No. 772,160. PATENTED OCT. 11, 1904.

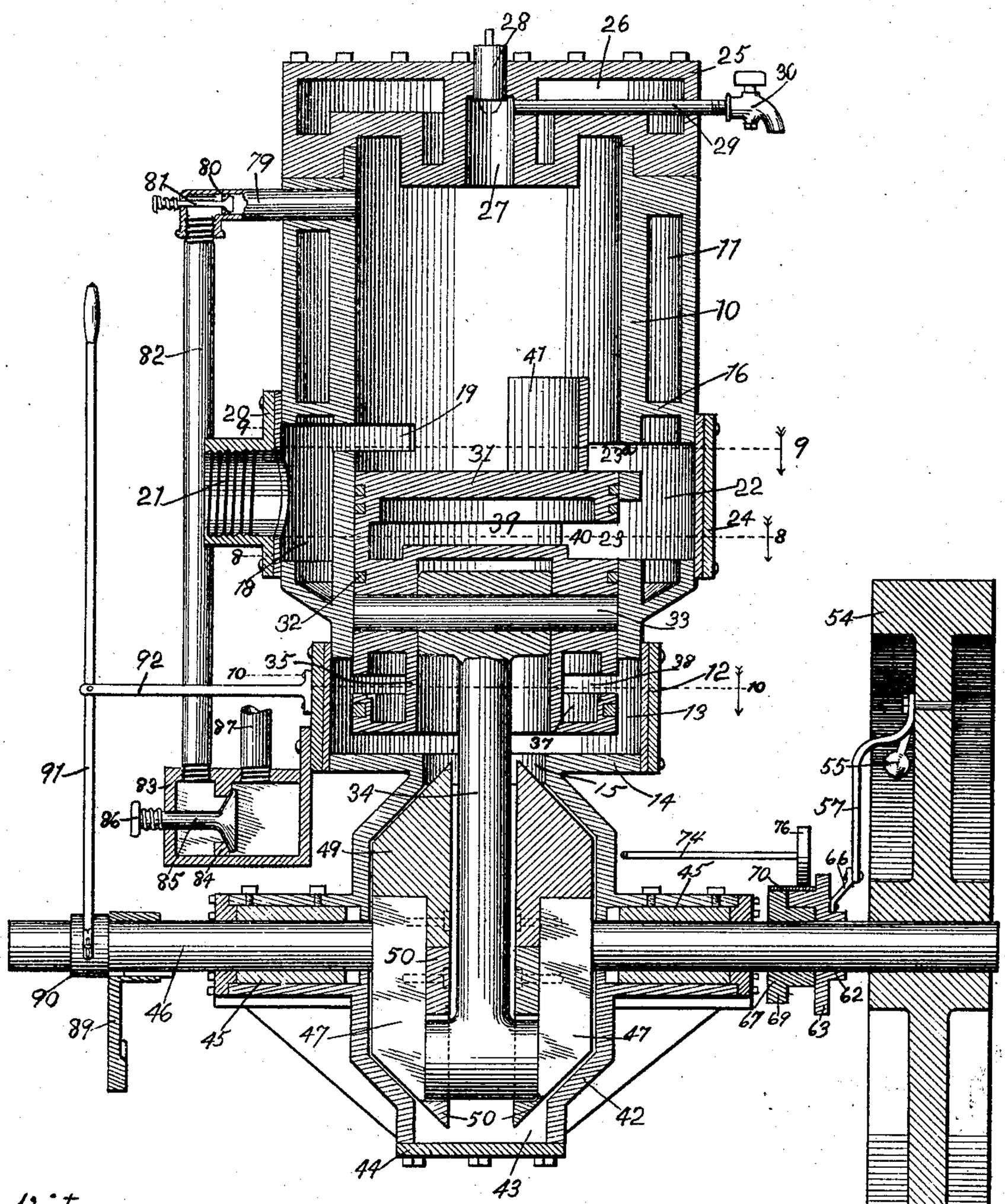
C. W. LITTLE.

EXPLOSIVE ENGINE.

APPLICATION FILED JUNE 3, 1903.

NO MODEL. 4 SHEETS—SHEET 1.

Fig. 1.



Witnesses.
K. K. Keffer.
F. F. Feibrock

Inventor C. W. Little.
by Orwig & Lane
attys

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NO MODEL. 4 SHEETS—SHEET 2.

Fig. 3.

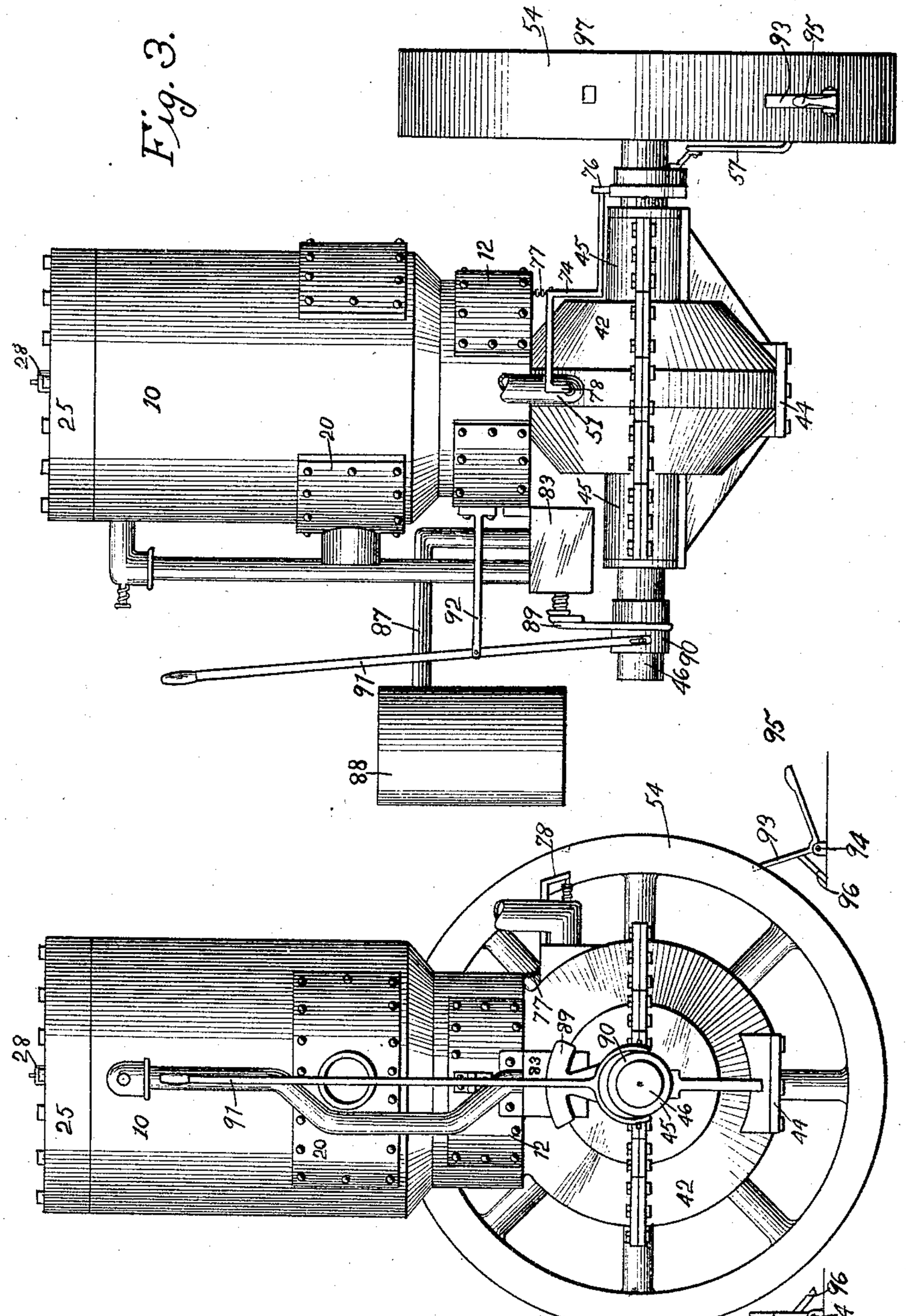

Fig. 2.

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NO MODEL. 4 SHEETS—SHEET 3.

Fig. 6.

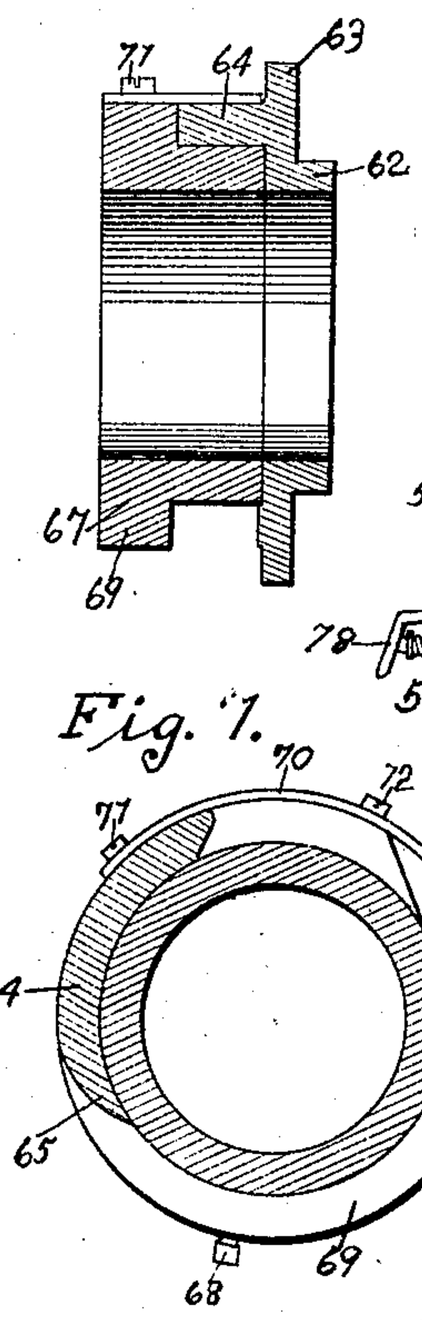


Fig. 7.

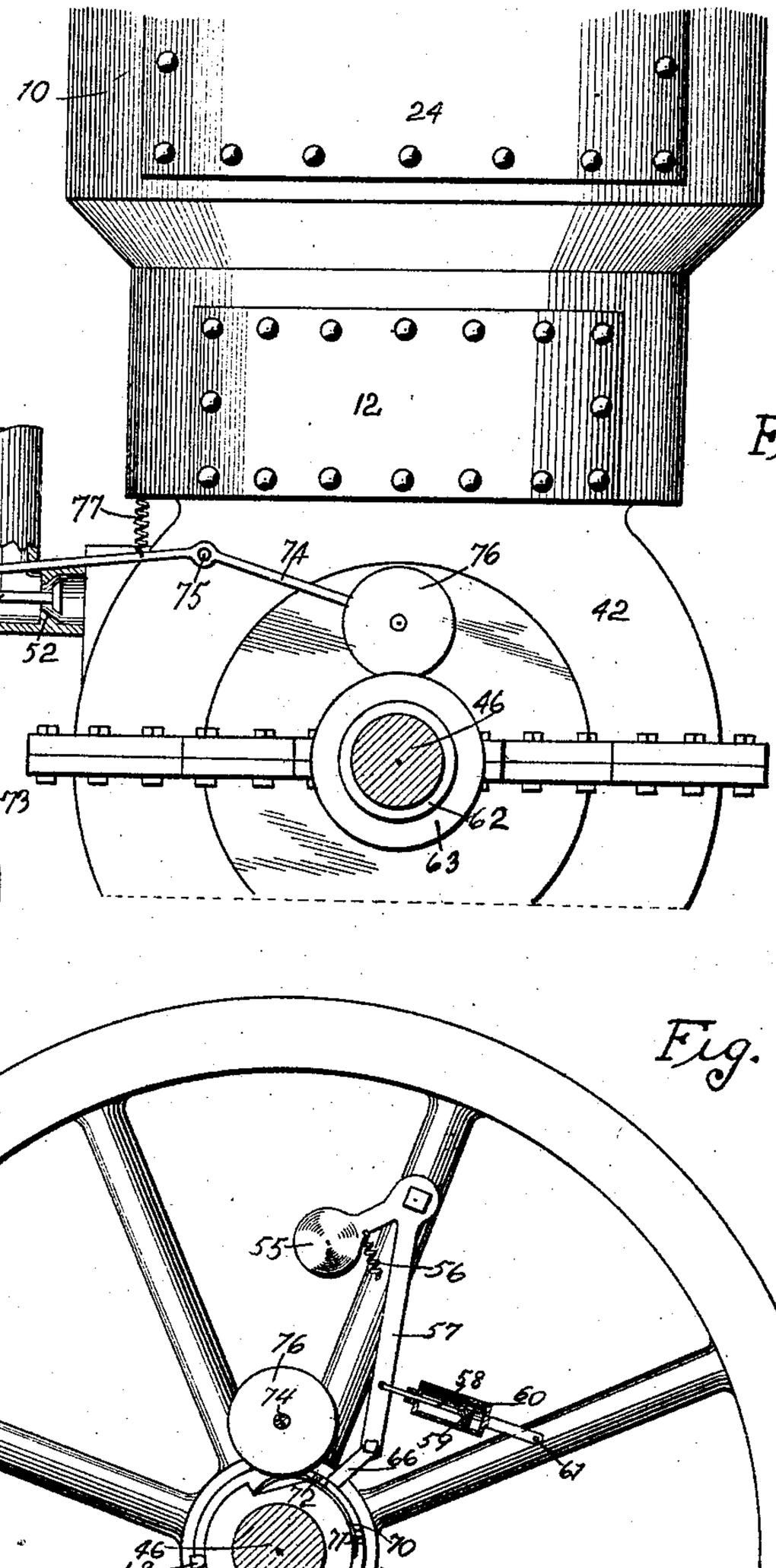
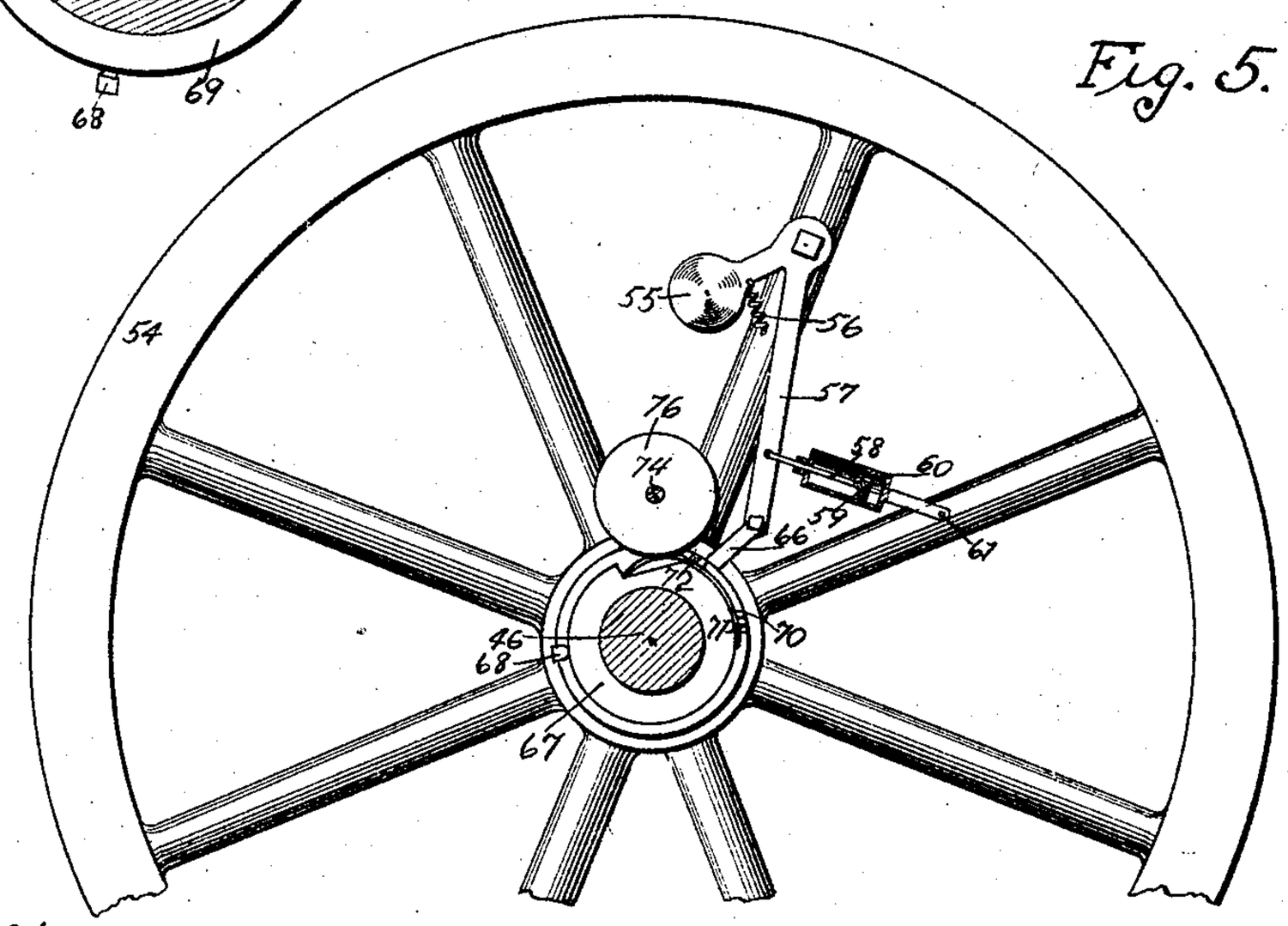


Fig. 4.

Fig. 5.



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NO MODEL. 4 SHEETS—SHEET 4.

Fig. 8.

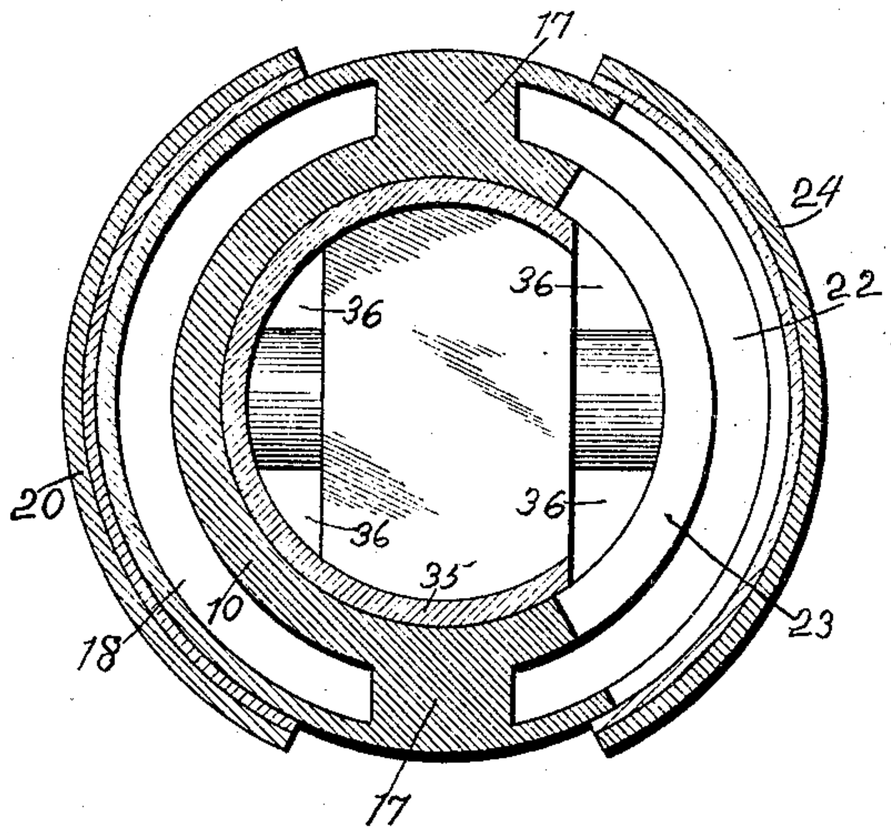


Fig. 9

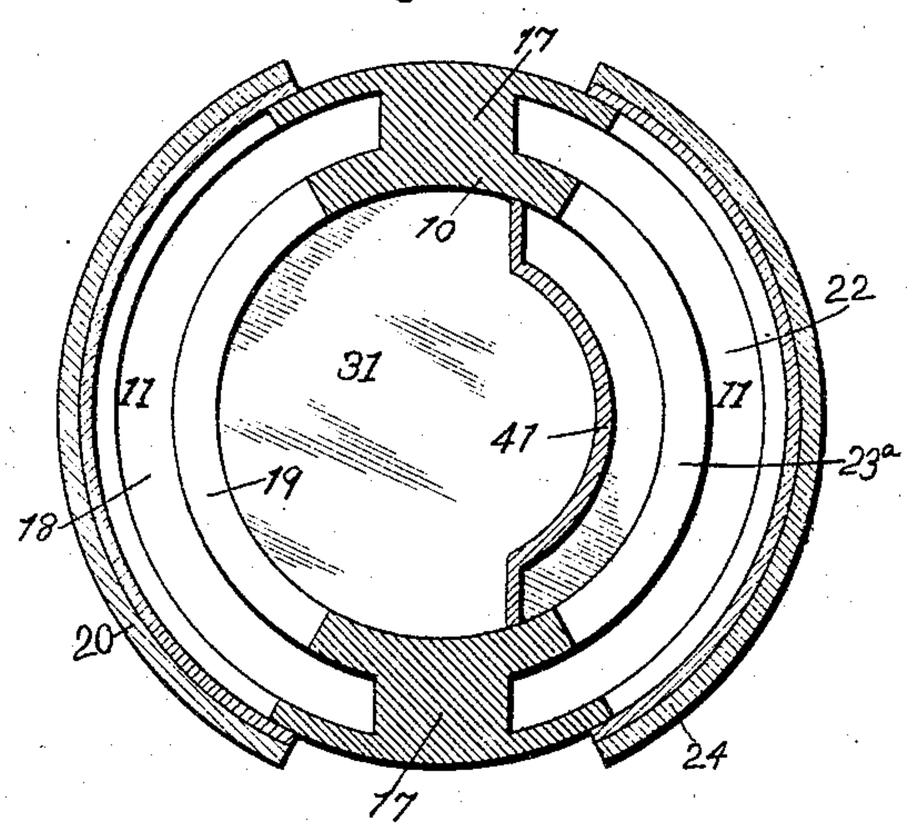


Fig. 10.

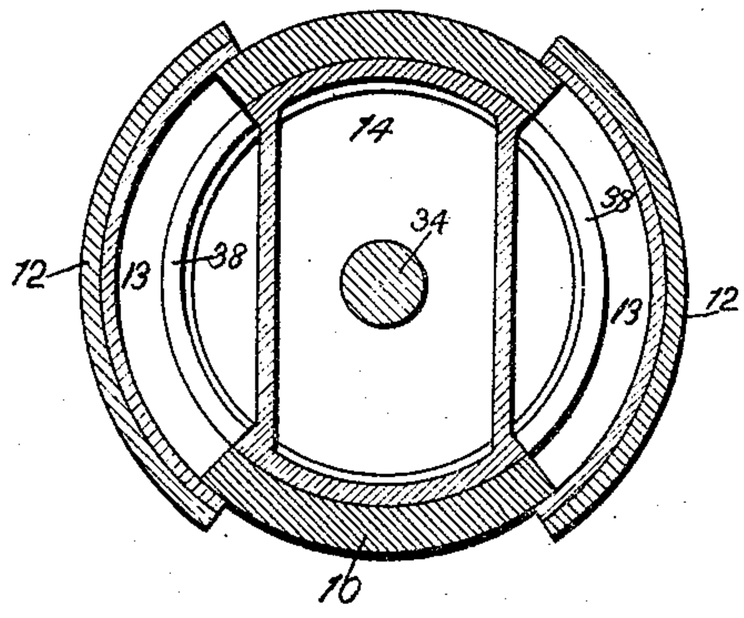
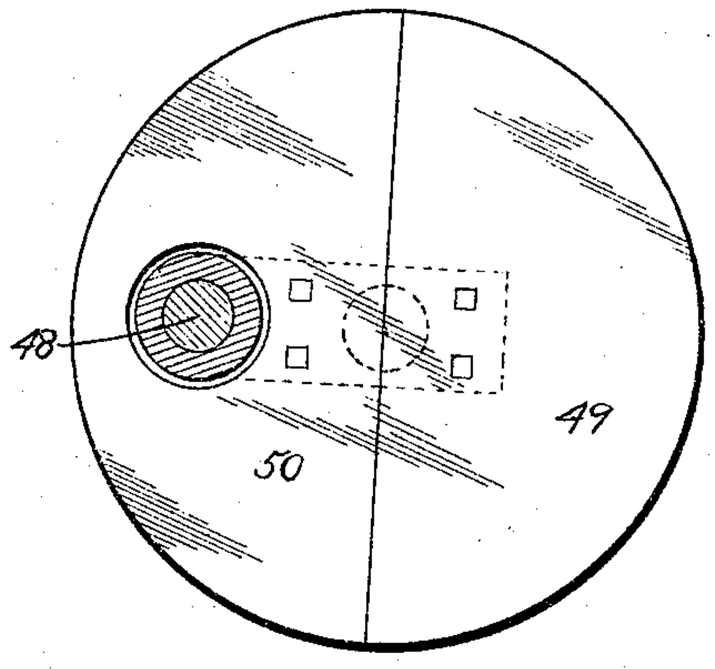


Fig. 11.



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Inventor, C. W. Little
by Owig & Lane Atty's.

PHOTO LITHOGRAPHED BY SARNETT & WILHELMS LITHO. & PTG. CO. NEW YORK.

No. 772,160. Patented October 11, 1904.

UNITED STATES PATENT OFFICE.

CHARLES WILKINS LITTLE, OF LINCOLN, NEBRASKA.

EXPLOSIVE-ENGINE.

SPECIFICATION forming part of Letters Patent No. 772,160, dated October 11, 1904.

Application filed June 3, 1903. Serial No. 159,870. (No model.)

To all whom it may concern:

Be it known that I, CHARLES WILKINS LITTLE, a citizen of the United States, residing at Lincoln, in the county of Lancaster and State of Nebraska, have invented certain new and useful Improvements in Explosive-Engines, of which the following is a specification.

The objects of my invention are to provide an improved explosive-engine of simple, durable, and inexpensive construction.

My invention consists in certain details in the construction, arrangement, and combination of the various parts of the device whereby the objects contemplated are attained, as hereinafter more fully set forth, pointed out in my claims, and illustrated in the accompanying drawings, in which—

Figure 1 shows a vertical central sectional view through the complete engine. Fig. 2 shows an end elevation of the complete engine. Fig. 3 shows a side elevation of same. Fig. 4 shows a side elevation of part of the engine-cylinder and crank-case, illustrating the valve for admitting gas to the crank-case and part of the governing mechanism controlling the movements of said valve, the valve-casing being broken away to show details of construction. Fig. 5 shows a side elevation of part of the fly-wheel and my improved governor attached thereto, the cylinder and piston attached to the governor-arm being shown in section. Fig. 6 shows a longitudinal sectional view through the adjustable governing-cam. Fig. 7 shows a central transverse sectional view through the device illustrated in Fig. 6. Fig. 8 shows a horizontal sectional view of the engine-cylinder and piston, taken on the line 8 8 of Fig. 1. Fig. 9 shows a like view taken on the line 9 9 of Fig. 1. Fig. 10 shows a like view taken on the line 10 10 of Fig. 1; and Fig. 11 shows a sectional view of part of the crank, showing one of the weights and counterbalances for filling the crank-case.

Referring to the accompanying drawings, I shall first describe the cylinder and cylinder-head.

The reference-numeral 10 is used to indicate the cylinder-body, open at both ends and provided with an annular chamber 11 to receive a cooling fluid. The interior of the cylinder-body portion 10 is of a size to closely fit the piston, hereinafter described, and directly beneath the body portion 10 is a supplemental cylindrical body portion 12, riveted to the part 10 and providing an annular chamber 13, the inside dimension of which is somewhat greater than that of the interior of the body portion 10. The lower end of the cylinder is closed by disk 14, riveted to the part 12 and provided with a round central opening 15, communicating directly with the crank-case, to be hereinafter described. About the central portion of the engine-cylinder I have provided a horizontal partition 16, extending completely around the cylinder and closing the lower end of the chamber 11, and, as will be seen in Figs. 8 and 9 of the drawings, two vertical partitions 17 are provided in the space between the inner and outer walls of the body portion 10, thus dividing that space below the partition 16 into two separate compartments for purposes hereinafter made clear. One of these compartments or chambers is indicated by the reference-numeral 18 and is utilized for the engine-exhaust, and it communicates directly with the interior of the cylinder through the opening 19, the length of which is about one-third of the diameter of the cylinder, and said opening 19 is located a short distance above the upper end of the piston when said piston is at its lower limit of movement, as shown in Fig. 1. This chamber 18 is closed by means of a plate 20, riveted to the exterior of the cylinder-body, and an exhaust-pipe 21 is connected with said plate and communicates with the chamber 18. The other chamber, which is separated from the chamber 18 by the vertical partitions 17, is indicated by the reference-numeral 22. This chamber 22 is open to the interior of the cylinder at 23, the length of said opening being substantially one-third the diameter of the cylinder and the top of the opening being a short distance below the top of the piston when the piston is in the position shown in Fig. 1. This chamber 22 also communicates with the interior of the cylinder through the opening 23^a, which opening is of a length corresponding to about one-third of the diameter of the cylinder and which extends upwardly a short

distance from the top of the piston when the piston is in the position shown in Fig. 1. The chamber 22 is closed on its exterior by the plate 24, riveted to the cylinder-body.

From the foregoing description it is obvious that the exhaust-chamber 18 opens into the interior of the cylinder and connects with an exhaust-pipe and does not in any way communicate with the chamber 22, which chamber opens only to the interior of the cylinder.

My object in constructing the engine with the chambers 18 and 22 open on their exterior (the said openings being covered by the plates 20 and 24) is simply for convenience in construction, and these chambers may be formed in any desirable way.

The cylinder-head, as shown in Fig. 1, comprises a body portion 25, having a chamber therein (indicated by the numeral 26) to receive a cooling fluid. In the central portion of the under part of the cylinder-head is a cylindrical opening 27, at the top of which the sparker 28 is introduced.

The numeral 29 indicates a pipe supported in the piston-head, one end of which communicates directly with the opening 27 and in line with the points of the sparker 28, and the other end is provided with a petcock 30 for purposes hereinafter made clear.

The piston.—The piston of my improved engine is designed to compress gas and to admit gas through passage-ways in the piston into the ignition-chamber of the engine at certain times. In general contour the piston is of cylindrical shape provided with a flat upper end 31, and the piston is accurately fitted inside of the cylinder, and a number of expansion-rings 32 are placed in the piston to engage the interior of the cylinder. A wrist-pin 33 passes transversely through the central portion of the piston from one side to the other, and the interior of the piston is hollow except for a casing to inclose the upper end of the pitman 34. This casing is indicated by the numeral 35 and is opened at its lower end only and is all cast complete with the piston. The said casing is formed integral with and is solid around the end portions of the pin 33 to firmly support said pin. This apparently divides the upper and lower portions of the hollow piston. However, the said portions communicate with each other through the passage-ways 36. (See Fig. 8.) In the lower end portion of the piston is an annular chamber 37, and an annular slot 38 communicates with the chamber 37 and leads to the exterior of the piston, part of the chamber 37 being below the said slot. This chamber 37 communicates with the chamber 39 at the top of the piston through the passage-ways 36, and the chamber 39 is open at 40, which opening extends about one-third of the diameter of the piston and is so arranged as to communicate directly with the chamber 22 when the piston is at its lower limit of movement. The only way that gas may enter is by passing from the chamber 39 at the top of the piston through the opening 40 in one side of the piston, then into the chamber 22, and then into the cylinder above the top of the piston, and obviously this can only be done when the piston is at a certain point in its movement where the opening 40 may communicate with the chamber 22. Formed on the top of the piston is a deflector 41, so positioned that when the piston is in the position shown in Fig. 1 said deflector will turn the gas entering the cylinder through the chamber 22 in an upward direction and not permit it to flow in a direction toward the exhaust-opening 19.

The crank-case and crank.—The lower end of the cylinder is closed by the head 14, and formed on or fixed to this head 14 is the crank-case. This crank-case is hollow and communicates with the cylinder through the opening 15. Its exterior is cylindrical and its ends are flat and its corners beveled at 42. An opening 43 is provided at its lower end to form a hand-hole, and this opening is covered by the plate 44. Formed on the ends of the crank-case are the boxes 45, through which the shaft 46 is passed. Within the crank-case the crank-arms 47 are fixed to the crank-shaft and the ends of the crank-arms 47 are connected by the pin 48. The pitman 34 is connected at one end to the pin 33 and at its other end to the pin 48. (See Fig. 11.) I have provided means whereby the space in the interior of the crank-case may be filled as nearly as possible to prevent the accumulation of a large quantity of gas therein, as follows: The reference-numeral 49 indicates balancing-fillers made of a heavy metal and bolted to the crank-arms. These balancing-fillers are each of semicircular shape and are placed side by side and are of a thickness extending from a point adjacent to the pitman to a point near the inner face of the crank-case. The reference-numeral 50 indicates the counterbalancing-fillers, preferably made of aluminium or similar material of light weight, and are of the same general contour as the balancing-fillers 49, except that they are cut away to admit the head of the pitman 34, and they are bolted to the crank-arms 47. By this means I have provided for occupying all of the space possible within the interior of the crank-case, and I thereby prevent the accumulation of any considerable quantity of gas in the crank-case. Furthermore, the balancing-weights will when at rest always be at the lower end of the crank-case, so that the engine will be in position for starting.

Gas-supplying mechanism.—The reference-numeral 51 indicates a gas-supply pipe to which a carbureter may be connected. This pipe communicates with the interior of the crank-case and is provided with a valve-seat 52 near the point where it enters the crank-case, and a spring-closed valve 53 is mounted

in the pipe adjacent to the seat. The said valve opens against the pressure of the spring in a direction toward the crank-case and closes against the valve-seat in a direction from the crank-case, so that pressure on the interior of the crank-case cannot open the valve. The movements of this valve are controlled by a governor, as follows: The reference-numeral 54 indicates a balance-wheel keyed to the crank-shaft 46. Pivoted to one of the spokes of the balance-wheel 54 is a governor-ball 55, arranged to move outwardly by centrifugal force, but normally held inwardly by spring 56. A governing-lever 57 is connected with the governor-ball. In this connection I have provided means whereby rapid movements of the lever 57 will be prevented and yet the said lever will not be firmly held in any position, as follows: The reference-numeral 58 indicates a piston pivoted to lever 57 and having a perforated piston-head 59 placed in a closed cylinder 60, said cylinder being pivoted to a part of the balance-wheel at 61. This cylinder is filled with oil or a similar fluid, and the lever 57 can move only by forcing the piston through the cylinder filled with oil, which moves slowly through the perforated piston, thus retarding and preventing rapid movements of the lever 57. This lever 57 is intended to operate an adjustable cam, which cam is constructed as follows: The reference-numeral 62 indicates a collar loosely mounted upon the shaft 46. This collar is provided with a flange 63 and projecting laterally from said flange is a cam 64, the outer face of which is concentric except at one end, where it is inclined inwardly at 65, the total length of the cam being about one-fourth the circumference of the flange 63. Fixed to the flange 63 is an arm 66, pivoted to the end of the lever 57, so arranged that a movement of the governor-ball will rotate the collar 62 on the shaft 46. The reference-numeral 67 indicates a second collar fixed to the shaft 46 adjacent to the collar 62 and held in place on the shaft by the set-screw 68. This collar 67 is provided with a flange 69 at one edge, the flanges 69 and 63 forming between them an annular groove. Fixed to the periphery of the flange 69 is a metal plate 70, held in place by the set-screws 71 and 72, and this plate 70 has one end inclined downwardly in an annular groove between the flanges 69 and 63 at the point marked 73, and the end of the plate 70 engages the collar 67 at the bottom of the said annular groove. It is obvious that the collar 62, bearing the cam 64, may rotate relative to the collar 67, bearing the plate 70, and when the cam 64 moves toward the inclined end portions 73 of the plate 70 then the cam-surface formed by the parts 64 and 70 is shortened, and when the cam 64 moves away from the part 73 then the cam-face is lengthened. The total length of the plate 70 is about one-fourth of a circle. Hence when these cam parts 64 and 70 are at one limit of their movement a cam-surface is formed in the annular groove between the flanges 69 and 63 of about a half-circle in length, and when at their other limit of movement a cam-surface is formed of about a quarter-circle length, and the length of the said cam-surface is controlled directly by the position of the governor-ball—that is to say, when the governor-ball is at its outer limit of movement on account of the centrifugal action caused by a high speed of the balance-wheel then the cam composed of the parts 64 and 70 is shortened, and when the governor-ball 55 is at its inner limit of movement the said cam is in position at its maximum length. I have provided means whereby the said cam composed of the parts 64 and 70 will operate the valve 53, as follows: The numeral 74 indicates a lever fulcrumed at 75 to the crank-case. On one end of the lever 74 is a roller 76, traveling in the annular groove between the flanges 69 and 63 and normally held downwardly in said groove by a contractile coil-spring 77. The opposite end of the lever 74 is provided with an inclined extension 78, so shaped that when the roller 76 is on top of or in engagement with the cam composed of the parts 64 and 70 the said extension 78 will engage and hold open the valve 53, and when the roller 76 is at the bottom of the annular groove the extension 78 will be out of engagement with the valve 53 and the valve will be held closed by its spring. The parts of this governing device are so arranged with relation to the piston that when the piston starts upwardly the valve 53 will be held open by the lever 74, and this valve is held open during about half of the upstroke of the piston when the cam composed of the parts 64 and 70 is of a minimum length, and the valve 53 is held open during substantially all of the upstroke of the piston when the said cam is of its maximum length.

The starting device.—In engines of this class that are especially designed for use in connection with automobiles it is of great importance that the engine may be started at full speed quickly and easily, and it is well known that considerable time is required in starting up an engine of this class before the proper mixture of gas can be drawn into the ignition-chamber to produce complete explosions. I have provided an attachment for explosive-engines by which a portion of the gas from the ignition-chamber is stored in a tank from each explosion of the engine until such time as the pressure of gas in this tank has reached a certain predetermined amount. Then the supply of gas from the ignition-chamber is cut off and a tank full of exploded gas and under pressure is provided, which may be utilized in starting the engine, and until the engine is in good working order and fresh gas properly mixed is being supplied to the engine in suf-

ficient quantities to operate the engine of itself. Then the auxiliary gas-supply may be cut off.

The reference-numeral 79 indicates a pipe communicating with the ignition-chamber near its upper end. This pipe is provided with a valve-seat 80, and a spring-closed valve 81 normally rests against said valve-seat, and the valve is arranged to close against its seat by pressure from the ignition-chamber outwardly, and the valve can be opened only by pressure in a direction toward the ignition-chamber. It may also be opened by hand. Communicating with the pipe 79 is a pipe 82, which also communicates with a valve-casing 83. In this valve-casing 83 is a valve-seat 84, and a spring-closed valve 85 normally rests against the valve-seat and is opened automatically by pressure from the ignition-chamber outwardly, but is closed against pressure in an opposite direction. On the end of the valve 85 is a head 86, for purposes hereinafter made clear. The valve-casing 83 also communicates with a pipe 87, which pipe leads to a tank 88, designed to contain gas under pressure.

The reference-numeral 89 indicates an arm slidingly but non-rotatably mounted upon the shaft 46. Connected with the arm 89 is a collar 90, moved by lever 91, fulcrumed to a support 92. By moving this lever 91 the arm 89 may be moved to position so that during its rotation it will engage and depress the head 86 of the valve 85, as required to open the valve, and when at its other position the arm 89 will not engage the head 86. The said arm is mounted on the shaft 46 in such position that it will engage the head 86 immediately after the piston has crossed the upper center of its stroke, so that the gas will pass from the tank 88 through the pipes 87, 82, and 79 into the ignition-chamber and will thereby force the piston downwardly. The arm 89 disengages from the head 86 when the piston approaches the lower end of its movement, so that the gas in the ignition-chamber may exhaust and the piston may move upwardly without compressing gas in the ignition-chamber.

The reference-numeral 93 indicates the lever fulcrumed to the support 94 and having a treadle 95 attached thereto and also having a brace 96 attached thereto. In the balance-wheel 54 is a notch 97, the notch being so positioned relative to the lever 93 that the said lever will enter the notch when the piston has just crossed the upper center of its movement. A similar lever 93 and connected parts is placed adjacent to the opposite side of the balance-wheel, and in use the operator moves the balance-wheel to position where it has just crossed the upper center in the direction which he wishes the engine to run. He then throws the lever 93 into the notch 97, thus preventing a rotation of the balance-wheel in the direction which it would naturally go when pressure was applied on the interior of the ignition-chamber, so that the pressure in the ignition-chamber may reach a certain predetermined amount before the balance-wheel may turn. Then when this pressure has reached the desired position the operator places his foot upon the treadle 95, thus releasing it from the balance-wheel and permitting the said balance-wheel to be rotated rapidly by the pressure upon the piston, thus instantly starting the engine to work rapidly, and by providing a similar device on each side of the fly-wheel the engine may be started in either direction.

In practical use and assuming that the tank 88 is full of gas under pressure and assuming, further, that it is desired to start the engine the operator may first open the petcock 30 and then turn the balance-wheel to position where the piston has just crossed the upper center of its movement in the direction which it is desired to have the balance-wheel turn. When the piston has crossed its upper center, the petcock 30 is closed, and one of the levers 93 is made to engage the corresponding notch in the balance-wheel, as required, to prevent further rotation of the balance-wheel in the same direction. When in this position, the arm 89 will engage the valve 85 and hold it open, so that gas in the tank 85 may enter the upper end of the ignition-chamber and press downwardly upon the piston, so that the full force of the compressed gas will be applied in a downward direction upon the piston. Then the operator places his foot upon the treadle 95, removing the stop 93 from contact with the balance-wheel, and thus permitting the shaft 46 to turn rapidly in the proper direction. During each downward stroke of the piston the compressed gas in the tank 88 works upon the piston, and during the upstroke of the piston the valve 85 is held closed, so that there is no pressure against the piston to prevent it from moving upwardly. If the tank 88 is not full of compressed gas, the engine is started by first rocking the balance-wheel until a partial vacuum is produced in the crank-case, the air in the lower end of the cylinder being forced upwardly to the top of the cylinder and then exhausted through the exhaust-openings. After this operation has been continued for a short time fresh gas will be drawn into the crank-case and will pass through the piston into the ignition-chamber and will be exploded in the ignition-chamber.

The engine is of the class known as "two-cycle engines," and assuming the piston starts at the top of the cylinder after an explosion the downward movement of the piston compresses the gas in the crank-case and in the lower part of the cylinder, the valve 53 being automatically shut to prevent the escape of gas from the crank-case. When the piston is near the lower end of its stroke, the exhaust-opening 19 is uncovered and the prod-

ucts of combustion are permitted to escape. Immediately after the exhaust-port is open the top of the piston passes the induction-opening 23ª, thus permitting the compressed gas in the piston and in the crank-case to flow into the ignition-chamber. The deflector 41 directs the gas to the top of the ignition-chamber, so that before the live gas can reach the exhaust-port 19 the piston again starts its upward movement and the exhaust-port is closed. During the next upward stroke of the piston gas is admitted to the crank-case through the valve 53, which is held open by the lever 74, and this gas fills the crank-case and the lower end of the cylinder and also the hollow chamber in center of piston. During this upward stroke the gas above the piston is compressed, and when upper center is reached it is exploded and the piston is driven downward. As before explained, the amount of gas admitted to the crank-case is controlled by the governor, and when the engine stops the weights 49 will hold the crank in position with the piston at its upper limit of movement. When the engine is running, the tank 88 may be filled with gas under pressure by holding the valve 81 open, so that each time an explosion occurs and the pressure of gas is strong enough to open the valve 85 a quantity of gas is forced into the tank 88 and the gas is prevented from returning by the valve 85. When the pressure in the cylinder becomes great enough, the valve 81 is released.

Assuming that it is desired to clean the sparker, I open the petcock 30, and when an explosion occurs the gas in the cylinder will be forced through the pipe 29 at great speed, thus blowing off any deposits of soot, &c., that may have accumulated upon the sparker.

Having thus described my invention, what I claim, and desire to secure by Letters Patent of the United States therefor, is—

1. In an explosive-engine, the combination of a cylinder, having a chamber in its side and also having two passage-ways communicating between the interior of the cylinder and the chamber, said cylinder also having an enlarged annular chamber at one end and a piston in the cylinder having an opening in its sides near one end, arranged to communicate with the enlarged annular chamber at a certain part of the piston-stroke and also having openings therein arranged to communicate with the openings in the cylinder when the piston is in position with the opening in its end communicating with the said annular chamber of the cylinder.

2. In an explosive-engine, the combination of a cylinder, having a chamber at one side and having two passage-ways communicating between the interior of the cylinder, and the said chamber, said cylinder also having at one end an enlarged annular chamber, said cylinder also having an exhaust-opening, and a piston having a hollow interior and provided near one end with an opening in its side, said opening communicating with the piston-chamber near one end of the piston, said piston also having at its other end an annular opening designed to communicate between the piston-chamber and the enlarged annular chamber at one end of the cylinder, said parts being so arranged that when the annular opening at one end of the piston communicates with the annular chamber in the cylinder, then the opening in the other end of the piston will communicate with one of the openings in the cylinder, and the piston will stand clear of the other opening in the cylinder, for the purposes stated.

3. In a device of the class described, the combination of a crank-case, a crank-shaft supported by the crank-case, crank-arms on the shaft within the case, a pitman-rod connected with the crank-arms within the crank-case, two semicircular fillers and weights within the crank-case secured to the crank-arms, two counterbalancing semicircular fillers within the crank-case and fixed to the crank-arms, made of light material, for the purposes stated.

4. In an engine, a piston having at one end an annular chamber and an opening from said annular chamber extending outwardly through the side of the piston, said piston having at its other end a chamber and an opening extended from said chamber outwardly through the side of the piston, said piston also having a passage-way communicating between the chambers at the opposite ends of the piston.

5. In an explosive-engine, the combination of a cylinder, having a hollow chamber in its side wall and also having two passage-ways communicating between said chamber and the interior of the cylinder, said cylinder also having an enlarged annular chamber at one end and a piston in the cylinder provided with passage-ways arranged when in one position to provide communication between the enlarged annular chamber and one of the passage-ways communicating between the interior of the cylinder and the said chamber in the walls of the cylinder, for the purposes stated.

CHARLES WILKINS LITTLE.

Witnesses:
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