No. 846,004. PATENTED MAR. 5, 1907.

C. H. BROOKS.

EXPLOSIVE ENGINE.

APPLICATION FILED AUG. 7, 1905.

Fig. 1.

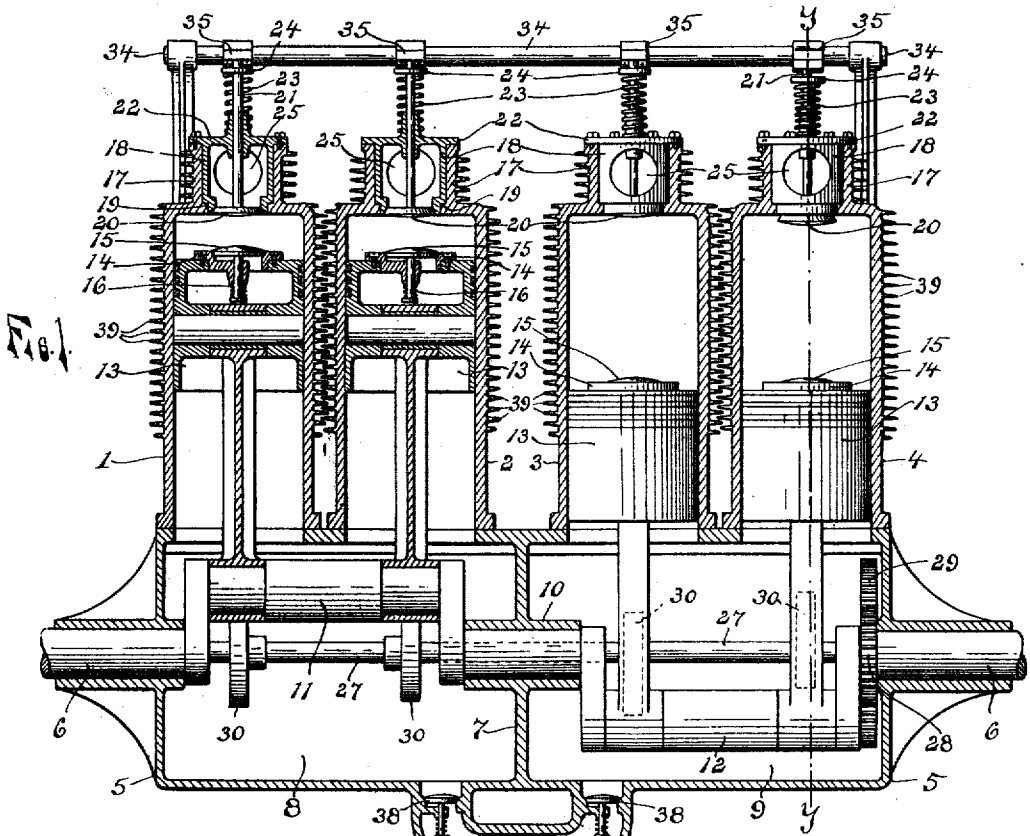
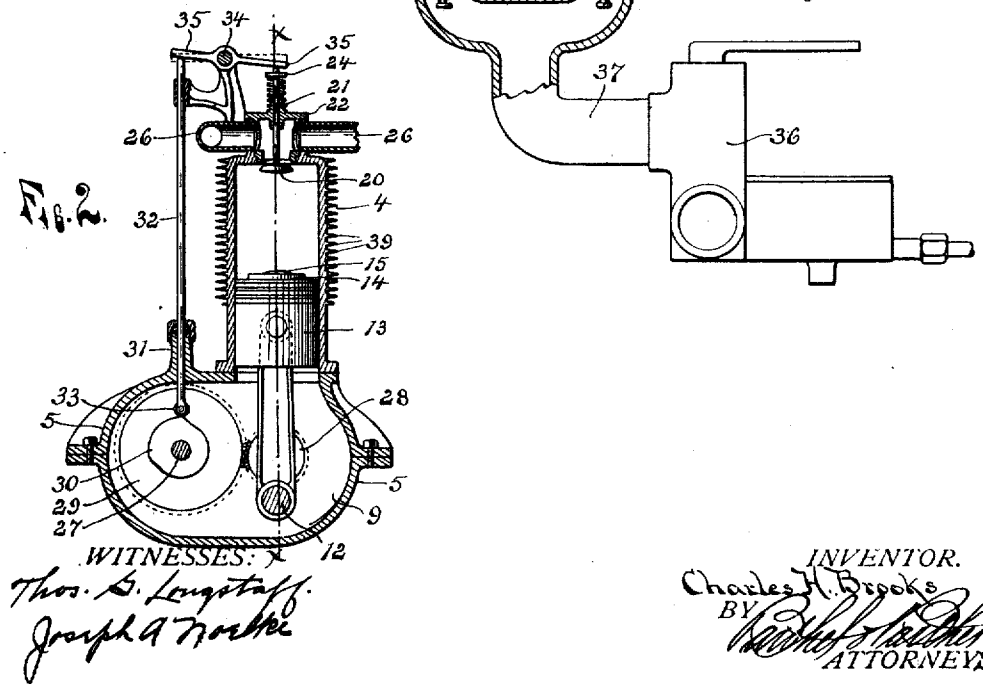


Fig. 2.



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EXPLOSIVE-ENGINE.

No. 846,004. Specification of Letters Patent. Patented March 5, 1907.

Application filed August 7, 1905. Serial No. 272,951.

To all whom it may concern:

Be it known that I, CHARLES H. BROOKS, a citizen of the United States of America, residing at Detroit, in the county of Wayne and State of Michigan, have invented certain new and useful Improvements in Explosive-Engines, of which the following is a specification, reference being had therein to the accompanying drawings.

This invention relates to improvements in explosive-engines of the multiple-cylinder type, and more especially to four-cycle engines of this class employing four or more vertical cylinders, the object of the invention being to provide means for introducing the explosive charges directly into the lower ends of the cylinders in such a manner that the pistons and parts will be cooled thereby, thus obviating, when radiating ribs are used, the necessity for a water-jacket. A charge will be forced into one of the cylinders at each half-revolution of the crank-shaft, driving the residue of the previously-exploded charge from the cylinder and filling the same to its fullest capacity, thereby securing the maximum power and speed with the use of a minimum amount of explosive mixture.

A further object of the invention is to provide an engine having the several advantages of the particular construction, arrangement, and combination of parts, all as hereinafter more fully described, reference being had to the accompanying drawing, in which—

Figure 1 is a vertical section on the line $x\,x$ of Fig. 2 of a device embodying the invention and showing the pistons and valve-cages for one set of cylinders in side elevation, and Fig. 2 is a transverse section on the line $y\,y$ of Fig. 1 drawn to a smaller scale.

As shown in the drawings, 1, 2, 3, and 4 are the vertically-extending parallel cylinders opening at their lower ends into an air-tight crank-case 5, formed with a bearing at each end fo the crank-shaft 6 and with a partition-wall 7, which divides the crank-chamber transversely into two equal air-tight chambers 8 and 9, and is formed with a bearing 10 to engage the shaft between its two oppositely-extending cranks 11 and 12. The pistons 13 in the two cylinders 1 and 2 are connected to the crank 11 in the chamber 8 to move simultaneously in the same direction, and the pistons in the cylinders 3 and 4 are connected to the crank 12 to move together in a direction opposite to that of the other pair of pistons.

In each piston-head is an opening within which is secured a ring 14, formed with a valve-seat for a valve 15, adapted to open into the cylinder above the piston, and a spring 16 on the stem of said valve normally holds the same to its seat. In the cylinder-head directly opposite said valve 15 is an opening, and extending upward around this opening is a cylindrical portion 17, forming a cylindrical bearing to receive a cylindrical valve-cage 18, which fits closely therein and is detachably held in place, with a shoulder 19, formed at its inner end, engaging a shoulder on the cylinder-head by bolts extending through a flange on its upper end into the end of the bearing 17. The inner end of the cage is open and formed with a valve-seat for an exhaust-valve 20, the stem 21 of which extends upward through a guide-bearing on the closed upper end 22 of the cage, and a coiled spring 23, sleeved on the outer end of said stem between a collar 24 thereon and the end of the cage, normally holds the valve to its seat. In opposite sides of each cage are openings 25, which register with similar openings in the sides of the cylindrical bearings 17, and exhaust-pipes 26 are secured in these openings to conduct away the exhaust.

Extending longitudinally through the crank-chambers at one side of and parallel with the crank-shaft is a cam-shaft 27, which receives motion from said crank-shaft by means of a small gear 28 on said shaft in mesh with a gear 29 of twice the size on the cam-shaft. Cams 30 are secured on the cam-shaft, and extending upward through vertical guide-bearings 31 on the top of a laterally-extending portion of the crank-case are the push-rods 32, provided with friction-rolls 33 on their lower ends to engage said cams. Mounted in suitable bearings on the upper ends of the cylinders is a fixed shaft 34, extending horizontally adjacent to and at one side of the upper ends of the valve-stems 21 of the exhaust-valves, and on this fixed shaft are mounted to freely turn rocker-bars 35, each having an arm extending laterally from the shaft in one direction into engagement with the upper end of one of said valve-stems and an arm extending in the opposite direction adapted to be engaged by

the upper end of one of the push-rods, which when moved vertically by its cam will rock one of said bars on the fixed shaft and open one of the exhaust-valves.

36 is any ordinary form of mixing-valve for supplying a mixture of air and vapor, which is drawn into the crank-case upon the upward or suction stroke of the pistons through a pipe 37, leading into the bottom of said crank-case, said pipe being branched to connect with each crank-chamber, and each branch is provided with an upwardly-opening valve 38 to prevent the air from being forced outward through the pipe and mixing-valve upon the compression or downstroke of the pistons.

The cams 30 are so set that they will open the exhaust-valves in a certain timed relation to the movement of the pistons and give the engine a four-cycle operation, and the pistons of each pair of cylinders move simultaneously in the same direction, so that when the piston in cylinder 1 is on its downstroke its valve 15 will be opened, and the explosive charge previously drawn into the crank-chamber 8 by the upstroke of said pistons 1 and 2 will pass into the cylinder through said valve, and at the same time the piston in cylinder 2 will be forced downward by a charge exploded therein and its valve held to its seat thereby, thus assisting to force the charge contained in the crank-chamber into cylinder 1. At the same time that the pistons in cylinders 1 and 2 are moving downward, as described, the pistons in cylinders 3 and 4 are moving upward, the piston in cylinder 3 compressing a charge just previously drawn in and the piston in cylinder 4 forcing the residue of a charge exploded during the previous downstroke of said piston out past the open exhaust-valve of said cylinder. During the next or upstroke of the piston in cylinder 1 the charge just drawn in is compressed, and the same movement of the piston in cylinder 2 forces out the residue of the charge just exploded therein. The charge just compressed by the upstroke of the piston in cylinder 3 is exploded during the next or downward stroke thereof, and during the simultaneous downward movement of the piston in cylinder 4 a charge is taken into said cylinder, its intake-valve being free to lift after the pressure thereon has been taken off by the previous exhaust movement of said piston. After compression the charge in cylinder 1 is exploded during the third movement of the piston in the cycle of operation, a charge is taken into cylinder 2, the residue from the previous explosion is exhausted from cylinder 3, and in cylinder 4 the charge just taken in is compressed. During the fourth movement of the pistons, which completes the cycle of operation, the residue from the charge just exploded in cylinder 1 is forced out, the charge just taken into cylinder 2 is compressed, a new charge is taken into cylinder 3, and in cylinder 4 an explosion takes place. This operation is made possible by dividing the crank-case into two separate air-tight chambers and causing the two pistons in the two cylinders communicating with each chamber to move in the same direction, thus creating upon the downstroke of each pair of pistons a high compression in their crank-chamber. Upon each downstroke of the pistons in each pair of cylinders an explosion takes place in either one or the other of the cylinders of that pair, so that one of the valves is automatically held to its seat, thus causing the charge to be driven with a great deal of force into the other cylinder. The exhaust-valve is preferably held open for a short time after the intake-valve opens, so that the inrushing charge will force out the residue of the previously-exploded charge not expelled by the clearing or exhaust stroke of the piston, and therefore each cylinder is completely cleared of the products of combustion and a very full charge taken in, giving a maximum of power and speed with the use of a minimum amount of explosive mixture.

The cooling of the pistons and parts is so aided by taking in the charges through the piston-heads from the crank-case that by forming the cylinders with radiating ribs 39 the necessity for a water-jacket and water circulation is obviated.

The head of each cylinder is shown as being cast integral with its cylinder, the opening therein being of sufficient size to permit the removal of the inlet-valve 15 therethrough; but, if desired, said heads may be made separate and bolted to the cylinders to permit of freer access to the piston-head. By providing a removable cage for the exhaust-valve of each cylinder the removal of said valve is greatly facilitated and its seat may be easily reground at any time.

Having thus fully described my invention, what I claim is—

1. In a multicylinder-engine having a series of pairs of cylinders, the combination therewith of an air-tight crank-case to which the cylinders are secured in communication therewith; a crank-shaft in said crank-case provided with cranks; pistons in said cylinders connected in pairs to said cranks, the pistons of each pair moving simultaneously in the same direction; a wall dividing the crank-case into separate crank-chambers with each of which two cylinders containing a pair of pistons communicate; means for admitting explosive charges compressed in each chamber into one of the cylinders in communication therewith, and means for controlling the exhaust from the cylinders.

2. In an explosive-engine, the combination of a series of cylinders arranged in pairs, an air-tight crank-case to which the cylin-

ders are secured in communication therewith, a partition-wall in said crank-case dividing the same into crank-chambers into each of which a pair of cylinders opens, a crank-shaft in the crank-case having cranks, pistons in each pair of cylinders connected to the cranks to move simultaneously in the same direction, inlet-valves in the heads of the pistons, exhaust-valves in the heads of the cylinders, and means for operating the exhaust-valves in timed relation to the movement of the pistons.

3. In a multicylinder-engine, the combination with a series of pairs of vertical cylinders having open lower ends, of an air-tight crank-case to which the open ends of the cylinders are secured, a partition-wall dividing the crank-case into separate crank-chambers with each of which a pair of cylinders communicate, a crank-shaft, pistons in the two cylinders opening into each chamber connected to the crank-shaft to move simultaneously in the same direction, valves in the heads of the pistons to permit the explosive charges from the chambers to pass upward through the pistons into the cylinders, exhaust-valves in the heads of the cylinders, a cam-shaft, gears for transmitting motion from the crank-shaft to the cam-shaft, cams on the cam-shaft, and means operated by said cams for opening the exhaust-valves in timed relation to the movement of the pistons.

4. In an explosive-engine, the combination of four or more vertical cylinders arranged in pairs and having open lower ends, an air-tight crank-case formed with separate crank-chambers each in free communication with one pair of cylinders, a horizontal crank-shaft having a crank in each chamber, pistons in each pair of cylinders connected to the crank in the chamber to move simultaneously in the same direction, a valve to admit explosive charges to each chamber, a valve in the head of each piston to permit the charges to pass into the cylinder above the pistons, an exhaust-valve in the upper end of each cylinder and means for opening said valves.

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

CHARLES H. BROOKS.

Witnesses:
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