No. 846,508. PATENTED MAR. 12, 1907.

S. A. REEVE.

EXPLOSION ENGINE.

APPLICATION FILED JULY 16, 1902.

3 SHEETS—SHEET 1.

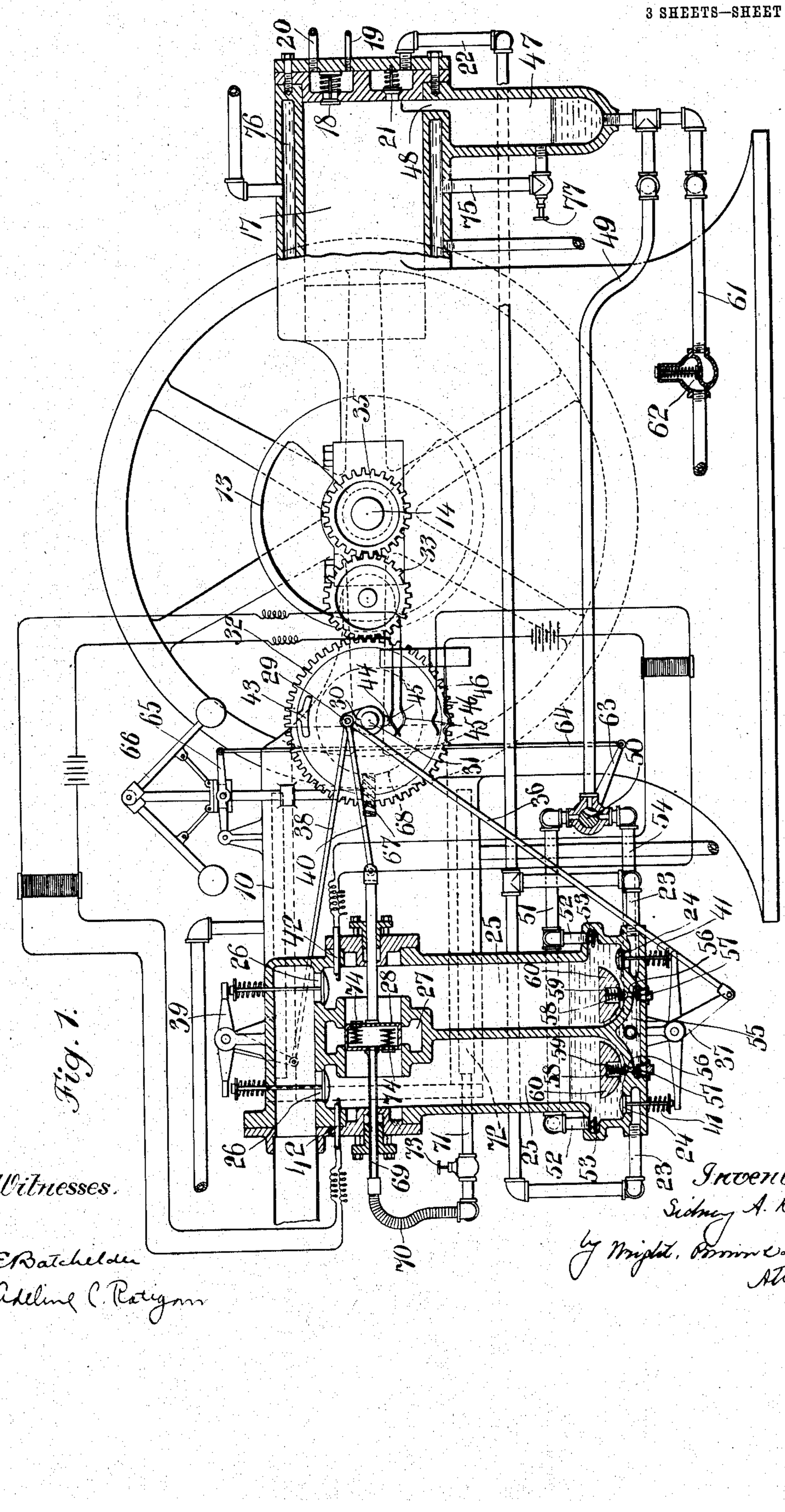

Fig. 1.

Witnesses.

E. Batchelder

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Sidney A. Reeve

by Wright, Brown & Quinby.

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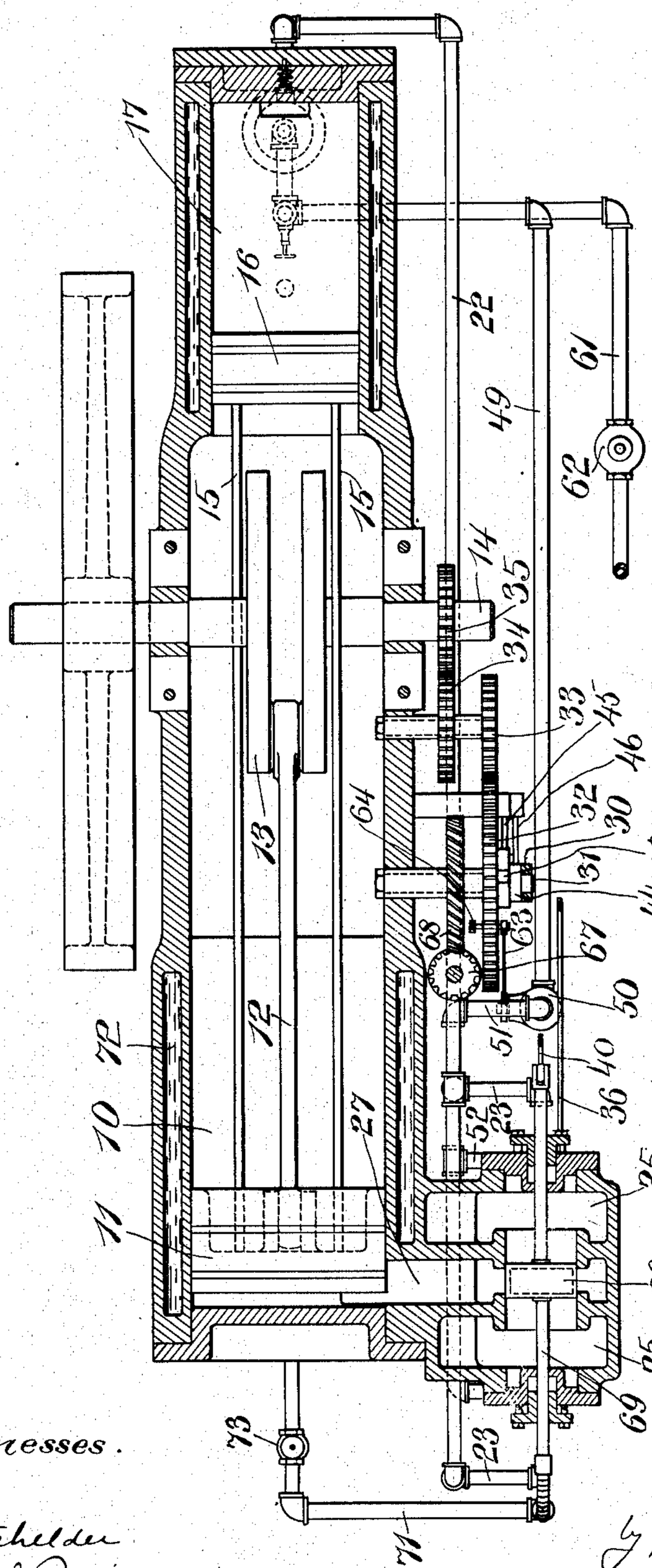

Fig. 2.

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3 SHEETS—SHEET 3.

Fig. 3.

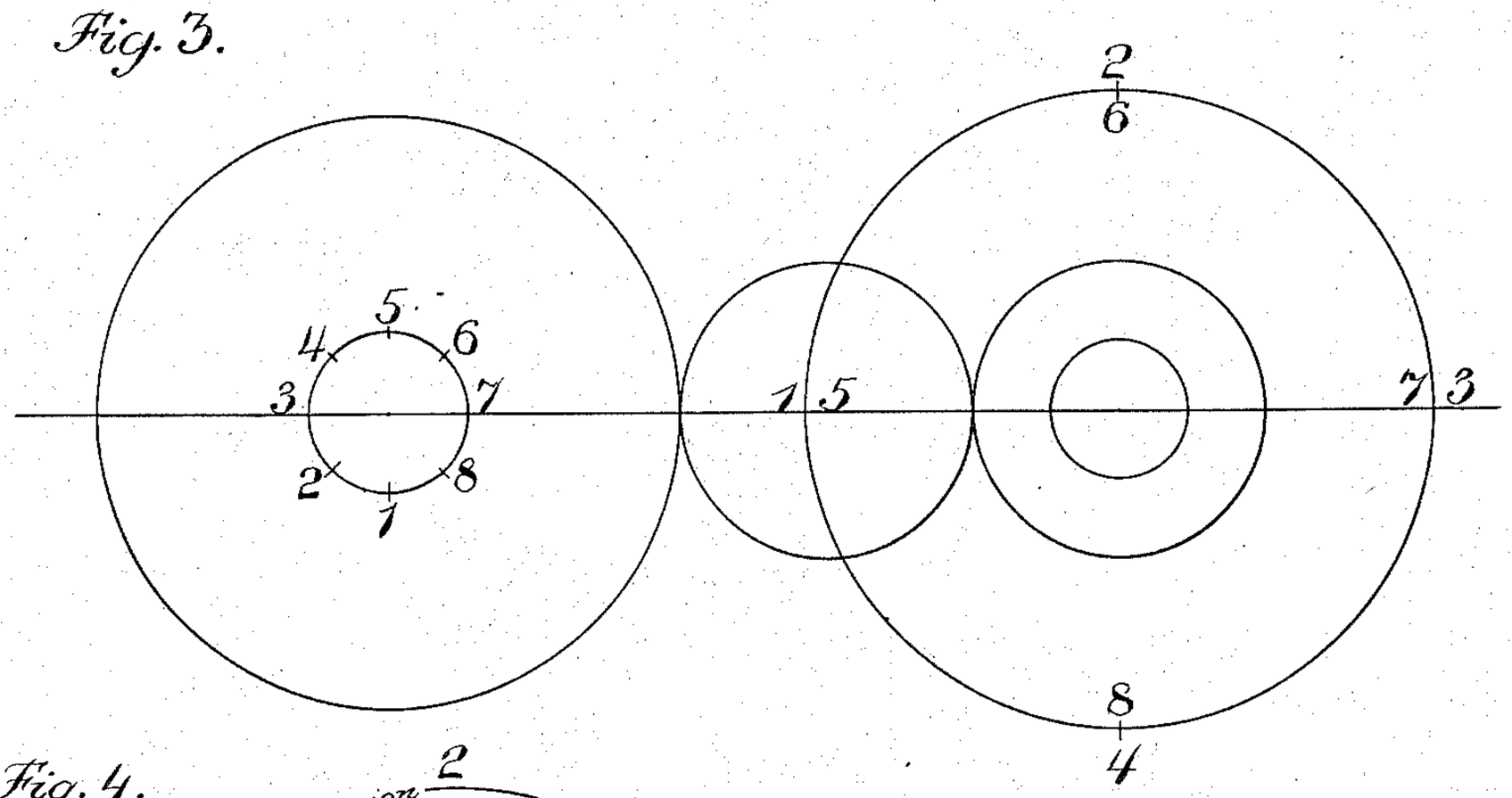


Fig. 4.

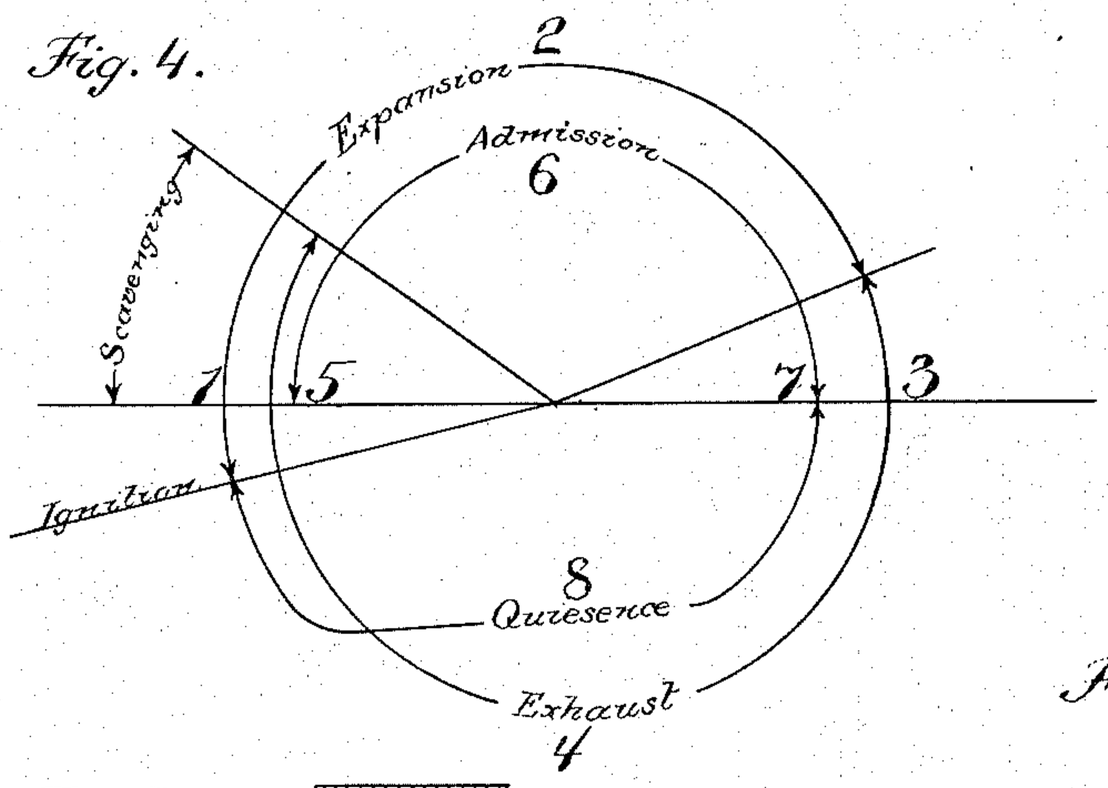


Fig. 5.

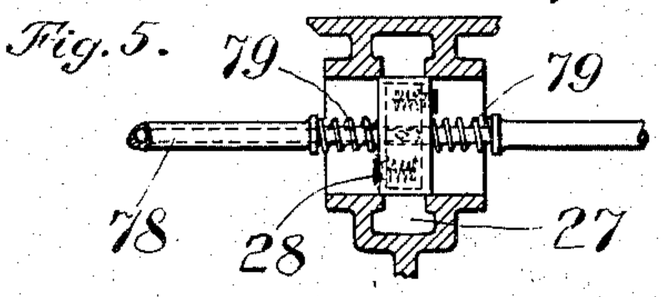
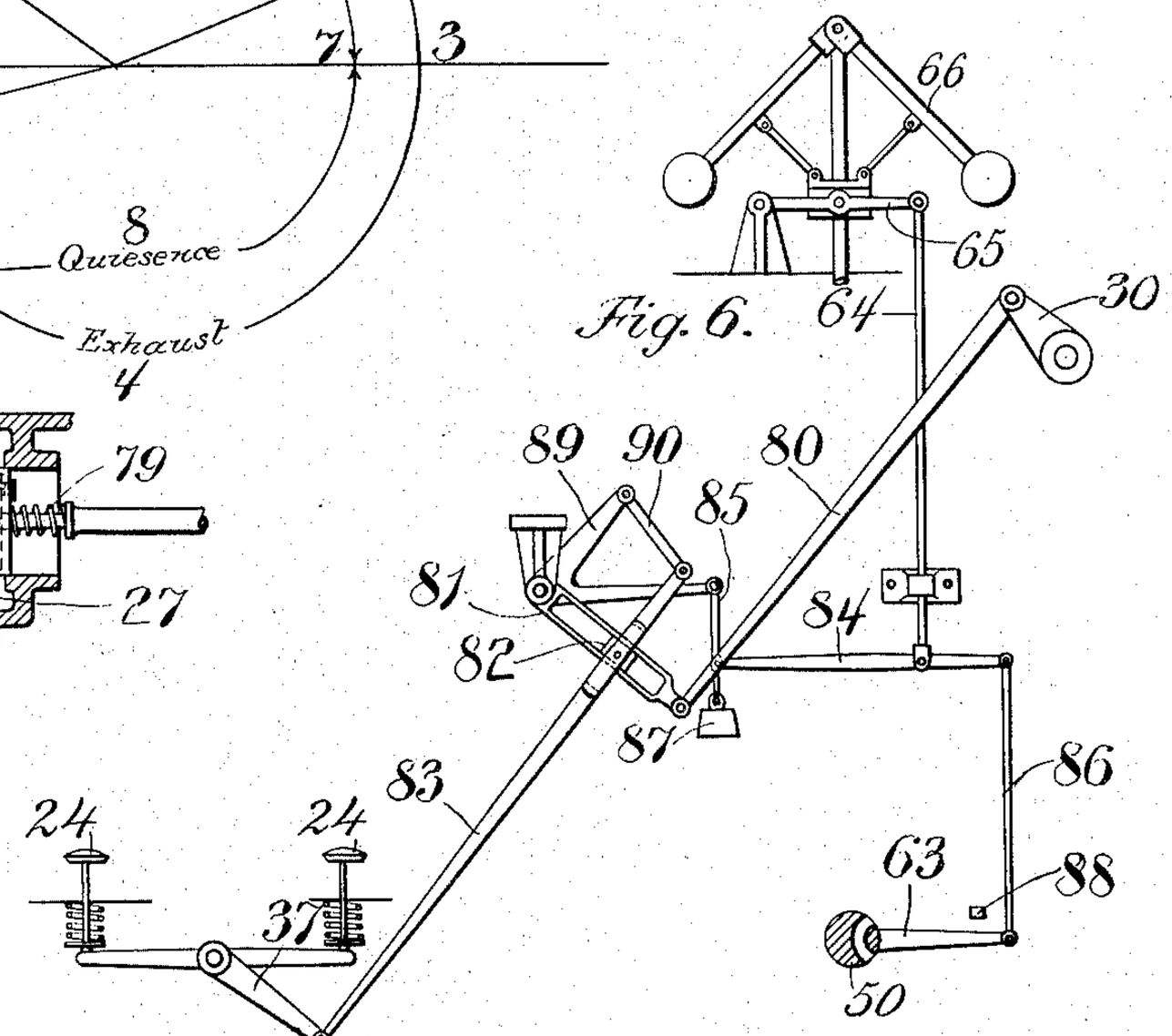


Fig. 6.



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UNITED STATES PATENT OFFICE.

SIDNEY A. REEVE, OF WORCESTER, MASSACHUSETTS, ASSIGNOR TO CHARLES F. BROWN, TRUSTEE, OF READING, MASSACHUSETTS.

EXPLOSION-ENGINE.

No. 846,508. Specification of Letters Patent. Patented March 12, 1907.

Application filed July 16, 1902. Serial No. 115,812.

To all whom it may concern:

Be it known that I, SIDNEY A. REEVE, of Worcester, in the county of Worcester and State of Massachusetts, have invented certain new and useful Improvements in Explosion-Engines, of which the following is a specification.

This invention relates to explosion-engines; and its principal objects are to secure an increased number of power impulses per number of revolutions of the engine-crank and to secure an increase in and improved control of efficiencies.

Of the accompanying drawings, Figure 1 represents a side elevation, partly in section, of an explosion-motor constructed in accordance with my invention Fig. 2 represents a horizontal section of the motor. Fig. 3 represents a diagram of the comparative positions of the main crank and the half-speed crank. Fig. 4 represents a diagram of the events of one cycle of the engine in terms of the position of the main crank. Fig. 5 represents a sectional view showing a modification. Fig. 6 represents a side elevation showing a second modification.

The same reference characters indicate the same parts in all the figures.

In the drawings, 10 is the main working cylinder, having a piston 11, connected by a pitman 12 with the crank 13 on the main shaft 14. The piston 11 is connected directly by rods 15 15 with the piston 16 of a compressor-cylinder 17. 18 is the admission-valve of said compressor-cylinder, through which the piston draws an explosive mixture on its suction-stroke from gas and air pipes 19 20, and 21 is the discharge-valve.

22 is the pipe for supplying combustible mixture to the engine, leading from the compressor-cylinder and having branches 23 23, terminating below two admission-valves 24 24. The latter are located at the lower part of a pair of explosion-chambers 25 25, having exhaust-valves 26 26 at their upper ends and a common outlet-passage 27, leading to the cylinder 10 and controlled by a sliding piston-valve 28.

The admission, exhaust, and piston valves are all operated from the wrist-pin 29 of a crank 30 on a shaft 31, operated at half speed from the main shaft 14 through gearing 32 33 34 35, the connection with the admission-valves being through rod 36 and lever 37, actuating the stems of said valves, with the exhaust-valves through rod 38 and lever 39, actuating the stems of said valves, and with the piston-valve 28 through a pitman-rod 40, connected with the stem of said valve. The admission-valves 24 are held closed by springs 41 and are not opened except by the lever 37. Admission and exhaust occur alternately in the two chambers 25, and ignition is performed alternately therein by igniters 42 42, whose circuits are actuated by cams 43 44, operating on contact-springs 45 46.

47 is a clearance space or chamber connecting by a passage 48 with the compressor-cylinder 17 and by a pipe 49, leading from its lower end, with the casing of a valve 50. From said casing also extend an induction-pipe 51, having branches 52 52, connected to the respective explosion-chambers 25 25 and controlled by check-valves 53 53, opening toward said chambers, and an eduction-pipe 54, leading to a chamber 55, which is connected with the lower ends of the explosion-chambers by outlets 56 56, controlled by check-valves 57 57, opening away from said chambers. The outlets 56 are also controlled by valves 58 58, normally held open by springs 59 59, but adapted to be closed by "floats" 60 60 when the latter are unimmersed, so as to prevent the escape of the gaseous contents of the explosion-chambers when all the water is out of them.

61 is an escape-pipe leading from the lower end of clearance-chamber 47 and containing a safety-valve 62, adapted to release water from the chamber 47 upon the attainment of a predetermined pressure of compression.

The valve 50 is adapted to connect either the induction-pipe 51 or the eduction-pipe 54 with the pipe 49, thereby establishing or permitting a flow of water either toward or away from the explosion-chambers 25. This valve is connected by an arm 63, rod 64, and lever 65 with a governor 66, driven through gearing 67 68 from the shaft 31.

It will be seen that the piston-valve 28 is hollow or chambered and receives a supply or circulation of water through its hollow

stem 69, flexible conduit 70, and pipe 71 from the water- acket 72 of the working cylinder 10. A hand-valve 73 controls the supply of water, which finds its way at certain periods through check-valves 74 74 into the explosion-chambers 25, as more fully hereinafter explained. Water may, if desired, be admitted to any other su table point in the system, as into the clearance-chamber 47, through a pipe 75, leading from the water-jacket 76 of the compressor-cylinder and having a hand-valve 77.

The operation is as follows: The relation between the main crank 13 and the crank 30 is illustrated in Fig. 3, in which the numerals on the large circle at the right represent successive positions of the main crank-pin, while the numerals on the small circle at the left represent corresponding positions of the pin 29 of the crank 30. Fig. 4 shows the succession of events for one complete cycle of two revolutions of the main crank in either one of the explosion-chambers 25. The clearance-space between the piston and cylinder-head in both cylinders is a very small proportion of the piston-stroke. Suppose the engine to be in motion at normal speed and under normal load and the clearance-space 47 nearly full of water, while the explosion-chambers 25 are nearly empty thereof. The compressor-cylinder 17 draws in at each left-handward stroke of its piston nearly its full measure of explosive mixture owing to the small clearance and compresses it during the following r ght-hand stroke into the pipe 22. Suppose the main crank to be at position 5 in Fig. 3. Fig. 4 shows what will occur n the right-hand explosion-chamber 25 As the main piston moves off from dead-center piston 28 moves to the right and shuts off the right-hand chamber 25 from the working cylinder. At this time, assuming the admission of water to be by way of pipe 71, a small quantity sprays into the right-hand chamber 25 through the right-hand check-valve 74 and descends through the gases in said chamber 25. At the samé time the right-hand admission-valve 24 opens and the charge from cylinder 17 is com pressed into the right-hand explosion-chamber. At the end of the stroke the cranks 13 and 30 are in the positions 7 7 of Fig. 3. The process of admission during this period is shown by the upper part of the inner semicircle in Fig. 4. While the cranks pass through positions 7 and 8 nearly to position 1, nothing happens in the right-hand explosion-chamber. At or near position 1 ignition occurs in said chamber and explosion follows. Valve 28 is now moving toward the left and opens the right-hand explosion-chamber to the working cylinder. Expansion occurs in said cylinder and the cranks move through positions 1, 2, and 3. At or before position 3 the right-hand exhaust-valve 26 opens and during the left-handward stroke of the main piston through positions 3, 4, and 5 of the main crank this valve 26 and the valve 28 remain open. The right-hand check-valve 74 also opens again and sprinkles water through the exhaust-gases. When dead-center of the main crank is reached at point 5, the right-hand exhaust-valve 26 preferably does not close immediately. Just before it closes the right-hand admission-valve 24 opens and the compressed contents of pipe 22 escape into the right-hand explosion-chamber and scavenge the burned gases therefrom. This completes the cycle in the right-hand explosion-chamber. The same cycle is being simultaneously performed in the left-hand explosion-chamber 25, but with the order of events shifted by the period occupied by one revolution of the main crank. It is evident, therefore, that the main piston receives an impulse at every outward stroke. During the foregoing action the governor 66 has supposedly been quiet or in a position of equilibrium, which is that wherein the valve 50 slightly opens the eduction-conduit 54 to the conduit 49. The same amount of water which enters the explosion-chambers 25 through pipe 71 is then vented through safety-valve 62. Now suppose the load to decrease. The ensuing rise of speed causes the governor 66 to rise and shut off the outflow through pipe 54 and possibly establish an inflow through pipe 51. In this event the water-level rises in explosion-chambers 25 and falls in clearance-chamber 47. It falls in the latter both because when the passage is open through pipes 49 51 there are periods of greater pressure in 17 than in the chambers 25, such periods occurring at or near the end of the compression-stroke in 17, and also because the accumulation of water flowing into the chambers 25 increases the compression in chambers 25, pipe 22, and clearance-chamber 47, and hence as much water flows through 62 as is admitted from pipe 71.

The effect of the fall of water-level in clearance-chamber 47 is to decrease the amount of mixture taken in by the compressor-cylinder on its suction stroke. A smaller quantity of mixture is therefore compressed into the chambers 25 and a weaker impulse stroke of the main piston ensues, thus tending to reduce the speed to normal; but it will be noted that the efficiency is not reduced, because this depends upon the degree of compression and the compression is not changed substantially. The efficiency is rather increased. owing to the expansion of a smaller charge into the same-sized main cylinder volume. The above regulating process must continue until the decreased impulses have brought the speed back to normal, in which case the governor will resume its former position, but the water will be lower in clear-

ance-chamber 47 and higher in explosion-chambers 25.

The action under increase of load is the reverse of the foregoing.

In the modification shown in Fig. 5 the piston-valve 28 is mounted loosely upon its stem 78 and centralized by springs 79 79, such construction securing a rapid and quick opening of the valve under the impulse of the explosion.

Fig. 6 shows a joint speed-control of the water-level in the explosion-chambers and the admission of mixture thereto. The numerals 30, 37, 63, and 64 in this figure represents the same elements as in Fig. 1, and the following-described operation will be readily understood by supposing that the connections shown in Fig. 6 are substituted for the connections shown in Fig. 1 between the half-speed shaft, the governor, and the mechanically-operated water-valves. In this case the crank 30 is connected by rod 80 with a rock-lever 81, having a guide for a sliding block 82, to which is connected a rod 83, actuating the arm of the lever 37, whereby the admission-valves are operated. The governor-rod 64 is attached to a floating lever 84, connected by link 85, lever 89, and link 90 with the rod 83, and by a link 86 with the arm 63, attached to the plug-valve 50. Lever 84 carries a weight 87 to depress its longer end. By this arrangement upon an increase of speed the arm 63 rises until it encounters stop 88. The outflow of water from the explosion-chambers is thus arrested, but regulation of the admission simultaneously takes place because of the upward swinging of lever 84 on its connection with rod 86 as a fulcrum and the consequent movement of block 82 toward the pivot of rock-arm 81. This decreases the throw of the lever 37 and the opening of the admission-valves, the immediate effect of which is as follows: It chokes back the pressure in pipe 22 and causes valve 62 to open and release water from 47, thus decreasing the supply of mixture to the engine. The throttling of the admission reduces the pressure in the explosion-chambers 25 previous to ignition, and hence reduces the force of the following impulse. By decreasing the length of the admission-arc in Fig. 4 at both ends this throttling destroys the effect in the explosion-chambers of the last part of the compression-stroke in the compressor and by accumulating volume in the clearance-space 47 tends to drive water out through valve 62. Since some or all of the scavenging is omitted, the power impulse is made slower and weaker. The above action affords a quick variation in power to meet a sudden and wide variation in load and is accompanied by a temporary loss of efficiency, which latter, however, returns to normal as soon as the water-levels have properly adjusted themselves and have caused the throttling of the admission to cease. With the arrangement shown in Fig. 6 the induction-conduit 51 of Fig. 1 may, if desired, be omitted.

I claim—

1. In an explosion-engine, the combination of a working cylinder and piston, a plurality of explosion-chambers alternately connectible with the same end of said cylinder, and compressing means distinct from said chambers and operated by the working piston for alternately charging said chambers with combustion fluid.

2. In an explosion-engine, the combination of a working cylinder and piston, a plurality of explosion-chambers alternately connectible with the same end of said cylinder, a compressor-cylinder having a piston operated by the working piston and having discharge connections with the respective explosion-chambers, and automatically-operated valve mechanism controlling the admission from said connections to the explosion-chambers.

3. In an explosion-engine, the combination of a working cylinder and piston, two explosion-chambers supplying the same end of the cylinder, a single moving valve structure adapted to alternately connect said chambers with the cylinder, and mechanism for moving said valve structure at half the number of cycles of the working piston.

4. In an explosion-engine, the combination of a working cylinder and piston, two explosion-chambers having a common outlet to the cylinder, a sliding piston-valve controlling said outlet, and mechanism for moving said valve at half the number of strokes of the working piston.

5. In an explosion-engine, the combination of a working cylinder and piston, a plurality of explosion-chambers, connected to supply the same end of said cylinder, means to alternately connect said chambers with the cylinder, a compressor-cylinder having a piston operated by the engine, and means to connect said compressor-cylinder alternately with said explosion-chambers.

6. In an explosion-engine, the combination of a working cylinder and piston, a compressor for charging said cylinder, distinct from said cylinder and having a clearance-chamber, means to supply a clearance-varying liquid to said chamber, and connections for controlling the liquid-level in said chamber by the compression in said cylinder.

7. In an explosion-engine, the combination of a working cylinder having a clearance-chamber, means for supplying a clearance-varying liquid to said chamber, and a compressor adapted to charge said cylinder and connected to control the liquid-level in said chamber.

8. In an explosion-engine, the combination of a working cylinder, a compressor-cylinder for charging the same, connected clear-

ance-chambers for said cylinders, and means to supply clearance-varying liquid to said chambers.

9. In an explosion-engine the combination of a working cylinder and piston, an explosion-chamber for said cylinder, a compressor-cylinder for charging said explosion-chamber having a piston driven by the engine and a clearance space or chamber, means to transfer liquid between said clearance-space and explosion-chamber, and means to supply said liquid thereto.

10. In an explosion-engine the combination of a working cylinder and piston, two explosion-chambers for said cylinder, a compressor-cylinder arranged to alternately charge said chambers and having a piston driven by the engine and a clearance space or chamber, means to transfer liquid between said clearance-space and explosion-chambers, and means to supply said liquid thereto.

11. In an explosion-engine the combination of a working cylinder and piston, an explosion-chamber for said cylinder, a compressor-cylinder for charging said explosion-chamber having a piston driven by the engine and a clearance space or chamber, means to transfer liquid between said clearance-space and explosion-chamber, means to supply said liquid thereto and means controlled in accordance with the speed of the engine for controlling the transfer of liquid.

12. In an explosion-engine the combination of a working cylinder and piston, two explosion-chambers for said cylinder, a compressor-cylinder arranged to alternately charge said chambers and having a piston driven by the engine and a clearance space or chamber, means to transfer liquid between said clearance-space and explosion-chambers, means to supply said liquid thereto and means controlled in accordance with the speed of the engine for controlling the transfer of liquid.

13. In an explosion-engine the combination of a working cylinder and piston, two explosion-chambers, a compressor-cylinder arranged to alternately charge said chambers and having a piston driven by the engine and a clearance space or chamber, means to transfer liquid between said clearance-space and explosion-chambers, means to supply said liquid thereto and means controlled in accordance with the speed of the engine for directing the flow alternately in opposite directions.

14. In an explosion-engine the combination of a working cylinder and piston, two explosion-chambers for said cylinder, a compressor-cylinder for charging said explosion-chambers having a piston driven by the engine and a clearance space or chamber, means to supply a liquid to said explosion-chambers and clearance-space, a liquid-transferring connection between said explosion-chambers and space including induction and eduction conduits connected to the explosion-chambers and having respectively check-valves opening toward and away from said explosion-chambers, and means to establish the flow alternately through said induction and eduction conduits.

15. In an explosion-engine the combination of a working cylinder and piston, two explosion-chambers for said cylinder, a compressor-cylinder for charging said explosion-chambers having a piston driven by the engine and a clearance space or chamber, means to supply a liquid to said explosion-chambers and clearance-space, a liquid-transferring connection between said explosion-chambers and space including induction and eduction conduits connected to the explosion-chambers and having respectively check-valves opening toward and away from said explosion-chambers, and means controlled in accordance with the speed of the engine for establishing the flow alternately through said induction and eduction conduits.

16. In an explosion-engine, the combination of a working cylinder and piston, an explosion-chamber for said cylinder, means to supply a liquid to said chamber, an inlet to the lower part of said chamber for supplying combustion fluid thereto, and an admission-valve controlling said inlet.

17. In an explosion-engine, the combination of a working cylinder and piston, an explosion-chamber for said cylinder, a compressor-cylinder for charging said explosion-chamber having a piston driven by the engine and a clearance space or chamber, means to transfer liquid between said clearance-space and explosion-chamber, means to supply said liquid thereto, and means to release liquid from said clearance-space upon the attainment of a predetermined pressure of compression.

18. In an explosion-engine, the combination of a working cylinder and piston, a plurality of explosion-chambers, means to alternately connect said chambers with the cylinder, means to admit liquid to said chambers, means to admit an explosive alternately to the chambers, and means to control the quantity of liquid and the admission of explosive according to the speed of the engine.

19. In an explosion-engine, the combination of a working cylinder and piston, an explosion-chamber for said cylinder, a compressor-cylinder for charging said explosion-chamber having a piston driven by the engine and a clearance space or chamber, means to transfer liquid between said clearance-space and explosion-chamber, means to supply said liquid thereto, and means to control the transfer of liquid, and the admission of the charge to the explosion-chamber, according to the speed of the engine.

20. In an explosion-engine, the combina-

tion of a working cylinder having a clearance-chamber, means to supply a clearance-varying liquid, and means controlled in accordance with the speed of the engine for directing the flow of said liquid alternately toward and away from said clearance-chamber.

21. In an explosion-engine, the combination of a working cylinder, an explosion-chamber therefor, a valve controlling communication between said cylinder and chamber and chambered for a cooling liquid, means for supplying said liquid to the valve, and an outlet from the liquid-chamber of the valve to said explosion-chamber.

22. In an explosion-engine, the combination of a working cylinder, two explosion-chambers therefor, a moving hollow valve structure adapted to alternately connect said chambers with the cylinder and having outlets to the chambers, and outwardly-opening check-valves for said outlets.

23. In an explosion-engine, the combination of a working cylinder, a reciprocating piston therein, an explosion-chamber therefor, and a valve timed with the piston and controlling the connection between said cylinder and explosion-chamber, said valve being arranged to open by the force of the explosion.

24. In an explosion-engine, the combination of a working cylinder, an explosion-chamber therefor, a valve controlling the connection between said cylinder and explosion-chamber and adapted to be opened by the force of the explosion in the latter, means for operating said valve, and an elastic connection between said valve and operating means.

25. In an explosion-engine, the combination of a working cylinder, two explosion-chambers therefor, a valve adapted to alternately connect said chambers with the cylinder, means for reciprocating said valve, and elastic means connecting said valve and said reciprocating means and arranged to permit said valve to yield in either direction.

26. In an explosion-engine, the combination of a working cylinder and piston, a charging-cylinder having a piston operated by the working piston, and clearance-varying means for one of said cylinders operated by the pressure in the other cylinder.

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

SIDNEY A. REEVE.

Witnesses:

ADELINE C. RATIGAN.

E. BATCHELDER.