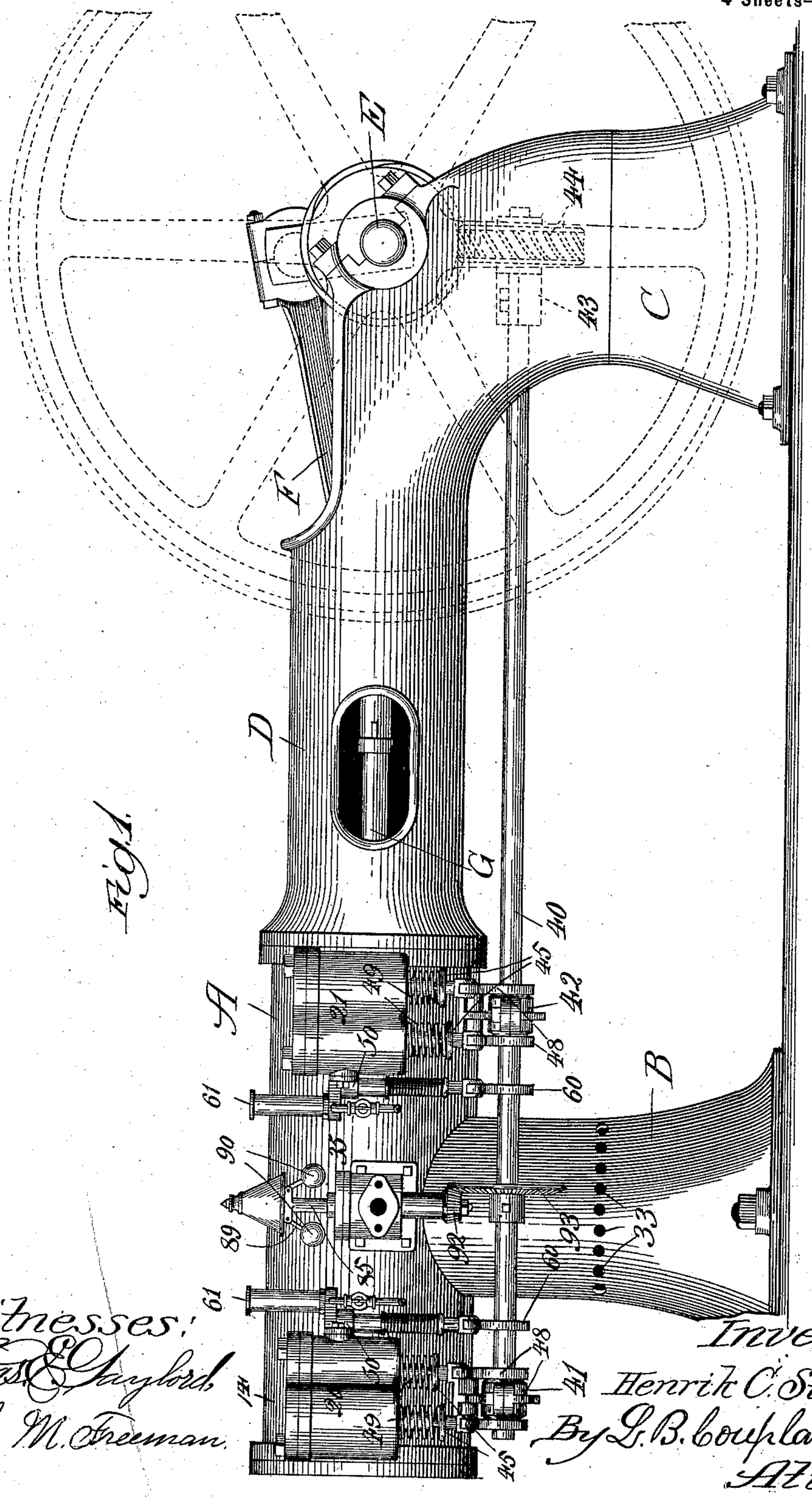
No. 709,060. Patented Sept. 16, 1902.

H. C. STRÄNG.

FOUR CYCLE EXPLOSIVE ENGINE.

(Application filed Feb. 15, 1896. Renewed Feb. 20, 1902.)

(No Model.) 4 Sheets—Sheet 1.



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(No Model.) 4 Sheets—Sheet 2.

Fig. 2.

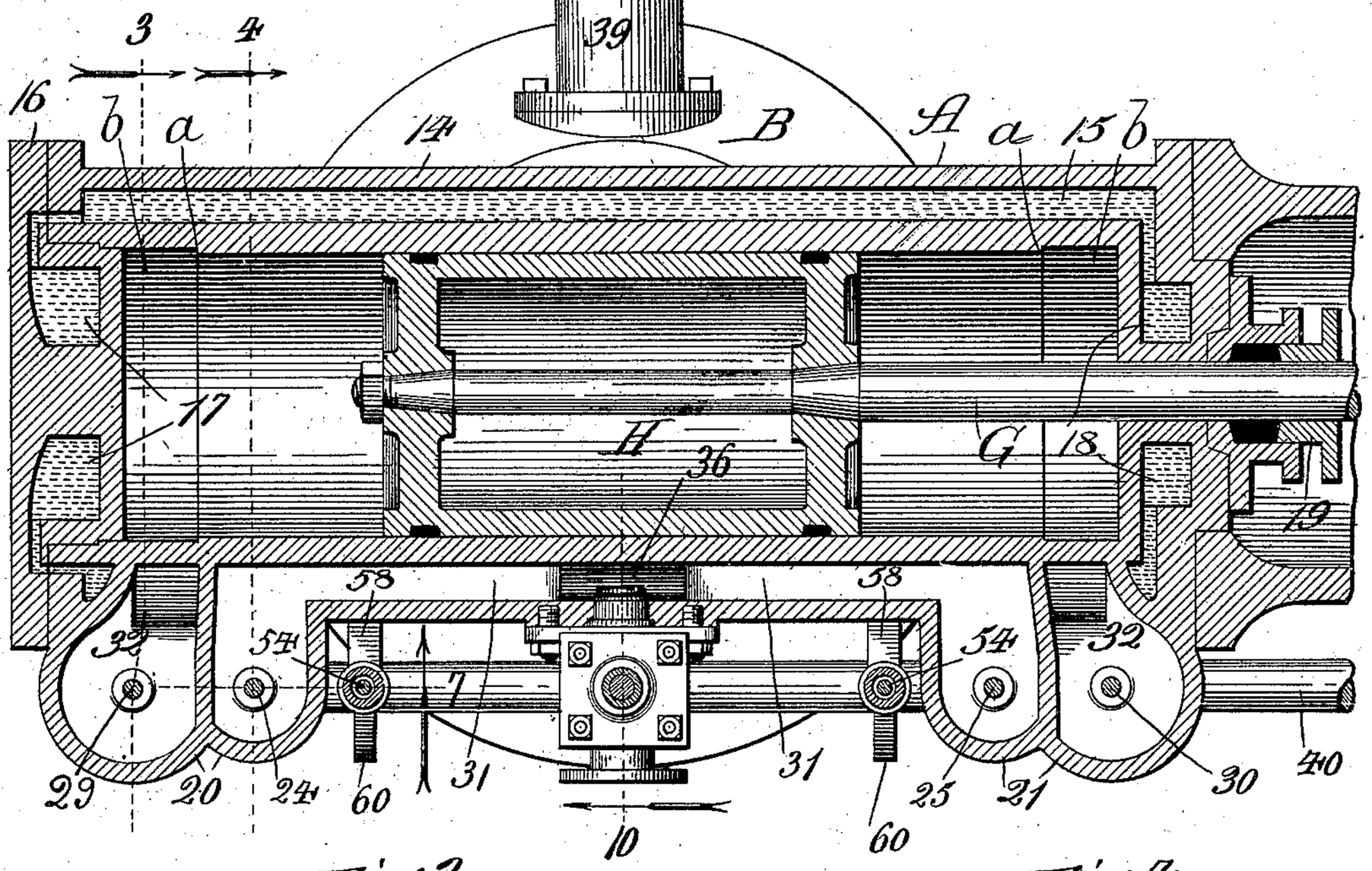


Fig. 3.

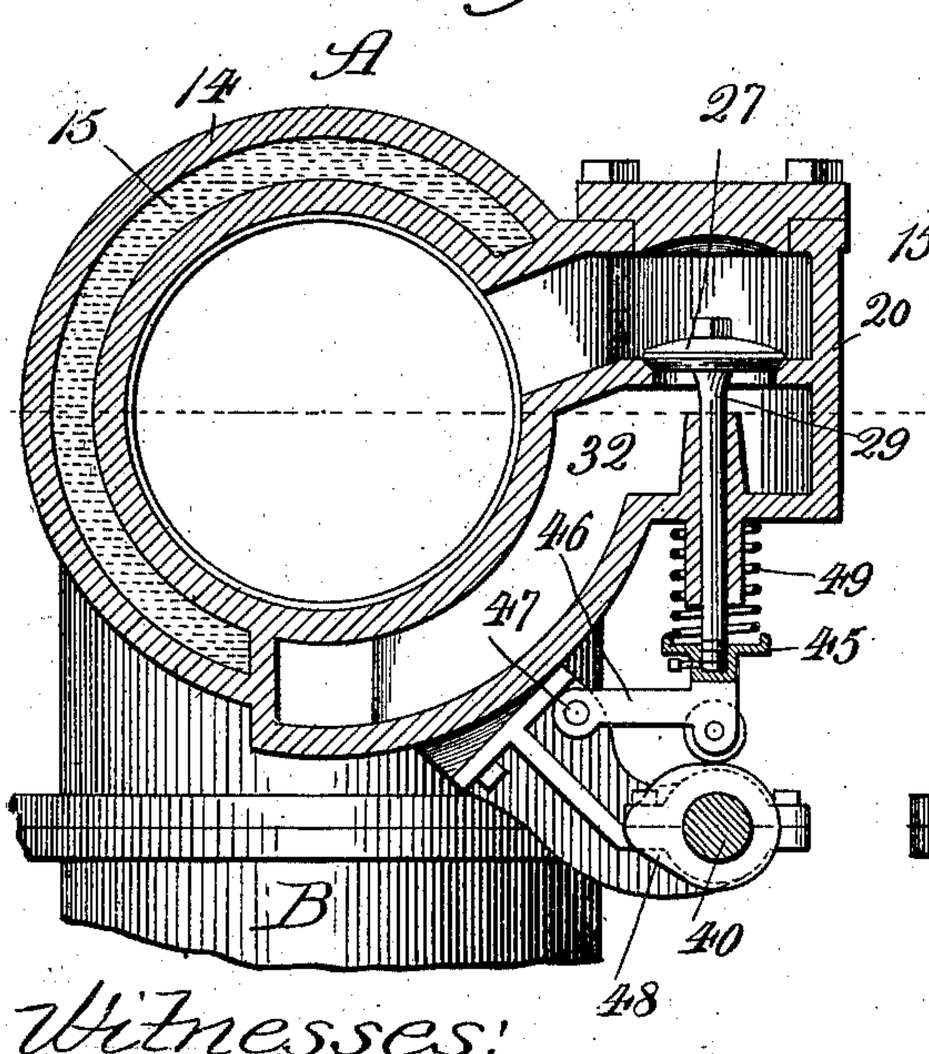
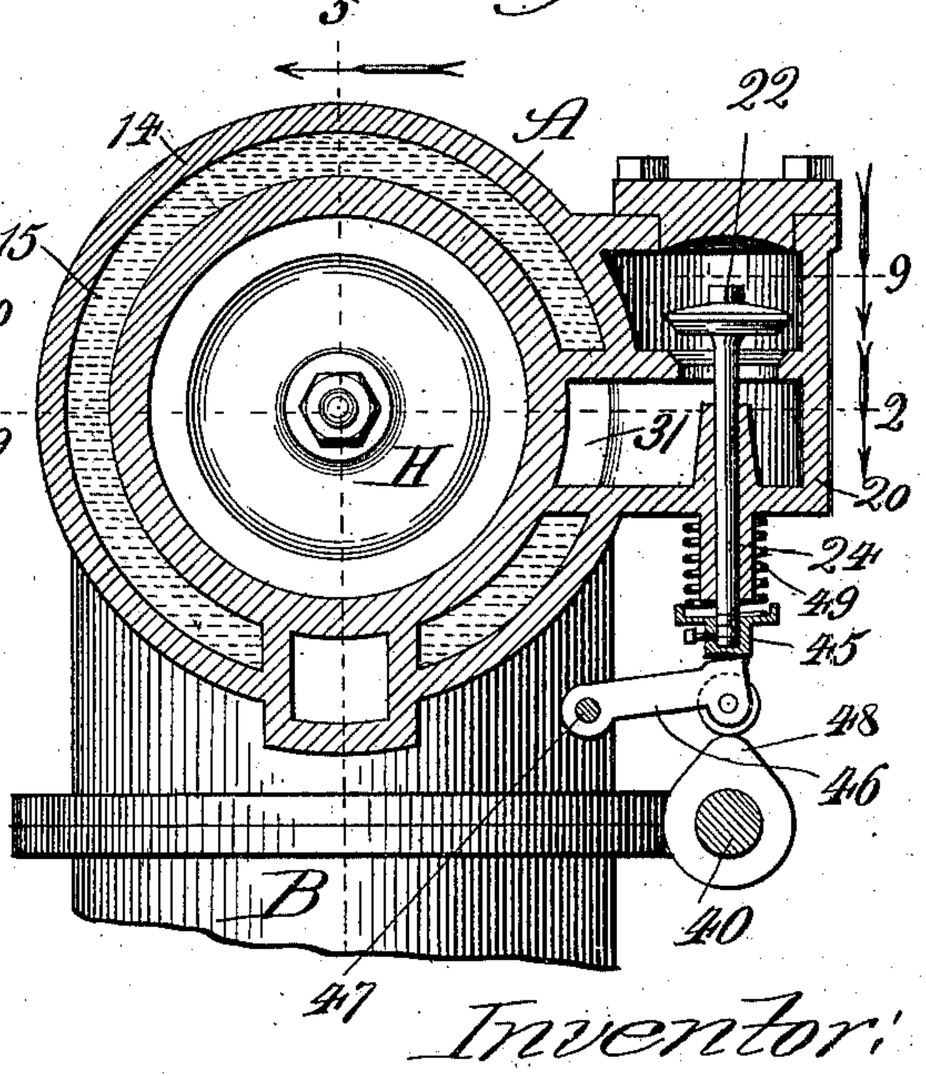


Fig. 4.



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(No Model.) 4 Sheets—Sheet 3.

Fig. 5.

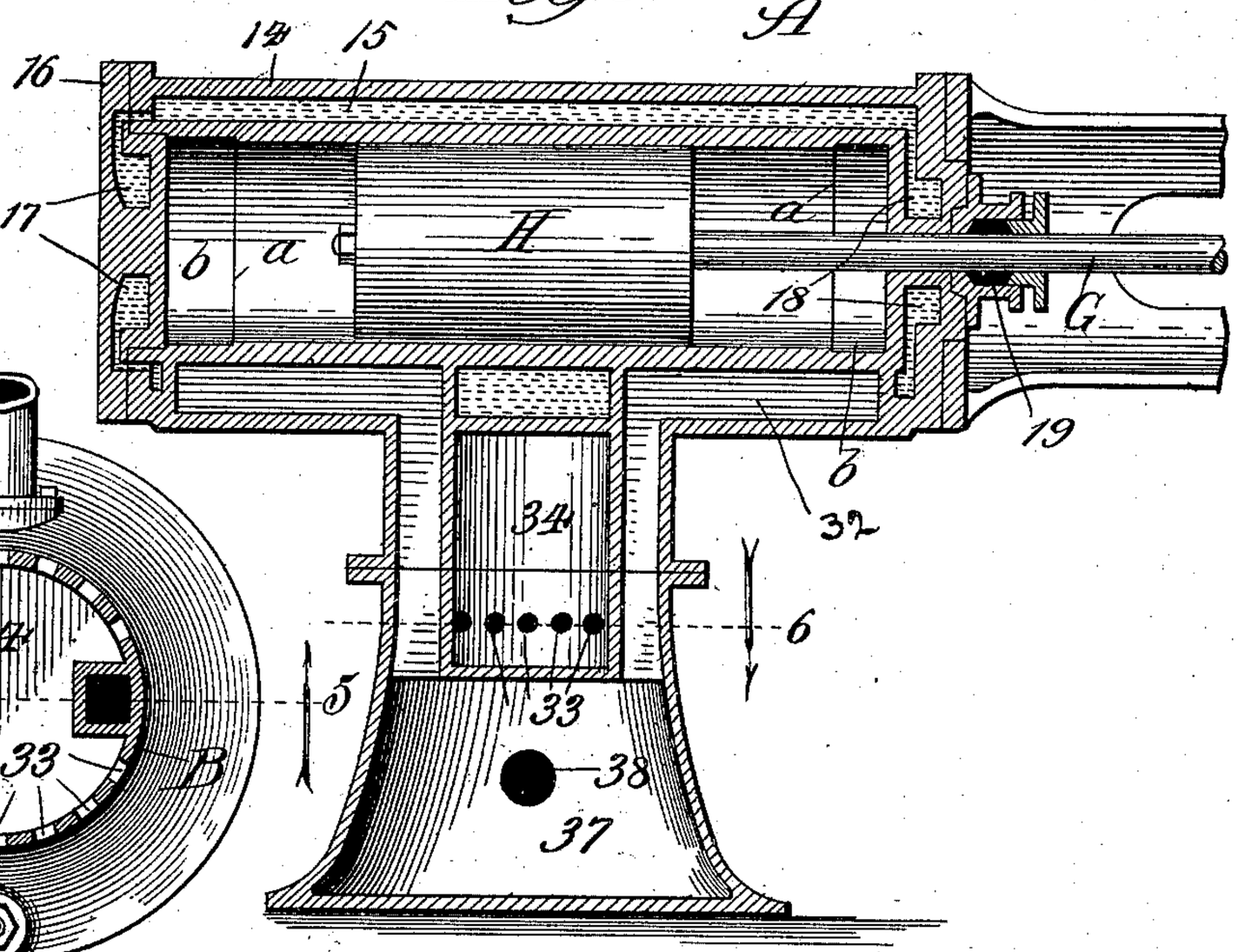
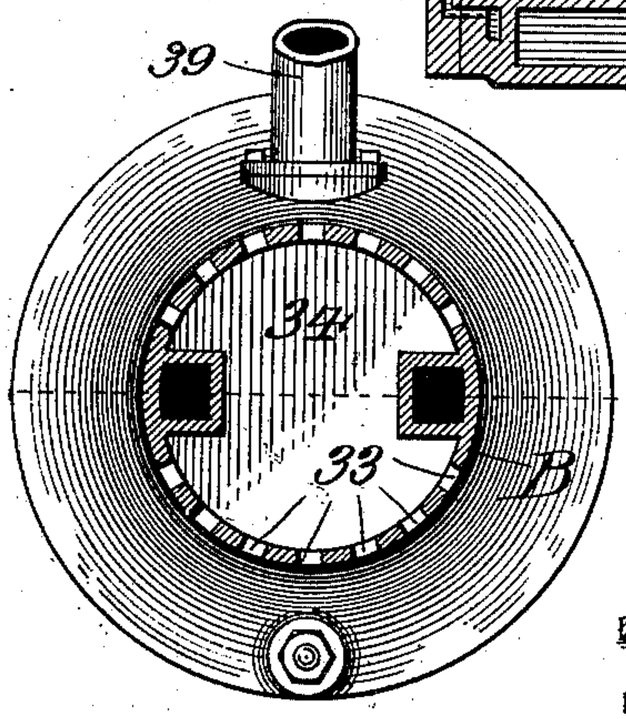
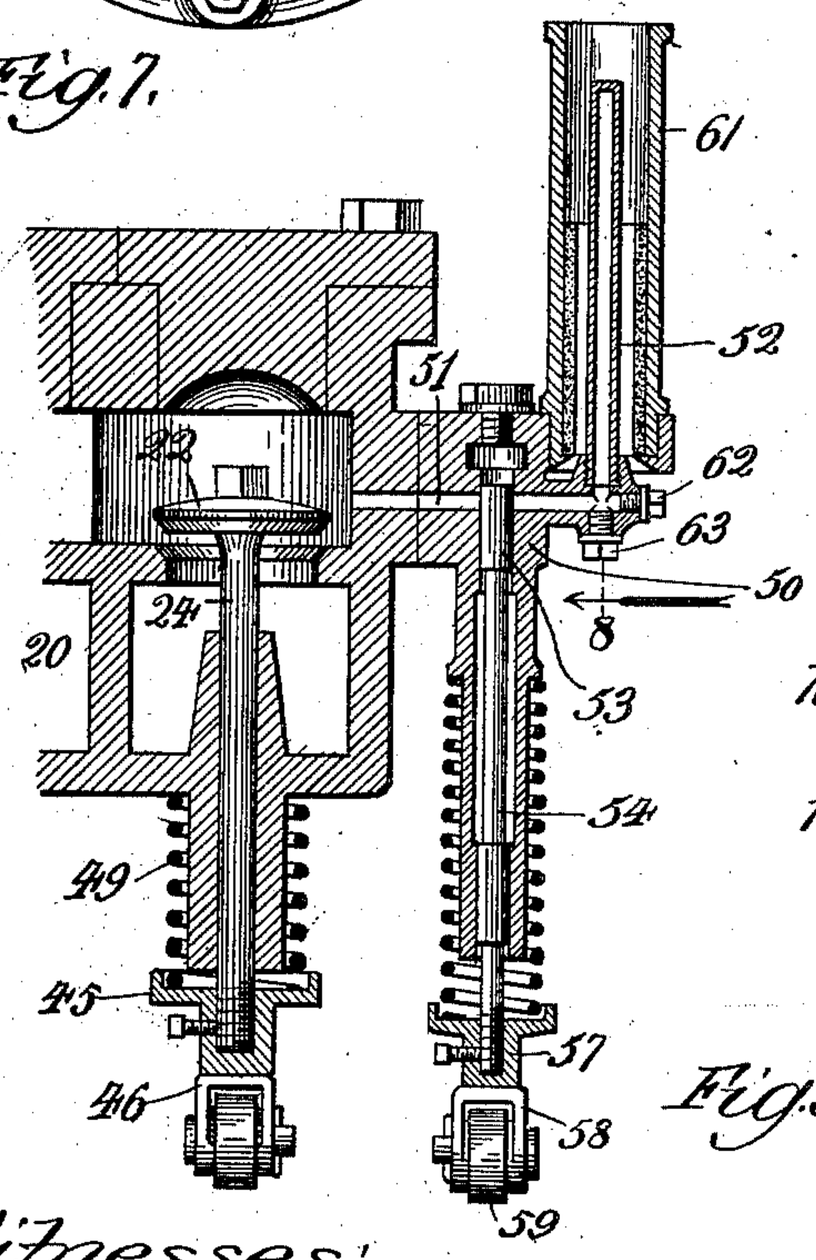


Fig. 6.

Fig. 7.





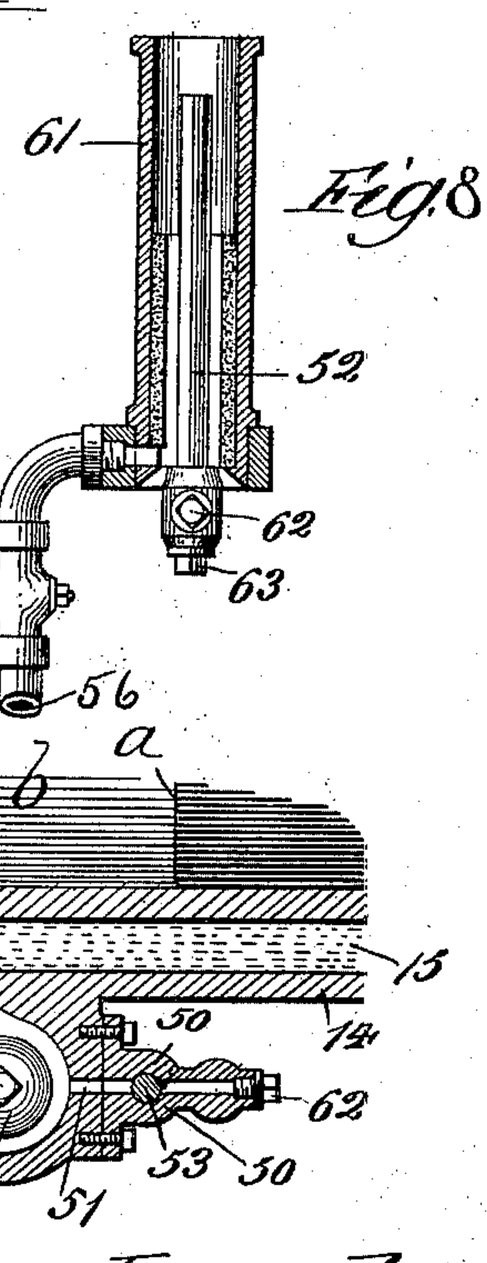


Fig. 8

Fig. 9.

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(Application filed Feb. 15, 1896. Renewed Feb. 20, 1902.)

(No Model.) 4 Sheets—Sheet 4.

Fig. 11.

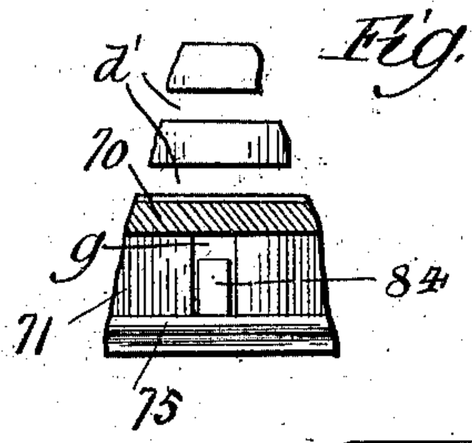

Fig. 10.

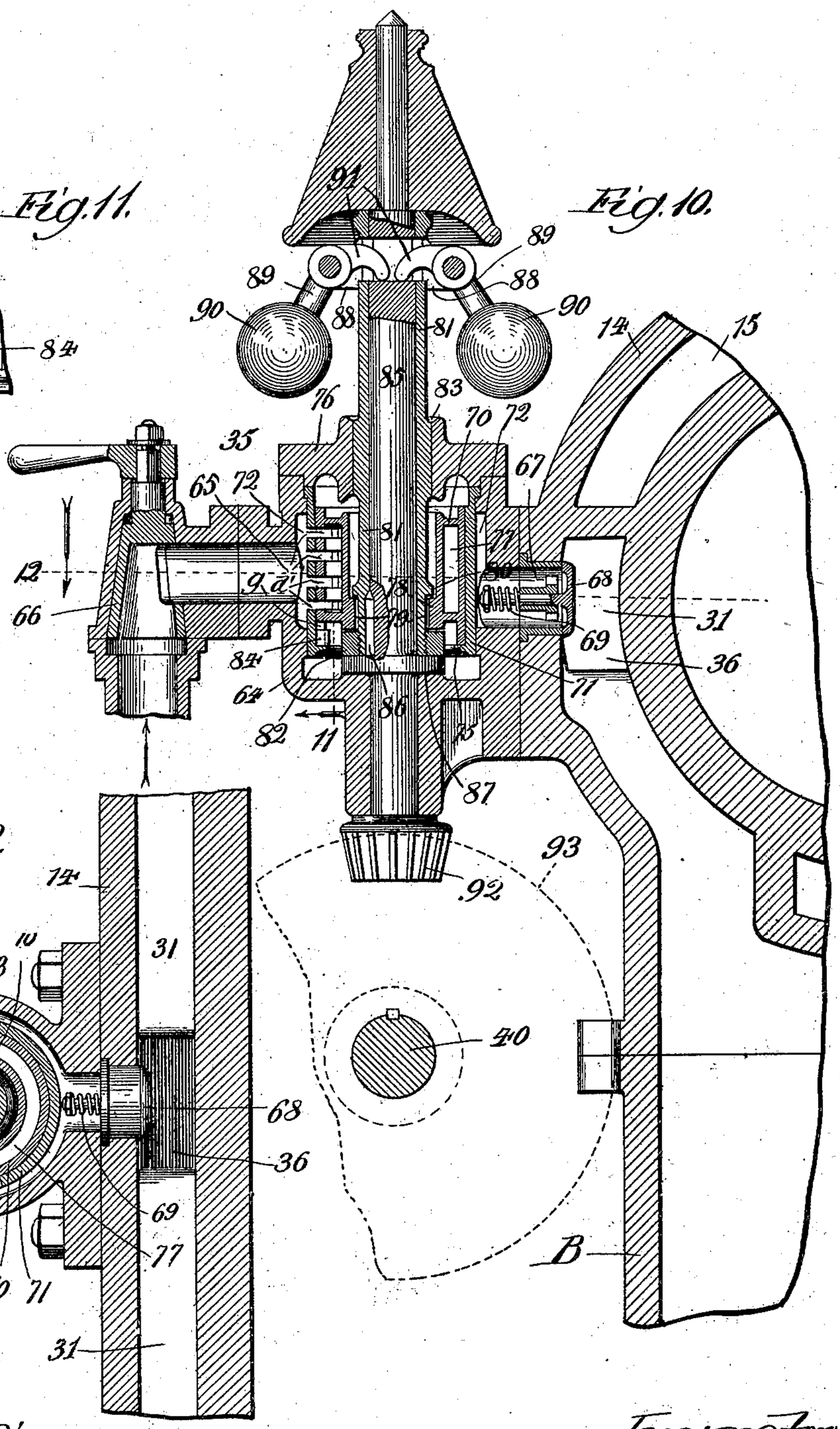

Fig. 12.

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UNITED STATES PATENT OFFICE.

HENRIK C. STRÄNG, OF CHICAGO, ILLINOIS.

FOUR-CYCLE EXPLOSIVE-ENGINE.

SPECIFICATION forming part of Letters Patent No. 709,060, dated September 16, 1902.

Application filed February 15, 1896. Renewed February 20, 1902. Serial No. 94,927. (No model.)

To all whom it may concern:

Be it known that I, HENRIK C. STRÄNG, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Gas-Engines; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to improvements in double-acting gas-engines.

The object of the invention is to simplify and improve the construction of gas-engines and in part to construct such an engine to feed back a part of the remains of a fired charge into the cylinder with a fresh charge; also, to improve and perfect certain working parts of the engine.

Figure 1 is a side elevation of the engine. Fig. 2 is a horizontal section of the cylinder and connections, said section being on line 2, Figs. 3 and 4. Fig. 3 is a transverse section on line 3, and Fig. 4 a transverse section on line 4, Fig. 2. Fig. 5 is a broken vertical section showing cylinder and base and some other parts, the sections being on line 5, Figs. 4 and 6. Fig. 6 is a horizontal section on line 6, Fig. 5; Fig. 7, an enlarged broken section on line 7, Fig. 2. Fig. 8 is a section on line 8, Fig. 7; Fig. 9, a broken detail section on line 9, Fig. 4; Fig. 10, a section through the governor and connections on line 10, Fig. 2; Fig. 11, a section on line 11, Fig. 10; Fig. 12, a horizontal section on line 12, Fig. 10.

A indicates the cylinder, which is mounted on hollow pedestal B. The cylinder is connected with the shaft-supporting pedestal C by the usual guide-frame D.

E denotes the crank-shaft; F, the connecting-rod; G, the piston-rod, and H the piston.

The cylinder has a water-jacket (indicated at 15) and water-spaces in the heads, (see 17 and 18.) A stuffing-box 19 is provided around the piston-rod. At each end of the cylinder there is a chamber *b*, into which the piston does not move, lines *a a* indicating the extreme movement of the piston. The piston H is of greater length than the length of its stroke, so that the working chamber at one end of the cylinder never extends as far toward the center of the cylinder as the proximate end of the working chamber at the other end of the cylinder, and the danger of communicating fire from one chamber to the other is lessened. At one side of the cylinder valve-chests and valves are arranged. The two ends are duplicates, as usual in double-acting engines.

The pedestal B has a central air-chamber 34, into which air may flow through holes 33. From this chamber 34 a passage 36 leads to a longitudinal passage 31 in the side of the shell of the cylinder. Air may thus enter chamber 34 and be drawn therefrom by suction toward either end of the cylinder. The gas which commingles with the air to form the explosive charge enters passage 31 through check-valve 68 and in said passage 31 is mixed with the air. The mechanism for controlling the entrance of gas will be hereinafter described. For the present the mixed air and gas will be called the "fresh mixture," and its course to the cylinder will now be described.

The description will in general be confined to the construction and operation of the devices at one end of the cylinder, it being understood that they are duplicated at the other end, although passage 31 is common to both ends of the cylinder.

The passage 31 leads to the casing 20, Fig. 2, and the mixture therein is prevented from moving to or toward the cylinder when valve 22 is closed. At the proper time valve 22 is opened, and at this time the piston is moving in the cylinder to suck in the mixture through passage *d*, Fig. 9, and so into the cylinder. When the proper quantity of mixture has thus been drawn into the cylinder, the valve 22 closes, and as the exhaust is also closed the return stroke of the piston compresses the mixture in the cylinder. When the proper instant arrives, the mixture is ignited by the operation of the timing-valve 50, and the mixture is exploded, both the inlet and the exhaust valve being closed during the explosion. The explosion drives the piston along in the cylinder, communicating power to the shaft and fly-wheel, as usual. On the return stroke the exhaust-valve 27 is opened by mechanism to be explained, and the burned gases are forced out through passage *d*, thence down and along passage 32, under the cylinder to the chamber 37 in the

pedestal B, from which chamber the waste passes through opening 38 to exhaust-pipe 39. The exhaust-valve 27 remains open until the crank-shaft has passed its center and the piston begins its backward movement, and during such backward movement until valve 27 is closed a part of the gases or exhaust-vapors is drawn back from the exhaust into the cylinder. At the same time valve 22 again opens and a new portion of mixture is drawn from passage 31, the new mixture and the vapors from the exhaust-passage commingling in the passage *d* and in the cylinder. When the predetermined quantity of the exhaust-vapors has been drawn into the cylinder, the exhaust-valve closes, and during the remainder of the backward movement of the piston the mixture that passes to the cylinder is drawn through valve 22. After valve 22 closes the compression-stroke is repeated, and at the close of such stroke the explosion again takes place. In the meantime a like operation takes place at the other end of the cylinder. Thus for one complete reciprocation of the piston and rotation of the crank two explosions take place—one explosion at each end of the piston—while at the next reciprocation no explosion takes place, the engine merely drawing in and compressing the charges to be fired at the next reciprocation, and after each explosion a part of the vapors of the explosion will be ejected and then drawn back along with the fresh mixture.

The shaft 40 extends parallel with the cylinder and is driven by gearing 44 from the main shaft. The shaft 40 is supported in bearings 41 42 43 and carries actuating-cams 48, which open the inlet and exhaust valves, and cams 60, which open the timing-valves. The form of the cams is such as to maintain the valves open for a proper time and the arrangement of the cams on the shaft such as to open the valves at the proper instant.

The valve-stem 24 of valve 22 passes through a tight joint in the casing 20 and has a screw-threaded cap 45 at its lower end, which cap may be adjusted on the valve-stem and held by a set-screw. A spring 49 surrounds a boss on the casing and bears on cap 45, tending to hold the valve to its seat. A link 46 is pivoted at 47 to a suitable support and has a friction-wheel running on cam 48. The outer end of this link supports the lower end of the valve-stem.

Gas is admitted to the ignition-tube 52 through pipe 56, and air is admitted around this tube to support combustion through apertures 95, Fig. 8. The ignition-tube is surrounded by a casing 61 and is closed at the bottom by a screw-plug 8. A cross-passage 51 leads from near the bottom of the ignition-tube to the chamber *d* in proximity to the inlet-valve 22. The outer end of this passage is closed by a screw-plug 62, and a timing-valve 53 serves to close this passage except when the charge is to be ignited. Valve 53 passes through seat 50, and its spindle 54 is connected by screw-thread to cap 57, resting on link 58, which link bears on cam 60. By removing plug 62 the passage 51 may be easily cleansed, and by removing plug 8 the ignition-tube may be cleansed.

The combined governor and equilibrium gas-valve 35 is preferably located midway between the timing-valves. The governor-valve casing 64 has a gas-passage leading to the air-passage 31, hereinbefore referred to. The cock 66 shuts off or permits the flow of gas to the governor-valve, and after passing this valve the gas may pass the check-valve 68 into the passage 31, being drawn in by the suction of the piston, the same as is air, as has been explained. Spring 69 holds valve 68 normally in position to close passage 67, but opens under suction.

The equilibrium-valve 70 is a cylindrical slotted sleeve fitting within a slotted sleeve 71, which sleeve 71 fits closely within the valve-casing 64 at top and bottom, but has an annular passage around it, except where such passage is cut off by vertical ribs 74, which ribs cut off the passage around sleeve 71. A cap 76 holds sleeve 71 in place. The slotted sleeve 70 has an annular chamber 77, which is reached by the cross slots or ports corresponding to the ports in sleeve 71. Inside the sleeve 70 there is an annular shoulder 78, which loosely fits an annular recess 79, which recess is between shoulder 80 on sleeve 81, and a nut 82 on the lower end of such sleeve. Sleeve 81 surrounds shaft 85 and has a bearing 83 in cap 76. The sleeve 70 does not normally have contact with either shoulder 80 or nut 82, being supported by lip 75 on sleeve 71. This leaves a clear space for lubrication through bearing 83. The sleeve 70 is held against rotation by lugs 84, projecting from sleeve or lining 71. The sleeve 81 is feathered to the shaft 85, as at 86, so as to turn with said shaft, but to have a longitudinal movement thereon. The lower end of sleeve 81 when in lowest position rests on collar 87 on shaft 85. The upper end of sleeve 81 has lugs 88, to which the levers 89 are pivoted, the inner ends of these levers resting in a slot in the shaft 85, and the outer ends bearing the balls 90, in position to rise by centrifugal action, as usual in governors of this class. Shaft 85 is driven from shaft 40 by the engagement of gears 92 93. From this construction it will be seen that when the governor is at rest the ports *a'* in the sleeves 70 and 71 are in line with each other, and there is an open passage through these ports, thence out through passages 73, and so around to the check-valve 68, and that the movable sleeve 70 is not supported by the governor; but when the governor moves with such rapidity as to lift the balls and sleeve 81 said sleeve will in turn lift sleeve 70, and so close or partly close the ports *a'* and shut off the gas more or less, according to the speed of the engine.

From the foregoing it should be understood

that the air is drawn into passage 31 at all times when there is suction at either end of such passage. The gas is drawn in and mingled with said air in such quantities as the governor permits, and that after the explosion and expulsion of vapors from the cylinder a certain portion of these vapors, being of the part last expelled from the cylinder, is drawn back into the cylinder through the same port as the fresh mixture of air and gas and mingled therewith. The theory of this operation is that a valuable residuum of unconsumed gas remains in the cylinder after the explosion and that by drawing back a certain part of the expelled charge and mixing it with the fresh charge economy is effected, both by the heating of the new charge and the saving of a remnant of the old charge.

What I claim is—

1. In a gas-engine, the double-action cylinder, the double-valve chest at each end of said cylinder and the supply and separate exhaust valves in said cylinder with means for actuating said valves, a mixing-chamber and passages extending from it to the valve-chambers at the respective ends of the cylinder, substantially as described.

2. In a gas-engine, the horizontal cylinder, the double-acting piston therein, the valve-chest at each end of said cylinder, each valve-chest having an inlet and exhaust valve and means for operating the same, a mixing-chamber and passages extending from it to the valve-chambers at the respective ends of the cylinder, substantially as described.

3. In a gas-engine, the governor, the governor-valve, inserted loosely in its seat, the casing inclosing said valve, the lining interposed between said valve and its casing, said lining having ports as described, and a sleeve having a reciprocating and rotary motion and adapted to move the governor-valve either upwardly or downwardly, substantially as described.

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

HENRIK C. STRÄNG.

Witnesses:

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L. B. COUPLAND.