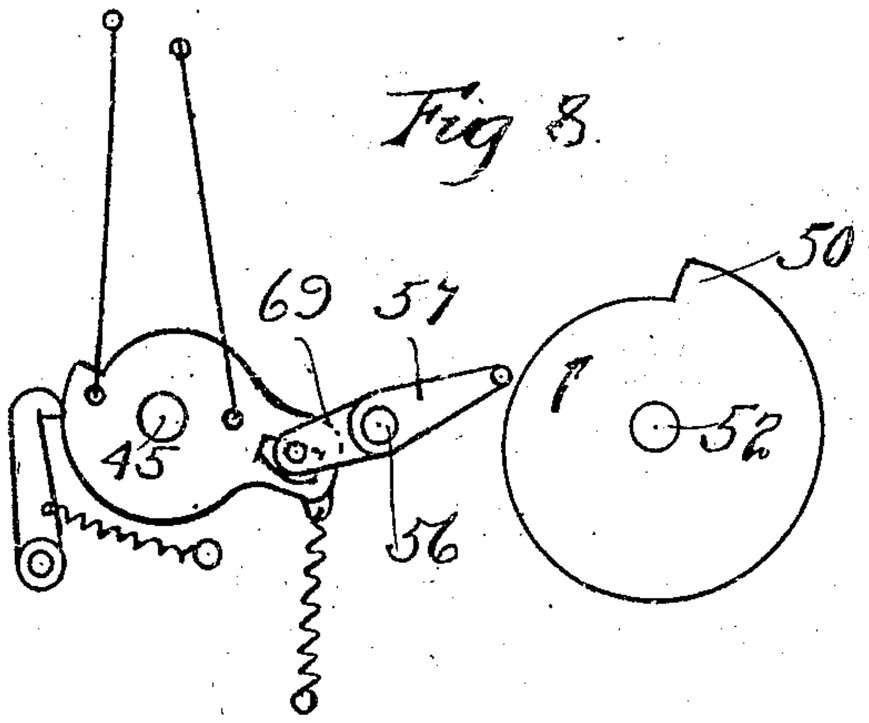


Fig. 11.

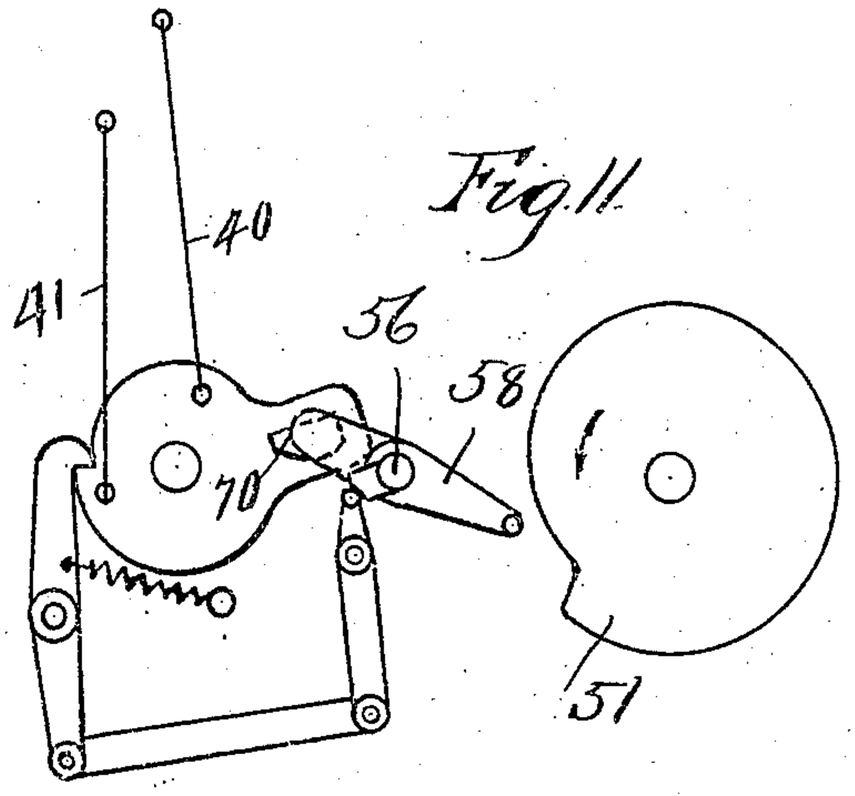


Fig 9.

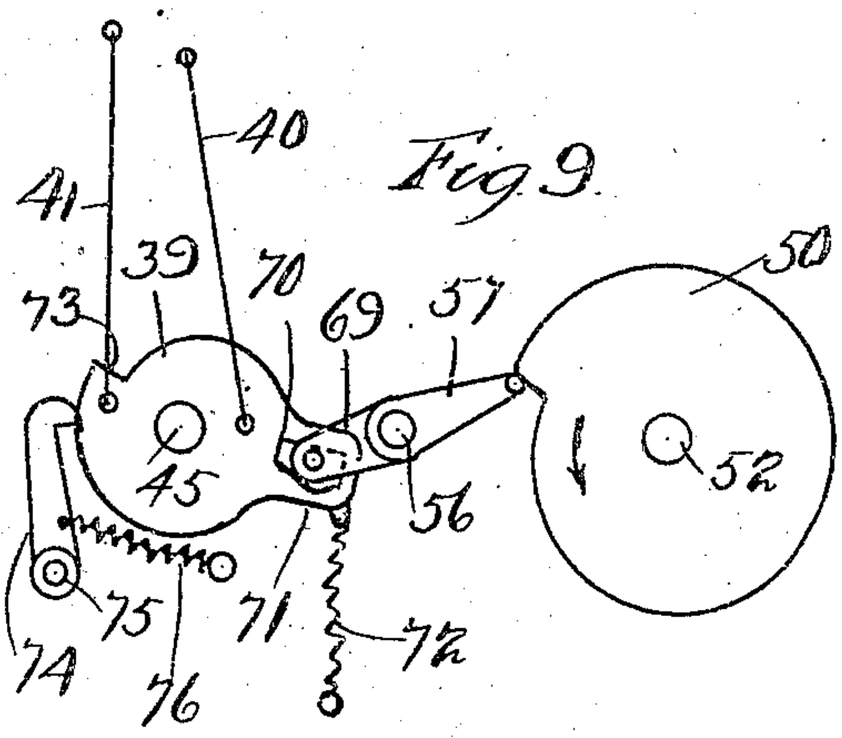


Fig 12.

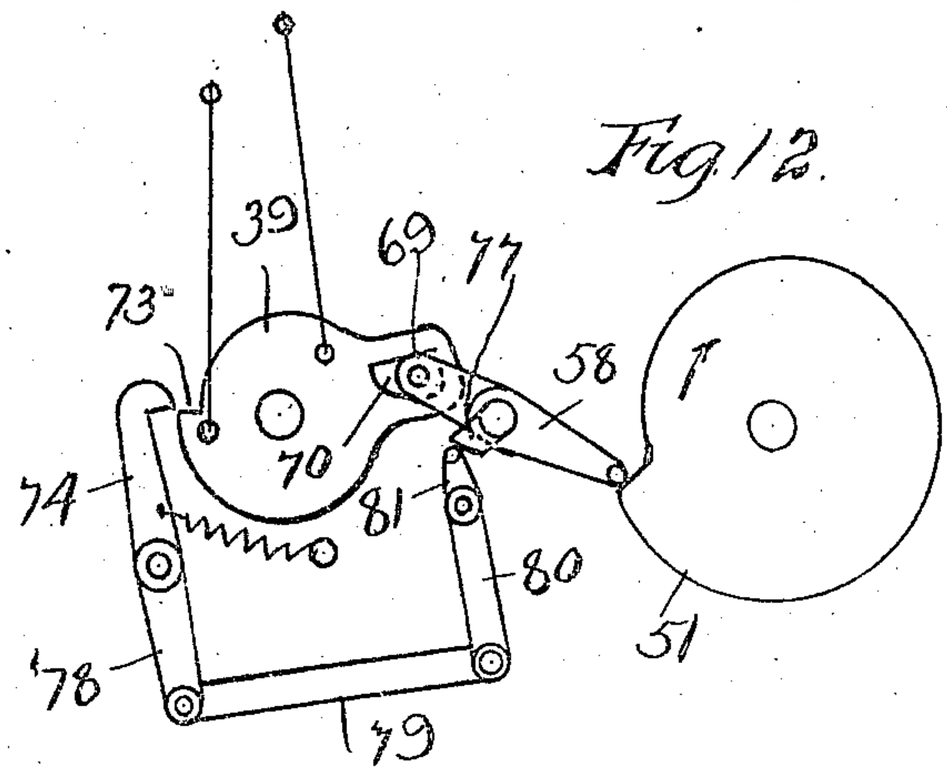


Fig 10

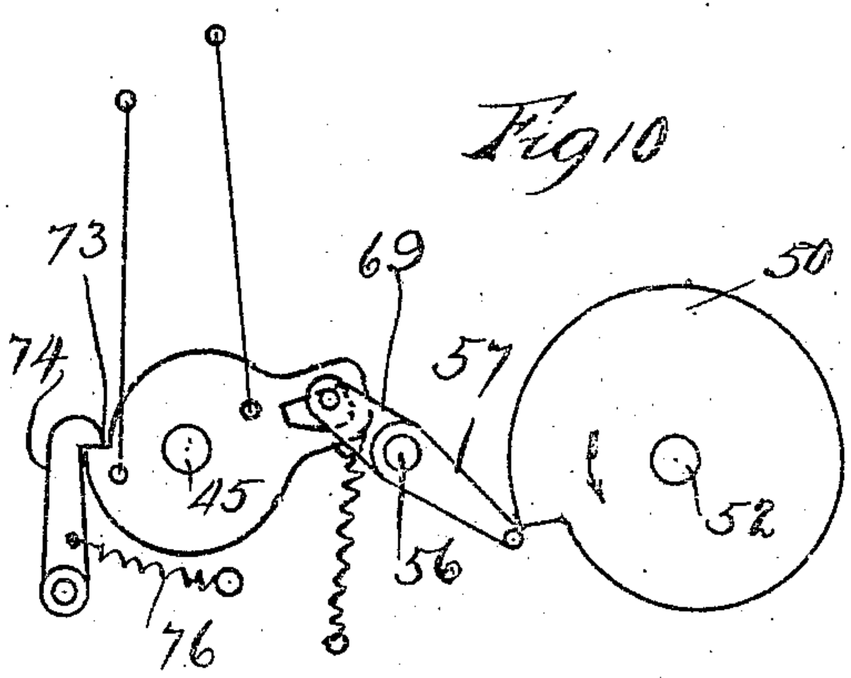
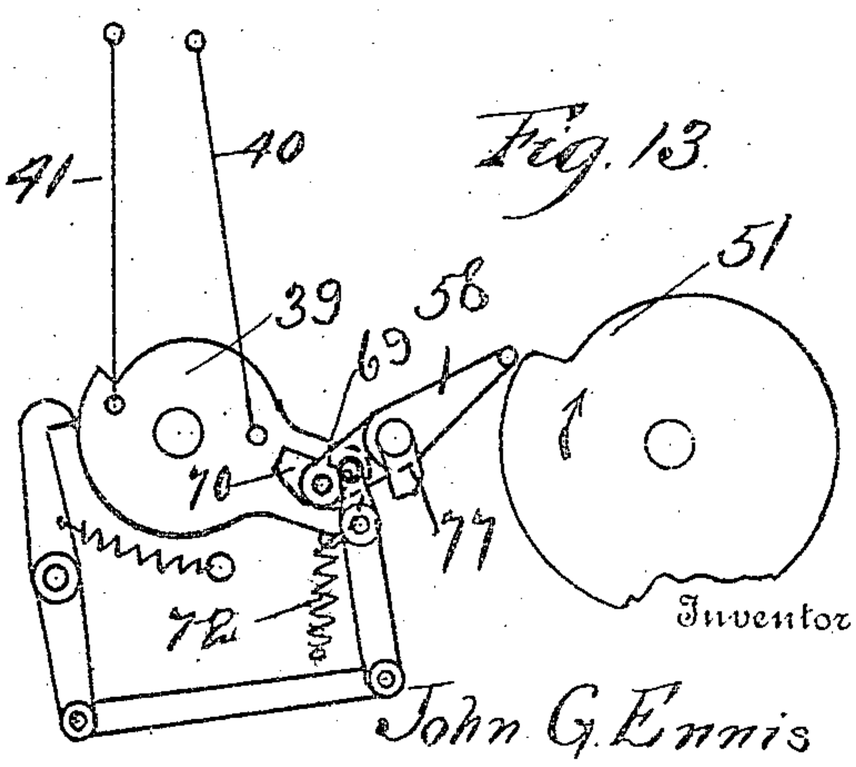


Fig. 13.



Witnesses

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GAS-ENGINE.

No. 863,838. Specification of Letters Patent. Patented Aug. 20, 1907.

Application filed December 31, 1906. Serial No. 350,197.

To all whom it may concern:

Be it known that I, JOHN G. ENNIS, a citizen of the United States, residing at Apponaug, in the town of Warwick, in the county of Kent and State of Rhode Island, have invented certain new and useful Improvements in Gas-Engines, of which the following is a specification, reference being had therein to the accompanying drawing.

This invention relates to a reversing apparatus for engines, and has for its object to provide a set of auxiliary valves to be attached to an explosive engine whereby the flow of gases through its valves into and out of the cylinder may be reversed at a predetermined point in the stroke either by hand or automatically and so reverse the running direction of the engine.

The ordinary gas engine, particularly of the marine and automobile type, are usually arranged to run always in one direction and when a reverse action is required it is necessary to reverse the rotation of the power transmitting shaft, which may be accomplished in different ways, but usually through the medium of gears. The reversing of the engine's action by means of gears has many objections, among others in high powered engines the reversing mechanism is of great weight, is very expensive to construct and maintain and its action cannot be depended upon. My improved mechanism obviates all of these well known objections and provides a simple device easy to manipulate and effective in its operation whereby the gas engine may be started to run either forward or backward or stopped and reversed while running in either direction, similar in its action in this respect, to an ordinary reversing steam engine

It is well known by those skilled in the art pertaining to explosive engines that when the igniting device is shut off and the explosion ceases the engine stops after making one or more revolutions due to its momentum, but on the last upward stroke of the piston the cushioning of the gas or compression in the cylinder (as it is usually called) prevents the crank from going way over the center and starts it backward in the opposite direction for a short distance and by the use of my mechanism I utilize this recoil or backward stroke to operate the sparking device at the proper time to explode this compressed gas in the cylinder to drive the piston downward and run the engine in the opposite direction, at the same time operating the auxiliary valves automatically to supply and exhaust the gases at the proper time while running in this new direction.

The invention consists of other novel features as will be fully described hereinafter and then pointed out in the appended claims.

A practical embodiment of the invention is represented in the accompanying drawings, forming a part of this specification, in which similar characters of reference indicate corresponding parts in all the views.

In the drawings: Figure 1—is a side elevation of an explosive engine in section showing a set of auxiliary valves attached thereto with mechanism actuated by the motion of the engine to operate said auxiliary valves to reverse the flow of gases through the main valves by the recoil or backward stroke of the engine. Fig. 2—is a rear elevation of the reversing mechanism. Fig. 3—is a top view showing the relative position of the reversing cams and dogs. Fig. 4—shows a wiring diagram whereby the reverse action of the engine completes a circuit and ignites the charge in the cylinder at the proper time and independent of the regular sparking system, which latter system is subsequently adjusted to do the sparking in the usual way. Fig. 5—is a section on line 5—5 of Fig. 1 through the auxiliary exhaust chamber and showing the valves thereon. Fig. 6—is a section on line 6—6 of Fig. 1 through the auxiliary supply chamber showing the valves that control it. Fig. 7—is a section on line 7—7 of Fig. 1 through the main valve chamber showing both of the main valves. Fig. 8—is an outline of the reversing cam and wrist plate showing the operating lever in position to be engaged by said cam on its return stroke to actuate said plate and so reverse the position of the auxiliary valves. Fig. 9—shows said cam in the act of engaging the operating lever. Fig. 10—shows the position of the cam after having operated said lever and wrist plate. Fig. 11—illustrates the arrangement of the cam which is to operate the lever and wrist plate while the engine is moving in the reverse direction to that illustrated in Figs. 8, 9 and 10, also showing the wrist plate latch and the connections thereto. Fig. 12—shows said cam in the position just after engaging said operating lever having moved the same upward a short distance to first throw out of engagement the latch with the wrist plate. Fig. 13—represents a further upward movement of said cam whereby the wrist plate has been actuated through the operating lever and thrown into position to again reverse the auxiliary valves.

Referring to the drawings the cylinder 1 shown therein is of the ordinary water-cooled four-cycle type used in the ordinary explosive engine, the same being mounted on the base 2. The usual reciprocating piston 3 in said cylinder is connected to the crank pin 4 by the connecting rod 5. Both of the main valves 6 and 7 serve as alternate inlet and exhaust valves, depending upon the direction of rotation of the main shaft, and said valves are caused to be opened by means of the cams 8 and 9 through the stems 10 and 11 and are closed by the action of springs 12 and 13 in the usual way. Bolted to this main valve chamber 14 is the auxiliary valve chamber 15 which latter, as is shown in Fig. 6, is provided with a gas reservoir 16 supplied through the inlet pipe 17. The gas from this reservoir passes to the main valve ports 18 or 19 through the ports 20 or 21 and passageway 22 or 23, the said ports 20 and

21 being controlled by the valves 24 and 25 to admit the supply into one or the other of said passageways according to the direction in which the engine is to run. The outer ends of these passageways 22 and 23 are opened and closed alternately by the auxiliary exhaust valves 26 and 27 to permit the gas to escape from the then exhausting main valve and be conducted away through the exhaust pipe 28, the opposite valve at that time of course being closed to prevent the escape of the supplying gas which is being admitted through the opposite passageway. In order to operate all of these auxiliary valves at the right time with relation to each other the levers 29 and 30 are pivotally mounted on the pin 31 to operate the valves 24 and 25 through their respective stems and the valves 26 and 27 are also operated through the levers 34 and 35 which are pivotally mounted on the pin 36, levers 29 and 34 being connected together through the link 37 to operate the valves 24 and 26 in time with each other, one being opened while the other is being closed. A similar action takes place with valves 25 and 27 through the movement of their respective levers which are linked together at 38. In order that all four of these valves shall work in unison with each other they have been connected through the arm 42 and flexible rod 40 to the wrist plate 39 where it is pivoted at 46, the other pair being connected through the arm 43, connecting rod 41 and crank 47 to which crank it is pivoted at 48. The connections 40 and 41, as best shown in Fig. 2, are made in two parts one sliding within the other being flexibly joined together by means of the spring 44. As above stated both sets of these valves are connected to their respective levers and on opposite sides of the shaft 45. In order to manipulate these valves by hand to open and close them as desired at any point in the stroke of the cylinder, I have provided an operating handle 49 which is fixed to the shaft 45 and by throwing this either up or down each set of the auxiliary valves are operated in opposite directions to reverse the direction of the flow of the gases through the main valve into and out of the cylinder, and by igniting the charge at the proper time the motion of the engine may be reversed and continued in that direction.

It is found in practice that the operation of a reversing device by hand requires a quick action of the operator at exactly the proper point in the stroke of the piston which requires considerable skill to accomplish. In order to obviate this difficulty and insure the valves being operated and the igniting to take place at exactly the proper time I have provided an attachment by means of which said valves and sparking device will be actuated automatically by the action of the engine itself. In accomplishing this purpose a pair of cams 50 and 51 are rotatably mounted on the shaft 52 which shaft is caused to run in time with the cam shaft 53 by means of the gears 54 and 55. These cams are similar in construction one being set to operate when working in an opposite direction to that of the other, as illustrated in Figs. 8 to 13 inclusive.

Mounted on the shaft 56 are the two dogs 57 and 58. At 59 is a lever pivoted at 60, the upper end of said lever being adapted to engage a groove 61 in the hub of said dog. The lower end of said lever 62 extending downward beyond the said pivoting point.

A hand operating lever 63 is pivoted at 64 and adapted to be moved by the handle 65 to swing on the segment 66 and by the lock 67 be secured to said segment in any desired position thereon. Both of the dogs 57 and 58 are mounted to slide on said shaft 56 on a feather key and are held normally outward by means of spring 68 acting on the respective levers 59; 59ª, which are alike in both cases.

Mounted on and fixed to the shaft 56 is the lever 69 which is arranged to engage a slotted portion 70 in an outwardly extending portion 71 of the wrist plate 39 so arranged that when either of the dogs 57 or 58 are operated in either direction said wrist plate and the shaft 1, on which it is mounted will be rotated a portion of a revolution. The extension 71 of said plate being normally held in its down position by the tension of the spring 72. On the outer periphery of this plate is a notch 73 adapted to be engaged by the pawl 74 which is pivoted at 75 and is under tension of the spring 76, therefore when the cam 50 rotates in the direction of the arrow, indicated in Fig. 9, it engages the outer end of the dog 57 and throws the same downward into the position shown in Fig. 10 reversing the position of the wrist plate the notch 73 being engaged by the spring actuated pawl 74 to hold the same in that position.

When the valves are to be reversed the cam 51 is rotated in the direction of the arrow, as illustrated in Fig. 12, engaging the outer end of the dog 58, the first upward motion of which rotates the small cam 77 and causes the same to withdraw the latch 74 from its notch 73 through the levers 78, 79, 80 and 81. This first movement does not operate to rotate the wrist plate 39, on account of the play of the engaging pin in the slot 70, until after the cam 77 has withdrawn the latch 74 from its notch, after which the said wrist plate is thrown to the opposite position, as illustrated in Fig. 13, and retained by its spring 72.

The wiring of the device is best illustrated in Fig. 4. When the lever 65 is on the contact plate 82 the connection to the igniting plug 83 is made through wire 84, dog 58, (which is in contact with the pin 85), battery 86, spark coil 87, timer 88, and wire 89, and back to the pivoting point of the lever by wire 90. When it is desired to reverse the engine the lever 65 is thrown onto the contact plate 91, the action of which places the dog 57 in position to be carried down by the action of the engine on its backward stroke to engage the pin 92 and when this is done the circuit is completed through the wire 92ª, dog 57, wire 93 through the battery 86 and other mechanism shown by way of wire 89 to the plug 83. An essential feature of this wiring is the auxiliary sparking circuit which is operated by a finger 95 on the lever 57 coming into engagement with the contact 96 during the motion of said dog from its up to its down position or vice versa, thereby completing this separate and independent circuit to the plug 83 through the wires 97 and 98, and insuring the igniting of the charge as the piston starts to reverse the motion of the crank.

The operation of the device may be more fully described as follows: Let it be supposed that the engine is running to the left in the direction indicated by the arrow in Fig. 1, and when it is desired to reverse its direction and run to the right the lever 65 is carried way over to the right side of the segment 66 breaking the circuit and shutting off the sparking device,

engaging the lever 62 and throwing the dog 57 into position to be engaged by the cam 50 and said lever secured in that position. Owing to the momentum of the moving parts the engine will naturally continue one or more revolutions, but on the last upward stroke of the piston the compression prevents the crank from again going over the center and the recoil or rebound starts it back for a short distance in the opposite direction. This short backward stroke on account of the previous setting of the handle 65 causes the cam 50 to engage the dog 57 and throw the same downward into the position illustrated in Figs. 1 and 10 and at the moment of changing this dog the charge is ignited through the independent circuit and the piston driven downward, thus starting the engine to run in this reverse direction. After having received its first impulse its permanent circuit is completed by the engagement of the dog 57 with pin 92 and its connecting wires and the timing mechanism may then be adjusted to regulate the point of ignition as desired. When it is wanted to reverse the engine and to again run it to the left the handle is carried way over to the left of the segment and the operation of the parts as above described is reversed. To stop the engine completely the lever 65 is carried to a central position between the two levers. When the engine is at rest it may be started in either direction by first setting the handle in the required position and then starting in the usual way.

My improved reversing apparatus may be readily attached to and operated on any of the four-cycle engines now in the market. It is simple in its construction, occupies but very little space, is easily handled and is positive in its action. By the application of this device the gas engine may be as readily reversed as the steam engine.

I have shown a set of auxiliary valves adapted to control the direction of the flow of gases both into and out of the cylinder and have also shown one arrangement of mechanism by which said valves may be operated by hand, but I do not confine myself to the mechanism shown as these valves may be operated by hand in various ways. I have also shown one form of mechanism for automatically operating these auxiliary valves by the action of the engine, but my invention is not restricted to the construction shown or the arrangement of parts described, or to the various details thereof as the same may be modified or re-arranged in various particulars without departing from the spirit and scope of my invention, the broad feature of which being a set of auxiliary valves operated either by hand or automatically to reverse the engine, one practical embodiment of which has been herein illustrated and described without attempting to show all of the various forms and modifications in which my invention might be embodied.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent, is:

1. An explosive engine comprising a cylinder, a piston working therein, a crank shaft operated by said piston, valves for controlling the flow of explosive gases to said cylinder, means for reversing said valves and simultaneously igniting the gases in said cylinder, whereby said engine is caused to run in the opposite direction.

2. An explosive engine comprising a cylinder, a piston working therein, a crank shaft operated by said piston, valves for controlling the flow of explosive gases to said cylinder, means for causing the compression in said cylinder to start the crank shaft in a reverse direction, and means operated by the reverse movement of said crank shaft for reversing said valves and simultaneously igniting the gases in said cylinder.

3. An explosive engine comprising a cylinder, a piston working therein, a crank shaft operated by said piston, main valves acting alternately as supply and exhaust according to the direction of rotation of said crank shaft, auxiliary valves for controlling the flow of gases through said main valves, and means for reversing said auxiliary valves and simultaneously igniting the gases in said cylinder, whereby said crank shaft is rotated in the opposite direction.

4. An explosive engine comprising a cylinder, a piston working therein, a crank shaft operated by said piston, an auxiliary valve chamber having a gas reservoir, passageways leading from said reservoir to said cylinder, main valves controlling admission of gas to said cylinder, auxiliary valves controlling admission of gases from the reservoir to the passage ways, means for causing the compression in the cylinder to start said crank shaft in a reverse direction, and means operated by the reverse movement of said crank shaft for reversing said auxiliary valves and simultaneously igniting the gases in said cylinder.

5. An explosive engine comprising a cylinder, a piston working therein, a crank shaft operated by said piston, an auxiliary valve chamber having a gas reservoir, passageways leading from said reservoir to said cylinder, main valves controlling the admission of gas to said cylinder, auxiliary valves controlling admission of gases from the reservoir to the passage ways, auxiliary exhaust valves, means for causing the compression in the cylinder to start the crank shaft in a reverse direction, and means operated by the reverse movement of the crank shaft for reversing said auxiliary admission and exhaust valves, and simultaneously igniting the gases in said cylinder.

6. An explosive engine comprising a cylinder, a piston working therein, a crank shaft, valves for controlling the flow of gases to said cylinder, means for causing the compression in said cylinder to reverse said crank shaft, a wrist plate for operating said valves, and means operated by the reversal of said crank shaft for shifting said wrist plate to reverse said valves.

7. An explosive engine comprising a cylinder, a piston working therein, a crank shaft, valves for controlling the flow of gases to said cylinder, means for causing the compression in said cylinder to reverse said crank shaft, a wrist plate for operating said valves, and means operated by the reversal of said crank shaft for shifting said wrist plate to reverse said valves and simultaneously igniting the gases in said cylinder..

8. An explosive engine comprising a cylinder, a piston working therein, a crank shaft, valves for controlling the flow of gases to said cylinder, auxiliary valves for regulating the supply of gases, means for causing the compression in said cylinder to reverse said crank shaft, a wrist plate for operating said auxiliary valves, and means operated by the reversal of said crank shaft for shifting said wrist plate to reverse said auxiliary valves.

9. An explosive engine comprising a cylinder, a piston working therein, a crank shaft operated by said piston, main valves controlling the admission of gases to said cylinder, auxiliary supply and exhaust valves, means for causing the compression in said cylinder to reverse said crank shaft, a wrist plate for operating said auxiliary valves, and means operated by the reversal of said crank shaft for shifting said wrist plate to reverse said auxiliary valves.

10. An explosive engine comprising a cylinder, a piston working therein, a crank shaft operated by said piston, main valves controlling the admission of gases to said cylinder, auxiliary supply and exhaust valves, means for causing the compression in the cylinder to reverse the rotation of said crank shaft, a wrist plate for operating said auxiliary exhaust valves, connections between said auxiliary exhaust and supply valves, whereby they are operated in unison, and means operated by the reversal of said crank shaft for shifting said wrist plate.

11. An explosive engine comprising a cylinder, a piston working therein, a crank shaft operated by said piston, valves controlling the supply of gases, means for causing the compression in said cylinder to reverse the rotation of said crank shaft, a wrist plate for operating said valves, a cam operated by said crank shaft, means for rocking said wrist plate, means for causing the cam to actuate the wrist plate rocking means and simultaneously causing the compression in the cylinder to reverse said crank shaft.

12. An explosive engine comprising a cylinder, a piston working therein, a crank shaft operated by said piston, valves controlling the supply of gases, a wrist plate for operating said valves, a cam operated by said crank shaft and provided with oppositely disposed cam faces, a rock shaft for operating said wrist plate, arms on said rock shaft, means for shifting said arms to alternately engage one or the other of said cam faces and simultaneously causing the compression in the cylinder to reverse said crank shaft.

13. An explosive engine comprising a cylinder, a piston working therein, a crank shaft operated by said piston, valves controlling the supply of gases, a wrist plate for operating said valves, a cam operated by said crank shaft and provided with oppositely disposed cam faces, a rock shaft for operating said wrist plate, arms on said rock shaft, means for shifting said arms to alternately engage one or the other of said cam faces and simultaneously causing the compression in the cylinder to reverse said crank shaft, and means for simultaneously causing an explosion of the gases in said cylinder.

14. An explosive engine comprising a cylinder, a piston working therein, a crank shaft operated by said piston, valves controlling the supply of gases, a spring held wrist plate controlling said valves, means for causing the compression in the cylinder to reverse said crank shaft, means operated by the reversal of said crank shaft to shift said wrist plate, and means for temporarily locking said wrist plate.

15. An explosive engine comprising a cylinder, a piston working therein, a crank shaft operated by said piston, valves controlling the supply of gases, a spring held wrist plate controlling said valves, means for causing the compression in the cylinder to reverse said crank shaft, means operated by the reversal of said crank shaft to shift said wrist plate, means for temporarily locking said wrist plate, and means for automatically releasing said wrist plate when said crank shaft is again reversed.

16. An explosive engine comprising a cylinder, two main valves to said cylinder, a pair of auxiliary valves to each of said main valves, means for connecting both pairs of said auxiliary valves to work in unison a wrist plate connected to said auxiliary valves and a cam actuated by the recoil of the piston, and means operated by said cam for shifting said wrist plate to reverse the position of the said auxiliary valves and run the engine in the opposite direction.

17. An explosive engine comprising a cylinder, valves for controlling the inlet and outlet to said cylinder, a wrist plate a cam actuated by the recoil of the piston, and means operated by said cam for shifting said wrist plate to reverse the flow of gases through said valves and simultaneously explode gases in said cylinder to run the engine in the opposite direction.

18. An explosive engine comprising a cylinder, two main valves to said cylinder, a pair of auxiliary valves to each of said main valves, means for connecting both pairs of said auxiliary valves to work in unison, a cam adapted to operate while rotating in one direction, a cam adapted to operate while rotating in the opposite direction, and means whereby said cams may be caused by the recoil of the piston to ignite the charge in the cylinder reverse the position of the auxiliary valves and reverse the running of the engine while running in either direction.

19. An explosive engine comprising a cylinder, two valves to said cylinder, a pair of auxiliary valves to each of said main valves, means for connecting both pairs of said auxiliary valves to work in unison, a cam actuated by the recoil of the piston, a wrist plate for operating said auxiliary valves, a dog operated by said cam for shifting said wrist plate to reverse the positions of said auxiliary valves and means for moving said dog into and out of engagement with said cam.

20. The combination with an explosive engine provided with a crank shaft, of means for reversing the direction of rotation of said shaft, said means including two sparking circuits, a reversing lever electrically connected with both circuits, and means controlled by said lever for closing one of said circuits as the other is opened, whereby the ensuing explosion will drive said crank shaft in a reverse direction.

21. The combination with an explosive engine provided with a crank shaft, of means for reversing the direction of rotation of said shaft, said means including two sparking circuits, a lever electrically connected with both of said circuits, and automatically operated reversing means controlled by said lever for closing one circuit as the other is opened, whereby the ensuing explosion will drive the crank shaft in a reverse direction.

22. The combination with an explosive engine provided with a crank shaft, of means for reversing the direction of rotation of said shaft, said means including two main sparking circuits, a lever electrically connected with both of said circuits, means controlled by said lever for closing one of said circuits as the other is opened, and an auxiliary sparking circuit controlled by said lever for igniting the charge immediately after shifting said lever and while the main circuits are temporarily open, whereby said crank shaft is reversed.

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

JOHN G. ENNIS.

Witnesses:
HOWARD E. BARLOW,
E. I. OGDEN.