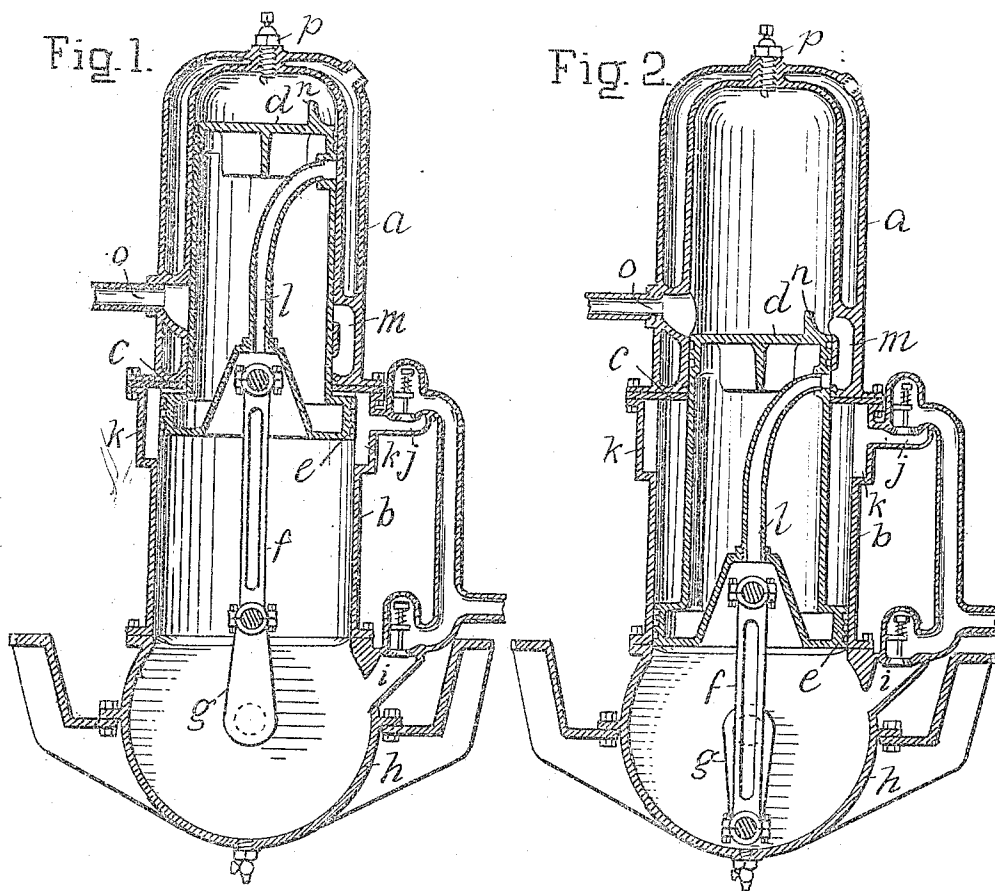


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INTERNAL COMBUSTION ENGINE.
APPLICATION FILED JUNE 20, 1906. RENEWED OCT. 30, 1912.
1,063,440. Patented June 3, 1913.



Witnesses:

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UNITED STATES PATENT OFFICE.

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INTERNAL-COMBUSTION ENGINE.

1,063,440.

Specification of Letters Patent.

Patented June 3, 1913.

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To all whom it may concern:

Be it known that I, WILLIAM HARPER, JR., a citizen of the United States of America, and a resident of New Bloomfield, Perry county, Pennsylvania, have invented certain new and useful Improvements in Internal-Combustion Engines, of which the following is a specification.

This invention relates particularly to explosive engines of the two-cycle type, having means exterior to the power-chamber of the engine for the compression of the incoming charge. This means comprises a chamber in a cylinder tandem with and of larger diameter than the cylinder containing the power-chamber. The cylinders are traversed by a reciprocating part which carries a piston head for each cylinder.

The object of the invention is to utilize in such a structure as an additional compression-chamber the annular cylinder space formed between one face of the larger piston head and the step between the cylinders.

A further object of the invention is to provide a passageway whereby the charge which is compressed in the annular chamber is added to the charge which is drawn directly into the main compression-chamber whereby both may be then transferred to the power-chamber.

A further object of the invention is to provide the passageway between the main compression-chamber and the power-chamber in part through the reciprocating part whereby it may be made as short and direct as possible.

In the accompanying sheet of drawings, which forms a part of this application,—Figure 1 is a longitudinal section through an engine embodying my invention showing the parts in the position which they assume immediately before or upon ignition. Fig. 2 is a similar section excepting that the parts are shown in the position assumed at the end of a power stroke.

The engine comprises, first, a cylinder *a*, which may, as shown be water-jacketed, and second, a cylinder *b* of larger internal diameter, tandem with the first cylinder and into which the chamber of the first cylinder opens directly, the cylinders hermetically joining through a step *c*. A reciprocating part consisting of a power piston head *d*

fitting the first cylinder, and a compression piston head *e* fitting the second cylinder, lies partly in each cylinder and is joined through a connecting rod *f* with the crank *g* of the engine. The cylinders have a common axis which in the illustrated position is vertical, and the first and smaller cylinder is above the other cylinder. The first cylinder is closed at the top and the second cylinder is in effect closed at its outer end, which with the engine vertical as shown is at the bottom, by the crank-case *h*. Three chambers are thereby formed by the cylinders and reciprocating part. Above the power piston head in the first cylinder is formed the power-chamber; below the compression piston head in the second cylinder and in the communicating chamber of the crank case, is the main compression chamber; and between the walls of the reciprocating part and the walls of the larger cylinder is formed an annular compression chamber. The amount which the volume of the latter varies is the product of the stroke of the reciprocating part multiplied by the difference between the areas of the cylinders. The charge for the engine is drawn into the main and annular compression chambers through check valves in inlet ports *i j* of the two chambers respectively. Ports *k l* formed in the wall of the larger cylinder are provided for the transfer of the compressed charge from the auxiliary to the main compression chamber, and a port consisting in part of a tube *l* through the reciprocating part and a passageway *m* formed in the wall of the smaller cylinder is provided for the transfer of the charge from the main compression-chamber to the power-chamber. A deflector *n* on the top of the power piston head directs the incoming charge upwardly in the power-chamber. The ports between the annular and main compression chambers serve as reserve spaces into which the charge in the auxiliary compression-chamber is in part compressed and held until released into the main compression-chamber. The crank-case affords the requisite reserve space for the main compression-chamber. An exhaust port *o* through the wall of the smaller cylinder is so located that it will be uncovered by the piston at the end of its stroke and per-

mit the escape of the exploded charge. A spark-plug *p* may be tapped through the wall of the smaller cylinder into the power-chamber to effect the ignition of the charge.

5 In describing the operation of the engine attention will be directed first to the induction and compression of the parts of the same explosive charge. Commencing with the parts of the engine positioned as illustrated in Fig. 1, on descent of the reciprocating part a charge is drawn into the annular or differential compression-chamber with this stroke. On the return stroke this charge is compressed, and concurrently a charge is drawn into the main compression-chamber. At the conclusion of this stroke the ports *k k* between the compression-chambers are uncovered and the compressed charge in the auxiliary compression-chamber is transferred and added to the charge in the main compression-chamber. On the next stroke with the descent of the reciprocating part the combined charge from the two compression-chambers is compressed in the main compression-chamber. At the conclusion of this stroke the passageway *l* through the reciprocating part is brought into register with the passageway *m* in the wall of the smaller cylinder and the compressed charge is transferred to the power-chamber. In passing into the power-chamber the incoming charge is first deflected to the top of the chamber on the side opposite the exhaust port so that it will be kept stratified from the exploded charge and displace and expel or scavenge the latter through the exhaust port. The exhaust port is properly adjusted in size or throttled so that this scavenging of the power-chamber will require about the length of time that the ports of the chamber remain open. On the next return stroke the charge is further compressed in the power-chamber and when compressed is ignited for the next downward stroke which is the power stroke for the combined charge above traced from the induction of its component parts.

It will be seen that there are six operations each occupying a stroke in one or the other of the three chambers, namely: induction in the annular compression-chamber, compression in the annular compression-chamber, induction in the main compression-chamber, compression in the main compression-chamber, compression in the power-chamber, and explosion and expansion in the power-chamber. But as one or the other takes place in each of the three

chambers at each stroke, it follows that all of the operations are taken, though not for the same explosive charge, in each two strokes or each revolution of the engine, and hence the engine may be termed a two-cycle engine, or an engine in which the operations recur at each two strokes, although each charge requires five strokes for its complete transit through the several chambers of the engine.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. An internal-combustion engine comprising tandem communicating cylinders of different diameters, a reciprocating part consisting of connected piston heads operating in the cylinders and forming a power-chamber in the smaller cylinder, a compression-chamber in the outer end of the larger cylinder, and an annular compression-chamber between the walls of the reciprocating part and the walls of the larger cylinder, inlet ports for both compression-chambers, means for closing both of the inlet ports, a suitably controlled communicating port between the compression-chambers, a suitably controlled communicating port between the compression-chamber of the outer end of the larger cylinder and the power-chamber, and an exhaust port for the power-chamber, substantially as described.

2. An internal-combustion engine comprising tandem communicating cylinders of different diameters, a reciprocating part consisting of rigidly connected piston heads operating in the cylinders and forming a power-chamber in the smaller cylinder, a compression-chamber in the outer end of the larger cylinder, and an annular compression-chamber between the walls of the reciprocating part and the walls of the larger cylinder, inlet ports for both compression-chambers, means for closing both of the inlet ports, a suitably controlled communicating port between the compression-chambers, a suitably controlled communicating port between the compression-chamber of the outer end of the larger cylinder and the power-chamber which includes a port through the reciprocating part, and an exhaust port for the power-chamber; substantially as described.

Signed by me at New York, N. Y., this 7th day of June, 1906.

WILLIAM HARPER, Jr.

Witnesses:

SAMUEL W. BALCH,
JAMES D. BENEDICT.