H. WHIDBOURNE & J. J. LISHMAN.

INTERNAL COMBUSTION ENGINE.

APPLICATION FILED AUG. 24, 1911.

1,024,711.

Patented Apr. 30, 1912.

2 SHEETS—SHEET 1.

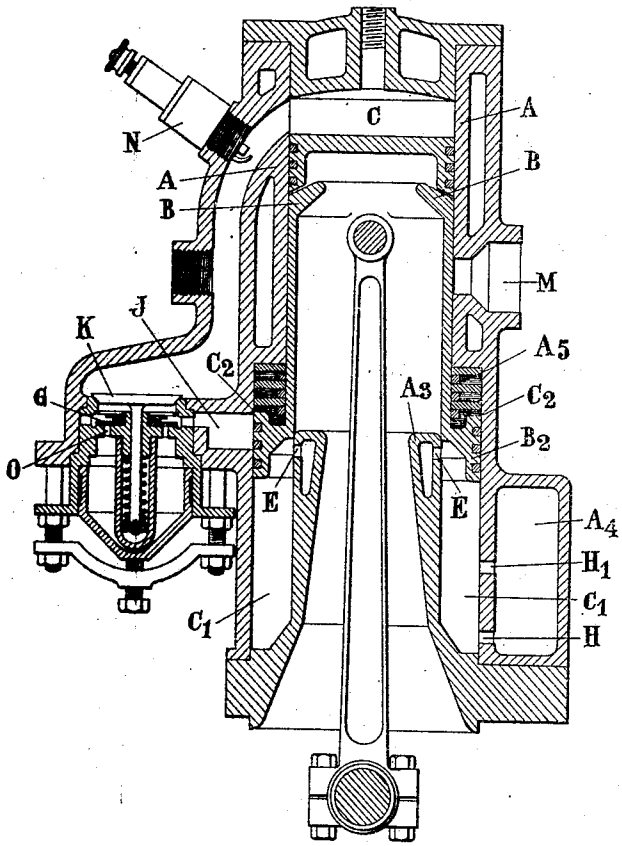

Fig.1.

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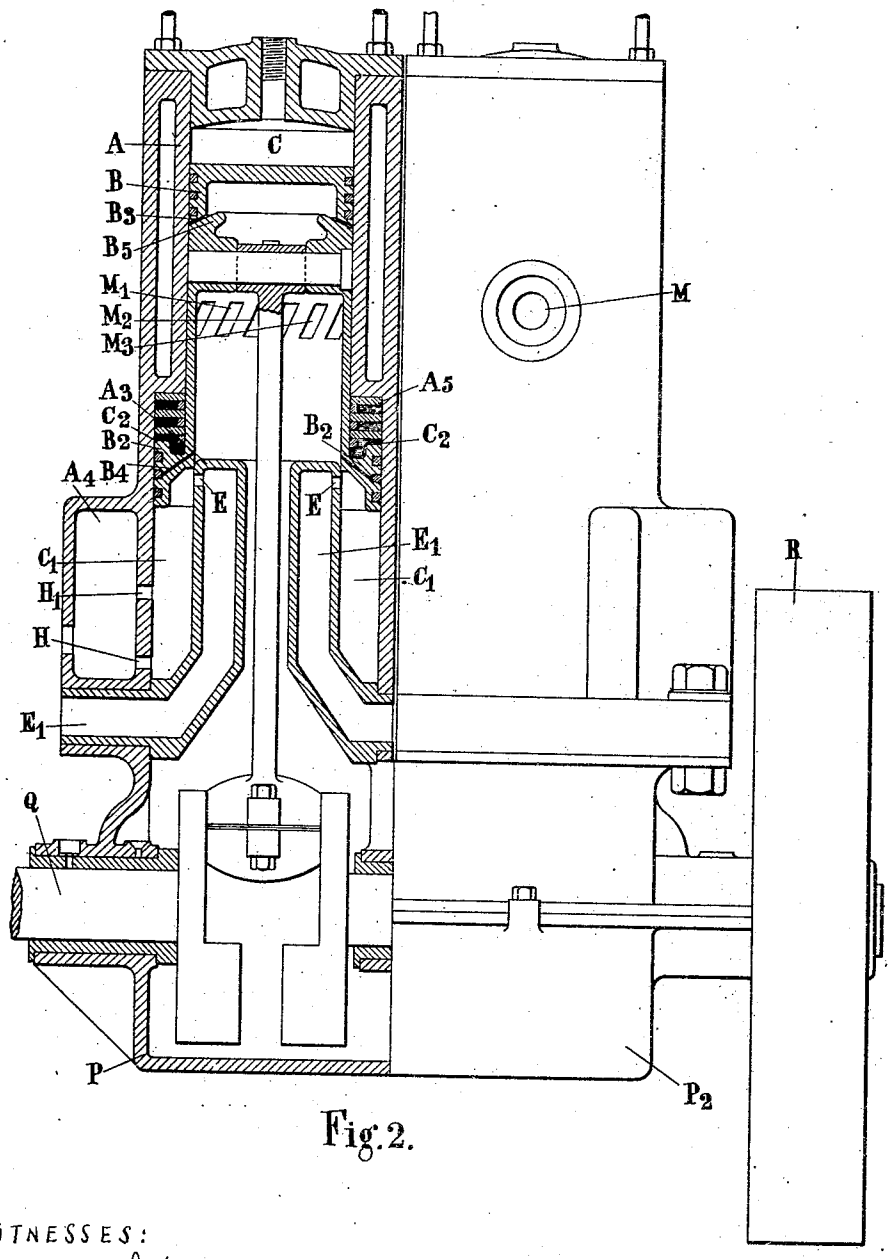

Fig. 2.

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UNITED STATES PATENT OFFICE.

HARRY WHIDBOURNE, OF PLYMOUTH, AND JOHN JAMES LISHMAN, OF SALCOMBE, ENGLAND.

INTERNAL-COMBUSTION ENGINE.

1,024,711. Specification of Letters Patent. Patented Apr. 30, 1912.

Application filed August 24, 1911. Serial No. 645,820.

To all whom it may concern:

Be it known that we, HARRY WHIDBOURNE, a subject of the King of Great Britain and Ireland, residing at Melville, Compton Park, Plymouth, in the county of Devon, England, and JOHN JAMES LISHMAN, a subject of the King of Great Britain and Ireland, and resident at Moult Tors, Salcombe, South Devon, England, have invented certain new and useful Improvements in and Relating to Internal-Combustion Engines, of which the following is a specification.

This invention relates to internal combustion engines of the two-stroke cycle type and of the kind having a cylinder of two diameters, in which works a piston of two corresponding diameters, said piston being hollow or trunk-shaped and sliding over a fixed inner sleeve arranged concentrically within the cylinder walls, the arrangement being such that one portion of the piston operates in the main working cylinder of the engine, while the other portion works in an annular chamber formed between the inner fixed sleeve and the cylinder walls and divides the same into two compartments.

The object of this invention is to incorporate in the construction above referred to, an arrangement of conduits and valves which enables an order of functions to be employed permitting of a more rapid and economical utilization of the combustible gases, a more efficient after-disposal of the same, the lowering of the maximum pressure and temperature, reduced heat loss to the cylinder walls and the obtainment of other advantages, including more sustained pressures resulting in a more even torque.

In the accompanying drawings, Figure 1 is a side sectional elevation showing one form of engine constructed in accordance with our invention, the crank case being removed. Fig. 2 is a front elevation with the crank case in position and showing one cylinder of the engine in section.

In carrying our invention into effect in one convenient manner we provide a piston B of two diameters working in a cylinder A of two corresponding diameters and sliding over an inner sleeve A_3 arranged concentrically within the cylinder walls and forming an annular chamber in which the piston end B_2 works. Ports H and H_1 communicate between the annular chamber and a second chamber or conduit A_4. Communication is established between the annular chamber and the working cylinder C of the engine by the passage or conduit J, within which passage a check or non-return valve K is situated, and the sparking plug or igniter N is preferably also disposed just within this passage, as shown in Fig. 1. The pipe leading from the carbureter or other source of fuel (not shown) is connected in any convenient manner to the passage or passages E_1 (Fig. 2) leading into the inner fixed sleeve over which the piston slides, and communicating with the annular chamber by the ports E as shown in Fig. 1.

M_1, M_2, M_3 in Fig. 2 show some of a series of ports serving as a communication between the engine cylinder and the exhaust port M, while B_3 and B_4 are oil-ducts which may be provided in the piston-head to enable the lubricant, when splash-lubrication is employed, to reach the cylinder walls, this action being assisted by the "well" formed between the rim B_5 and the inside of the piston B.

A_5 illustrates an arrangement of spring-controlled or other rings to counteract any tendency which the compressed charge may have to leak from the annular chamber, while O shows one of the ducts leading to the valve G.

In Fig. 2 of the drawings the crank casing is shown in section at P and in elevation at P_2, while an external flywheel R is mounted upon one end of the crankshaft Q, although an internal flywheel may be employed if desired.

The operation of the engine is as follows:—During its in-stroke the piston creates a vacuum in the annular chamber C_1, which vacuum, at the end of the piston's upward or in-stroke, suddenly draws into the annular chamber C_1 a charge of explosive mixture on the piston end B_2 passing the port E. On the piston's outward stroke which is also the power stroke of the working cylinder C it slightly compresses this charge, while at the same time piston displacement in the middle chamber C_2 draws in through the valve G a charge of air or other neutral gas at short atmospheric pressure. At or near the end of the outward stroke of the piston B the charge of explosive mixture which has been trapped and compressed in the lower chamber C_1 is transferred to the middle chamber by means of

the ports H and H_1 and immediately a corresponding quantity of air or neutral gas is delivered through the conduit J past the non-return valve K to the working cylinder C by displacement, where it acts as a scavenging charge—the exhaust port M being opened when in this position. The charge of explosive mixture transferred from one chamber to the other and displacing the air or neutral gas in front of it, is not sufficient to fill the working cylinder as well, air only reaching the working cylinder while the exhaust port is open. On the return or compression stroke of the piston B the exhaust port is closed and the charge of explosive gas now trapped in the middle chamber C_2 is forced through and past the conduit J and the non-return valve K into the working cylinder against the rising pressure of the air now trapped in the latter, and at or about the end of the return stroke the gas charge is ignited by the sparking plug N or by other effective or convenient means. The piston is then driven outward by the explosion and expansion of the explosive charge, assisted by the independent expansive fluid, consisting mainly of air which as mentioned above is trapped in the cylinder at the beginning of the compression stroke, the oxygen of the latter being available for assisting combustion when required, resulting in an odorless exhaust due to the fact that complete combustion is insured owing to the trapped air providing an excess of oxygen. Moreover this trapped charge of air or inert gas also absorbs some of the heat generated by the explosion of the working charge and consequently the maximum pressure is reduced while at the same time a more sustained and even pressure will result and consequent on the maximum temperature also being reduced less heat will be lost to the cylinder. During this outward or working stroke, the hereinbefore described functions are taking place with the result that at the end of the stroke and at the moment the exhaust port M is uncovered, air for scavenging is forced into the working cylinder C in consequence of the displacement brought about by an explosive charge being again transferred to, and trapped in, the middle chamber C_2 in readiness for the return or compression stroke as hereinbefore described.

Governing of the engine may be effected by any of the well-known methods, and when it is arranged to govern on the throttle, economical working of the engine is obtained due to the fact that compression is practically constant, even when the explosive charge is greatly reduced, because at or about the instant when compression begins the whole of the space in which compression takes place is filled with gas, partly air and partly explosive mixture, and this space is also open to the atmosphere at this instant so that compression always begins with the same volume at the same pressure, *i. e.* atmospheric, the only variation being in the proportion of the explosive charge to neutral gas. The igniter N is preferably disposed where shown in the charging duct J where it is surrounded at the required moment by the explosive mixture enabling certain and rapid ignition to take place.

Although it has been stated in the specification that a charge of air or other neutral gas is forced from the annular chamber C_2 into the cylinder, in actual practice small traces of explosive charge will remain in the valve pocket between the valves K and G, so that the charge of air or neutral gas will in all probability not be pure, but will contain a very slight admixture of explosive gas. It is also obvious that while retaining the functions herein described, we may vary the construction and arrangement of the piston and other parts without departing from the spirit of this invention.

Having now described our invention what we claim as new and desire to secure by Letters Patent is:—

1. An internal combustion engine of the two-stroke cycle type, comprising, a cylinder having two portions of different diameters, one of the portions serving as a main working cylinder, a piston having two parts of different diameters arranged to work in said two portions of the cylinder respectively, a sleeve arranged concentrically within the cylinder and forming with one of the portions of the cylinder an annular chamber which is divided into two separate compartments by one of the two piston parts, means for admitting an explosive mixture into one of the compartments, means for admitting an inert gas into the other compartment, means for connecting the latter compartment with the main working cylinder, and means for connecting the two compartments with each other near the end of the outward stroke, whereby the working of the piston in said annular chamber causes a charge of inert gas contained in one of the compartments to be forced into the main working cylinder by and in front of the charge of explosive mixture admitted and compressed in the other compartment of the annular chamber, substantially as described.

2. An internal combustion engine of the two-stroke cycle type, comprising, a cylinder having two portions of different diameters, one of the portions serving as a main working cylinder, a piston having two parts of different diameters arranged to work in said two portions of the cylinder respectively, a sleeve arranged concentrically within the cylinder and forming with one of the portions of the cylinder an an-

nular chamber which is divided into two separate compartments by one of the two piston parts, passages formed in the sleeve within the cylinder for the admission of an explosive mixture into one of the compartments, means for admitting an inert gas to the other compartment, means for connecting the latter compartment with the main working cylinder, an additional chamber, and passages between the latter and the annular chamber, whereby the working of the piston in the annular chamber causes a charge of inert gas contained in one of the compartments to be forced into the main working cylinder by and in front of the charge of explosive mixture admitted in the other compartment from which it is expelled into the inert gas compartment past the additional chamber and through the passages between the latter and the annular chamber, substantially as described.

3. An internal combustion engine of the two-stroke cycle type comprising a cylinder having two portions of different diameters, one of the portions serving as a main working cylinder, a piston having two parts of different diameters arranged to work in said two portions of the cylinder respectively, a sleeve arranged concentrically within the cylinder and forming with one of the portions of the cylinder an annular chamber which is divided into two separate compartments by one of the two piston parts, passages in the sleeve within the cylinder for admitting an explosive mixture into one of the compartments said passages being provided near the inner stroke end of the piston part arranged to work in the portion of the cylinder which forms an annular chamber with the sleeve, a conduit leading to the other compartment, a non-return valve for admitting an inert gas to the latter conduit and compartment, a passage for connecting said conduit with the main working cylinder, a non-return valve in said passage, means for connecting together the two compartments of the annular chamber, and an exhaust port in the main working cylinder, whereby the explosive mixture is admitted into one of the compartments toward the end of the instroke of the piston, compressed therein during the outward stroke of the same, and forced thence into the other compartment toward the end of the outward stroke, the inert gas being drawn into its compartment during the outward stroke of the piston and forced thence into the main working cylinder by the compressed explosive mixture while the exhaust port is open, and the explosive mixture being forced from the inert gas compartment into the working cylinder while the exhaust port is closed, substantially as described.

In testimony whereof we have signed our names to this specification in the presence of two subscribing witnesses.

HARRY WHIDBOURNE.
JOHN JAMES LISHMAN.

Witnesses:
ARTHUR JOSEPH FORSHEW,
ARCHIBALD HARDING.