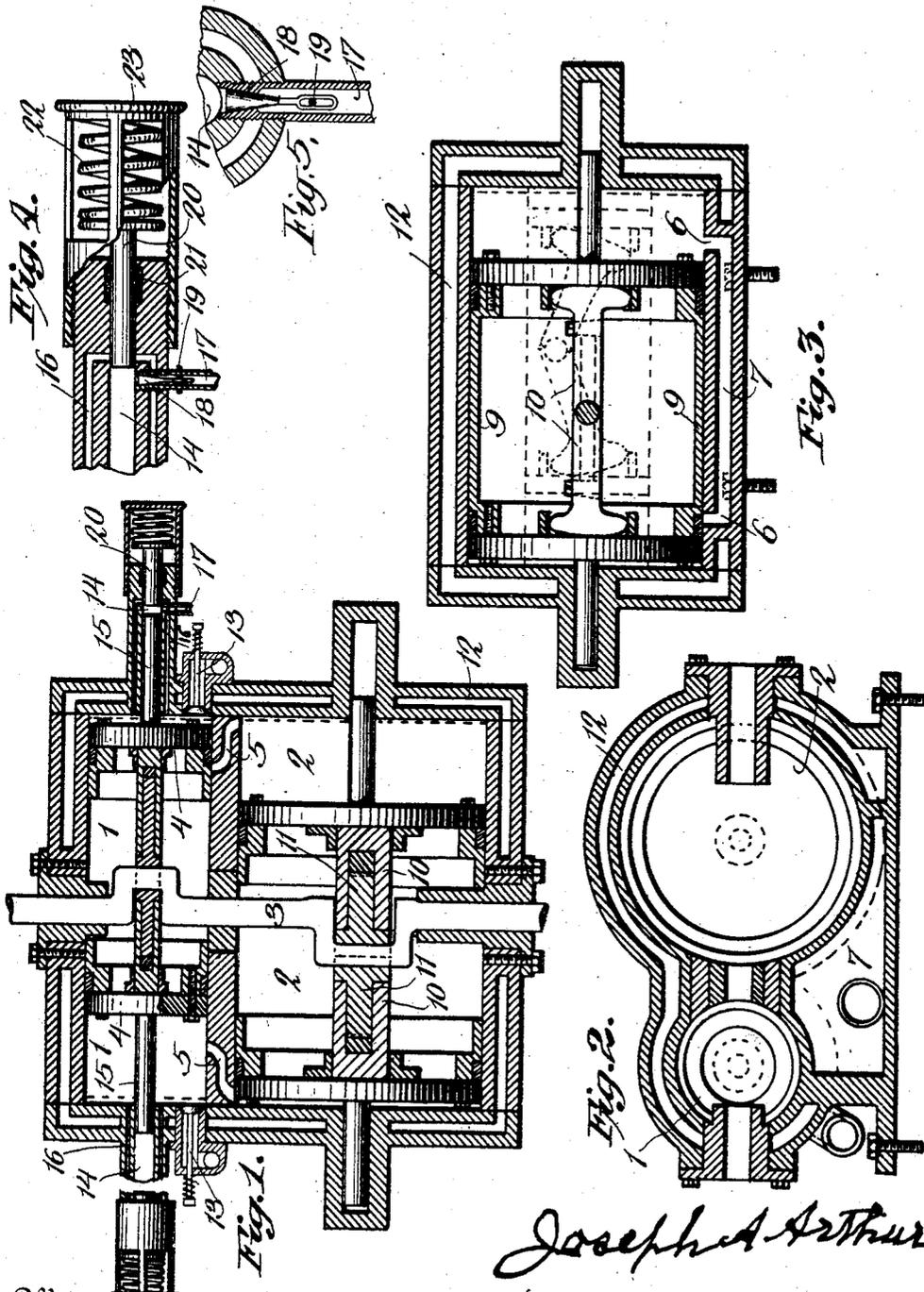


J. A. ARTHUR.
INTERNAL COMBUSTION ENGINE.

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UNITED STATES PATENT OFFICE.

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INTERNAL-COMBUSTION ENGINE.

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To all whom it may concern:

Be it known that I, JOSEPH A. ARTHUR, a citizen of the United States, residing at New York, in the county of New York and State of New York, have invented certain new and useful Improvements in Internal-Combustion 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.

My invention relates to improvements in internal-combustion engines, and particularly to ignition devices therefor; and it consists in novel means for igniting explosive charges in such engines by the compression of a small quantity of combustible gas to a point at which the ignition is automatic.

My invention further consists in novel features of construction of the igniting device, as hereinafter set forth, and particularly pointed out in the claims.

The objects of my invention are to avoid the use of flame or electric igniters and obtain automatic ignition by compression of combustible gases to the ignition-point without excessively-high compression in the combustion-cylinders, to regulate the time of ignition, and to make the ignition device simple, compact, and efficient.

I will now proceed to describe my invention with reference to the accompanying drawings, in which a compound engine the high-pressure cylinders of which have igniters embodying my said invention is illustrated and will then point out the novel features in claims.

In the said drawings, Figure 1 shows a central horizontal section through the engine-cylinders. Fig. 2 shows a transverse section of the cylinders on the line of the crank-shaft. Fig. 3 shows a central vertical longitudinal section of the low-pressure cylinder. Fig. 4 shows a detail side elevation and partial section of one of the igniting devices. Fig. 5 shows a detail cross-section of one of the auxiliary compression-cylinders through the center of its admission-valve.

In the said drawings numeral 1 designates high-pressure or combustion cylinders, 2 low-

pressure cylinders, and 3 a crank-shaft common to the cylinders. The high-pressure cylinders are arranged opposite each other with their pistons 4 in line, and the cylinders 2 are similarly arranged beside the high-pressure cylinders. Ports 5 connect the high-pressure and low-pressure cylinders, the high-pressure pistons 4 forming slide-valves for these ports. The low-pressure cylinders are provided with exhaust-ports 6, Fig. 3, communicating with an exhaust-space 7, Fig. 2, and the low-pressure pistons 8 form slide-valves for these exhaust-ports. The high-pressure pistons are connected to move together, and the low-pressure pistons are similarly connected in the manner illustrated in Fig. 3 by spacing-pieces 9. The connecting-rods are toggle-links 10, each comprising a main section provided with a curved T-head, fitting within a socket of the corresponding piston, and a bearing-section 11, fitting into a socket in the main section and having a bearing for the cranks of the crank-shaft 3. The position assumed by the connecting-rods at half-stroke is shown in dotted lines in Fig. 3. I have shown the cylinders surrounded by the usual cooling-jacket 12, through which cooling-water may be circulated.

Any suitable type of admission-valves and valve-gear may be employed. I have shown for the purpose ordinary spring-closed puppet admission-valves 13, arranged to be opened by suction; but positively-operated valves may be used instead.

For igniting the explosive charges I provide means for compressing a small quantity of combustible gas to such point that it will ignite and cause the burning gases to pass into the combustion-chamber and mingle with the main charge therein, which has been compressed, but not necessarily to so high a pressure. Such ignition means comprises cylinders 14, arranged in line with the high-pressure cylinders, the pistons of which cylinders 14 are tail-rods 15 projecting from the pistons 4, said cylinders having ports or passages 16 for connecting them with their respective combustion or working cylinders 1. A pipe 17 connects with each of these cylinders 14 for the purpose of supplying gaseous fuel

thereto, each such pipe being provided with a check-valve comprising a valve-plug 18, co-acting with a taper valve-seat and limited in its motion by a pin 19 working in a slot in the stem of the valve, so that accidental contact of the valve with the auxiliary compression-piston 15 is prevented. Communication between cylinders 14 and their passages 16 is normally prevented by valve-pistons 20, passing through stuffing-boxes 21 in the ends of cylinders 14 and provided with cushion-springs 22, retained in place by spring-cages 23, arranged to screw upon the cylinders 14. At the instant of explosion of a charge in the auxiliary compression-cylinder 14 valve-piston 20 is forced back, permitting the burning gases to pass through passages 16 into the cylinder 1 and ignite the charge there. During the ensuing expansion period the piston 20 is forced forward by its cushion-spring 22, again closing passages 16.

The operation of the engine is as follows: At the beginning of the suction-stroke in each high-pressure cylinder the piston 4 draws into said cylinder through the admission-valve a charge of combustible gas, the ignition-piston 15 at the same time drawing into the auxiliary cylinder 14 a charge of combustible gas. In the succeeding compression-stroke the charges in cylinders 1 and 14 are compressed, the charge in 14 being compressed until at or near the end of the stroke. The gas in 14 ignites automatically, forcing back the piston 20, and so passing through passages 16 into the cylinder 1 and igniting the main charge there. Near the end of the ensuing expansion-stroke the piston 4 uncovers the port 5, leading to the low-pressure cylinder, so that on the next stroke the gases are exhausted from cylinder 1 into cylinder 2 and expand therein, doing effective work. Near the end of the expansion-stroke in the low-pressure cylinder its piston uncovers the exhaust-port 6 of that cylinder, and on the next succeeding stroke the gases exhaust into chamber 7 and thence out through a suitable exhaust-outlet. The time of ignition may be regulated by screwing the spring-cages 23 in or out. This has the effect of varying the point in the stroke at which the igniting charge reaches the pressure of automatic ignition. It is obviously an easy matter to vary this time as desired while the engine is running.

While I have described the engine as operating on the four-cycle plan, it is obvious that it may also operate upon the two-cycle plan, means being provided for compressing the charge initially and the admission-ports of the high-pressure cylinders arranged to admit the charge thereto after the exhaust-ports have been opened and the ports for admitting gas to the auxiliary compression-cylinders 14 being similarly arranged.

It is obvious that my invention is susceptible of many variations and modifications and

that certain parts may be used in connection with other parts of different construction, for which reason I do not limit myself to the details of construction and arrangement herein illustrated and described.

What I claim is—

1. In an internal-combustion engine, the combination with a working cylinder and means for supplying a combustible charge thereto, and a piston for said cylinder, of igniting means comprising an auxiliary compression-cylinder, a piston for said auxiliary cylinder deriving its motion from said first-named piston, means for admitting a combustible charge to said auxiliary cylinder, said auxiliary cylinder having a passage for connecting it with said first-named cylinder, and an outwardly-opening valve having a spring arranged to resist outward movement thereof, said valve normally closing said passage, but arranged to be operated by pressure within said auxiliary cylinder when ignition occurs therein.

2. In an internal-combustion engine, the combination with a main working cylinder having means for admitting a combustible charge thereto, and a piston for said cylinder, of an auxiliary compression-cylinder, a piston therefor, means for admitting combustible gas to said auxiliary cylinder, said auxiliary cylinder having a passage connecting it with the main cylinder, a valve normally closing said passage and projecting through the end of said auxiliary cylinder, said valve arranged to be opened by pressure resulting from combustion in said auxiliary cylinder, a spring arranged to permit said valve to yield when ignition occurs in said auxiliary cylinder, and means for adjusting the action of said spring.

3. In an internal-combustion engine, the combination with a main working cylinder having means for supplying a combustible charge thereto, and a piston therefor, of an auxiliary compression-cylinder in line with said main cylinder, a piston for said auxiliary cylinder projecting from and actuated by a piston of the main cylinder, means for admitting a combustible gas to said auxiliary cylinder, said auxiliary cylinder having a passage connecting it with the main cylinder, and a spring-actuated valve normally closing said passage but arranged to be actuated by pressure resulting from combustion in said auxiliary cylinder to open said passage.

4. In an internal-combustion engine, the combination with a main working cylinder having means for supplying a combustible charge thereto, and a piston therefor, of an auxiliary compression-cylinder in line with said main cylinder, a piston for said auxiliary cylinder projecting from and actuated by a piston of the main cylinder, means for admitting a combustible gas to said auxiliary cylinder, said auxiliary cylinder having a passage connecting it with the main cylinder, a

valve normally closing said passage and projecting through the end of said auxiliary cylinder, a spring arranged to act upon the projecting portion of said valve to press the valve inward, and a spring-cage inclosing the spring and adjustably secured to the auxiliary cylinder.

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

JOSEPH A. ARTHUR.

Witnesses:

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H. M. MARBLE.