Aug. 31, 1926. 1,597,924

A. L. POWELL

INTERNAL COMBUSTION ENGINE

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Fig. 1.

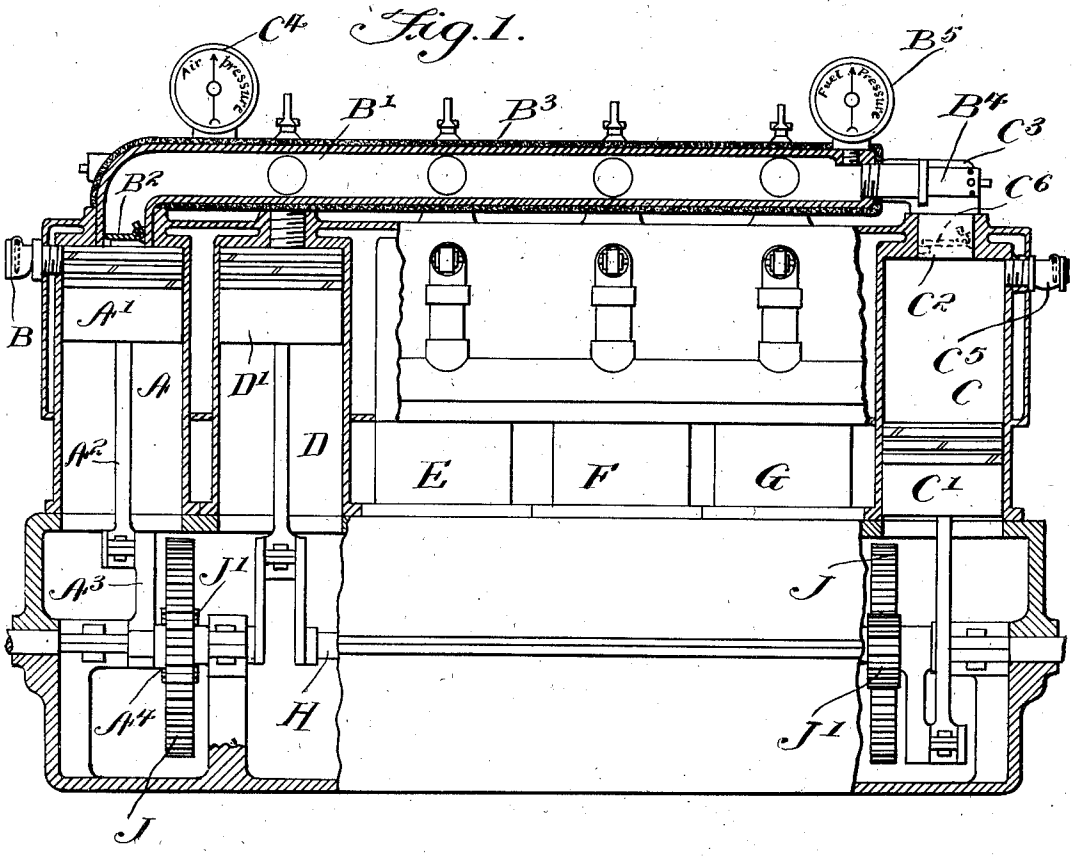


Fig. 4.

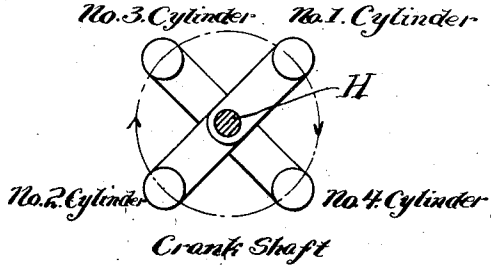
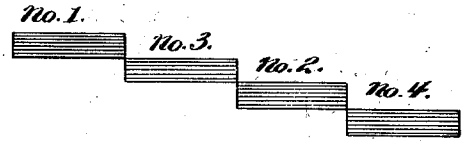


Fig. 5.



Firing order and power impulses to one revolution of crank

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Fig. 2.

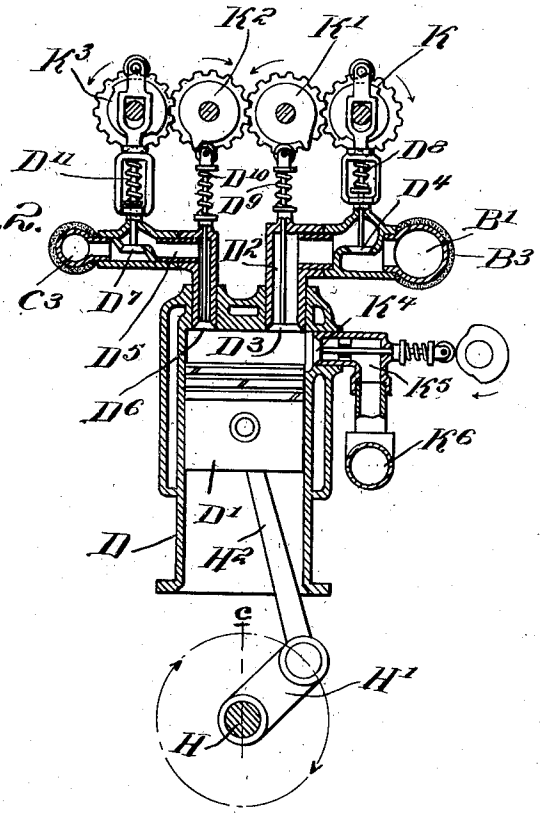
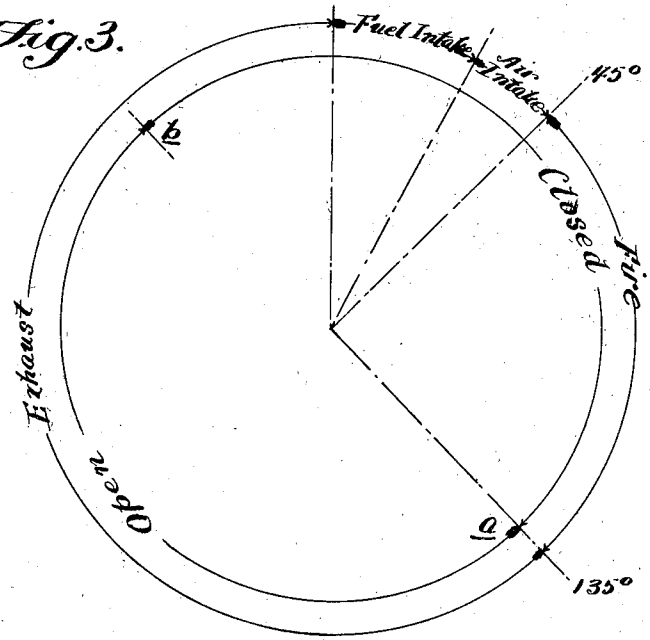


Fig. 3.



Inventor

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Patented Aug. 31, 1926. 1,597,924

UNITED STATES PATENT OFFICE.

ALVAH L. POWELL, OF MILES CITY, MONTANA, ASSIGNOR TO THE A. L. POWELL POWER CO., INC., OF MILES CITY, MONTANA, A BODY CORPORATE.

INTERNAL-COMBUSTION ENGINE.

Application filed February 2, 1921. Serial No. 441,968.

My invention relates to improvements in internal combustion engines in which I use novel means for preparing the firing charge, and for introducing it in the cylinder. I also effect ignition in a direct, mechanical way that adds to the efficiency of an engine equipped with my improvements.

In the accompanying drawings I show a form of my invention, applied to a four cylinder engine.

Fig. 1 is an elevation, partly in section.

Fig. 2 is a sectional elevation from the end, showing the valves and valve gear, and one operating cylinder.

Fig. 3 is a diagram of the cycle of operation.

Fig. 4 is a diagram showing the relation of crank stroke to the order of explosion in the cylinders.

Fig. 5 is a diagrammatic arrangement to show the relation of power impulses to one revolution of the crank, the order of firing and sequence of impulses.

In Fig. 1 six cylinders of an engine are shown, but of these only the four intermediate are for power. Cylinder A is mounted on a casing and contains a piston A^1, connecting rod A^2, the latter conventionally fitted to a crank, A^3, on a crank shaft, A^4. The description given holds for each of the other cylinders and working parts.

Cylinders A and C are for intake and compression only. The cylinder A is connected to the fuel supply of the engine and, on each downstroke of piston A^1 a charge is drawn in through a check valve B. On return stroke this charge is compressed and forced into a pipe, B^1, a check valve, B^2, preventing its return to cylinder A. The pipe B^1 is of relatively large diameter and is suitably covered by heat insulating material, as shown at B^3. A safety valve, B^4, is connected to the end of this line, and a pressure gauge B^5 is used to register variations of compression. At the opposite end of the engine a cylinder C, containing a piston, C^1, connects through an opening, C^2, with a pipe C^3, Fig. 2, that runs parallel to pipe B^1. This pipe is also protected by heat insulating packing and is fitted with a second pressure gauge, C^4. On each outstroke of piston C^1 a charge or air is drawn into cylinder C through a check valve, C^5. On return stroke of said piston this charge is compressed and forced into the pipe C^3, being retained therein by a check valve, C^6. The compression of the pure air is much greater than that of the fuel mixture and for this reason the diameters of the retaining pipes, or reservoirs, vary, as shown. Between the cylinders A an C are four others, each connected to the pipe B^1 and C^3 by passages controlled by a series of poppet valves, about to be described. The cylinders D, E, F, G, are for power, and the energy developed in them by successive explosions is transmitted to a crankshaft, H, by conventionally fitted connecting rods and cranks, similar to those previously described, with reference to piston A^1. In order to maintain proper compression in the pipes B^1, C^3, I cause the pistons therein to make eight strokes to one of the power pistons. This I effect by driving the compression shafts four times faster than the shaft H. A gear, J, meshing with a pinion, J^1, multiplies the rotation of the compressing cranks in the proportion given.

As all of the power cylinders are duplicates of each other it will only be necessary to give the operation of one to understand the others. In the head of cylinder D a flue, D^2, passes to pipe B^1. In the walls of said flue are valve seats on which are seated poppet valves D^3, D^4. A flue D^5 similarly communicates from cylinder D to a pipe reservoir, C^3. In said flue there are located the poppet valves D^6, D^7. The valves D^3, D^4, D^6, D^7, are held to their seats by spiral springs, D^8, D^9, D^{10}, D^{11}, and their movement from their seats is controlled by the cams K, K^1, K^2, K^3, through the action of the rollers shown on end of each valve stem Fig. 2. The said cams are revolved by a series of meshing gears, as shown in Fig. 2, these gears being driven by suitably disposed operative means from the power shaft. These means are not shown. On the side of cylinder D, an operable valve K^4 controls admission to an exhaust flue, K^5, that leads to exhaust pipe, K^6.

At end of upstroke of piston D^1 the valves D^4, D^7, are lifted by the cams connected therewith, and charges of explosive mixture and pure air escape from the reservoirs, B^1, C^3, into the space between the said valves and valves D^3, D^6. On the diagram, Fig. 3, these valves are open from *a* to *b*. At end of upstroke of piston there is only clearance between it and cylinder head, scaveng-

ing thus being carried to the extreme point of effectiveness. During this stroke exhaust valve K^4 remains open, but the exhaust action goes on for more than half a revolution, as shown in diagram, Fig. 3, and valve K^4 is open throughout this interval. As the crank H^1, Fig. 2, passes over the dead center *c* valve D^3 opens and a compressed charge of air and fuel enters the cylinder. On closing of valves D^3 valve D^6 opens and a charge of the highly compressed air from pipe C^3, enters cylinder. The compression of this air has been carried to a point where its temperature is sufficiently high to effect ignition, the insulation of C^3 retaining the heat for a reasonable period. Ignition takes place, and power is developed by piston D^1, said power being transmitted to shaft H by the connecting rod, H^2, and crank H^1. The power is developed during that part of the crank circle embraced between forty five degrees and one hundred and thirty five degrees, Fig. 3. Exhaust valve K^7 again opens, and the burned charge escapes and is driven out, as indicated on diagram.

The double arrangement of valves between cylinder and reservoir pipes, B^1, C^3, is to preclude back firing from said cylinder to said pipes. The valves D^3, D^6, are always closed when D^4, D^7, are open, cutting off admission to B^1, C^3.

Each piston operates on a two cycle basis, developing power on each outstroke, and this power stroke bears the same relation to the crank circle; that is, each actuates the crank through a distance between forty five degrees and one hundred and thirty five degrees, there being no overlapping. The power shaft therefore receives an impulse each quarter of a revolution and as there are four power cylinders, the thrust on shaft remains even and constant. In Fig. 4 I give a diagram that illustrates the relation and movement of the cranks with reference to each other, while in Fig. 5, I show, diagrammatically, the relation of the firing order to that of the power impulses through one revolution of the crank.

I thus secure an engine of relatively simple construction and great mechanical efficiency, and an automatic ignition derived from mechanically compressed and superheated air.

What I believe is new, and ask to have protected by Letters Patent, is—

1. In an internal combustion engine, the combination of a gaseous fuel reservoir, a compressed air reservoir and a combustion chamber, means whereby said gaseous fuel is compressed, means whereby said air is compressed, each of said reservoirs being connected with the combustion chamber by means of separate flues, a valve controlling the admission of the gaseous fuel from the fuel reservoir to its flue, a second valve controlling the admission of fuel from the last mentioned flue to the combustion chamber, a third valve controlling the admission of air from the air reservoir to the flue communicating therewith and a fourth valve controlling the admission of air from the last mentioned flue to the combustion chamber and means whereby said valves may be successively positively actuated.

2. In an internal combustion engine, the combination of a gaseous fuel reservoir, a compressed air reservoir and a combustion chamber, each of said reservoirs being connected with the combustion chamber by means of separate flues, a valve controlling the admission of the gaseous fuel from the fuel reservoir to its flue, a second valve controlling the admission of fuel from the least mentioned flue to the combustion chamber, a third valve controlling the admission of air from the air reservoir to the flue communicating therewith and a fourth valve controlling the admission of air from the last mentioned flue to the combustion chamber and means whereby said valves may be positively actuated, said means including four shafts, a gear on each shaft intermeshing with the gear on the adjacent shaft whereby the adjacent shafts are rotated in opposite directions, a cam carried by each shaft and a plunger connecting each valve to its actuating cam.

3. In an internal combustion engine, the combination of a gaseous fuel reservoir, a compressed air reservoir and a combustion chamber, each of said reservoirs being connected with the combustion chamber by means of separate flues, a valve controlling the admission of the gaseous fuel from the fuel reservoir to its flue, a second valve controlling the admission of fuel from the last mentioned flue to the combustion chamber, a third valve controlling the admission of air from the air reservoir to the flue communicating therewith and a fourth valve controlling the admission of air from the last mentioned flue to the combustion chamber, means whereby said valves may be positively actuated, said means including four shafts, a gear on each shaft intermeshing with the gear on the adjacent shaft whereby the adjacent shafts are rotated in opposite directions, a cam carried by each shaft, a plunger connecting each valve to its actuating cam, and means adapted to normally hold said valves in closed position.

4. In an internal combustion engine, the combination of a gaseous fuel reservoir, a compressed air reservoir and a combustion chamber, each of said reservoirs being connected with the combustion chamber by means of separate flues, a valve controlling the admission of the gaseous fuel from the fuel reservoir to its flue, a second valve controlling the admission of fuel from the last

mentioned flue to the combustion chamber, a third valve controlling the admission of air from the air reservoir to the flue communicating therewith and a fourth valve controlling the admission of air from the last mentioned flue to the combustion chamber, means whereby said valves may be positively actuated, said means including four shafts, a gear on each shaft intermeshing with the gear on the adjacent shaft whereby the adjacent shafts are rotated in opposite directions, a cam carried by each shaft, a plunger connecting each valve to its actuating cam, an exhaust flue communicating with the combustion chamber, a valve seated between the entrance to said flue and said combustion chamber and means whereby said last mentioned valve is actuated.

In testimony whereof I affix my signature.

ALVAH L. POWELL.