No. 731,995. PATENTED JUNE 23, 1903.

A. T. COLLIER.

INTERNAL COMBUSTION ENGINE.

APPLICATION FILED FEB. 16, 1903.

NO MODEL. 3 SHEETS—SHEET 1.

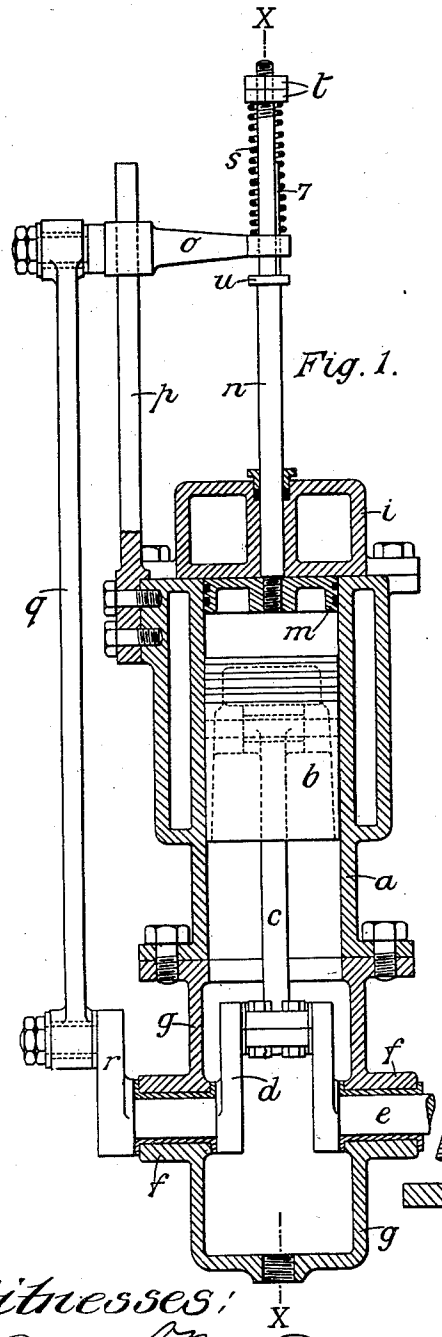


Fig. 1.

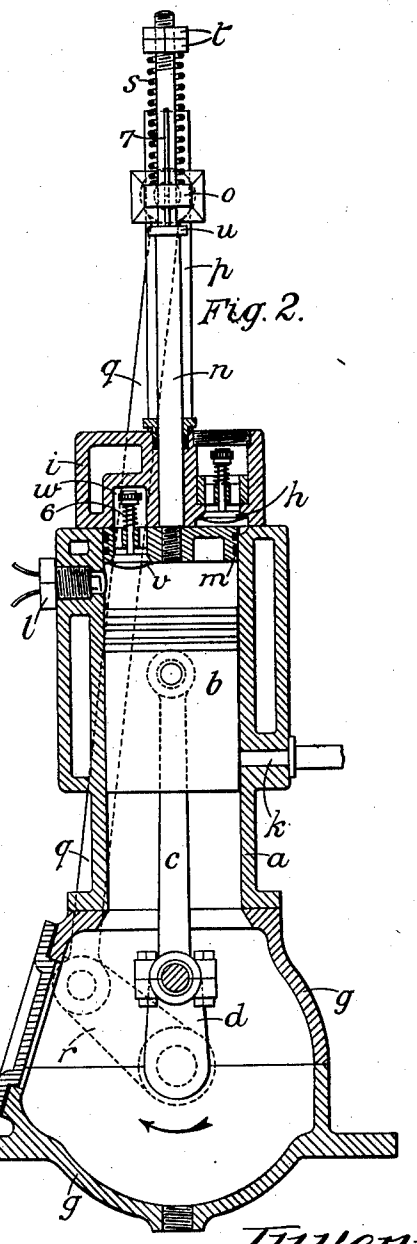


Fig. 2.

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Inventor
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THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

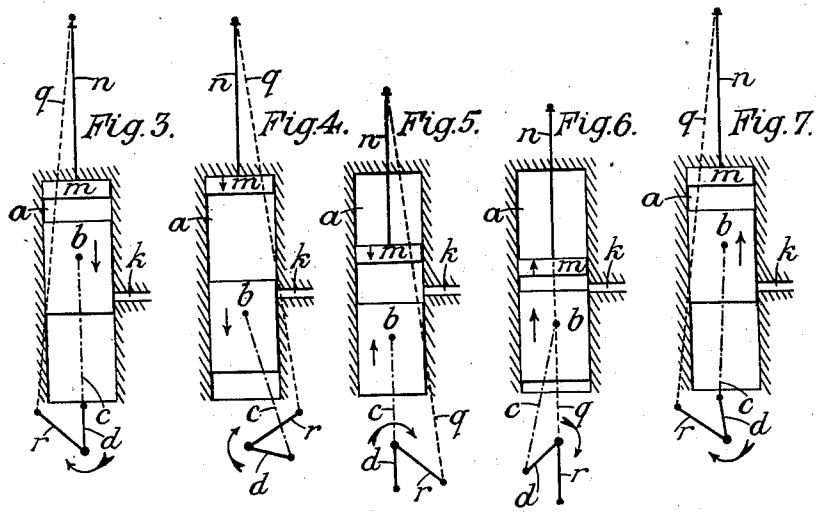
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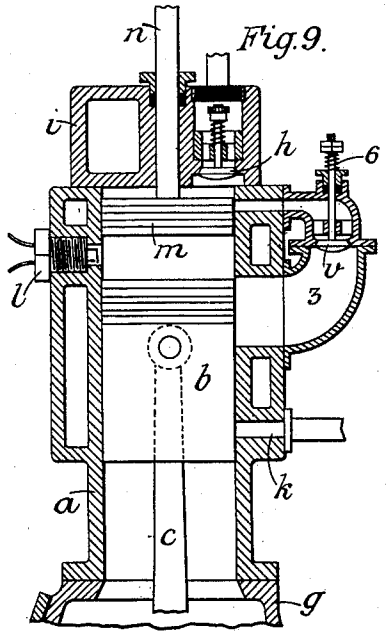
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INTERNAL COMBUSTION ENGINE.

APPLICATION FILED FEB. 16, 1903.

NO MODEL. 3 SHEETS—SHEET 2.





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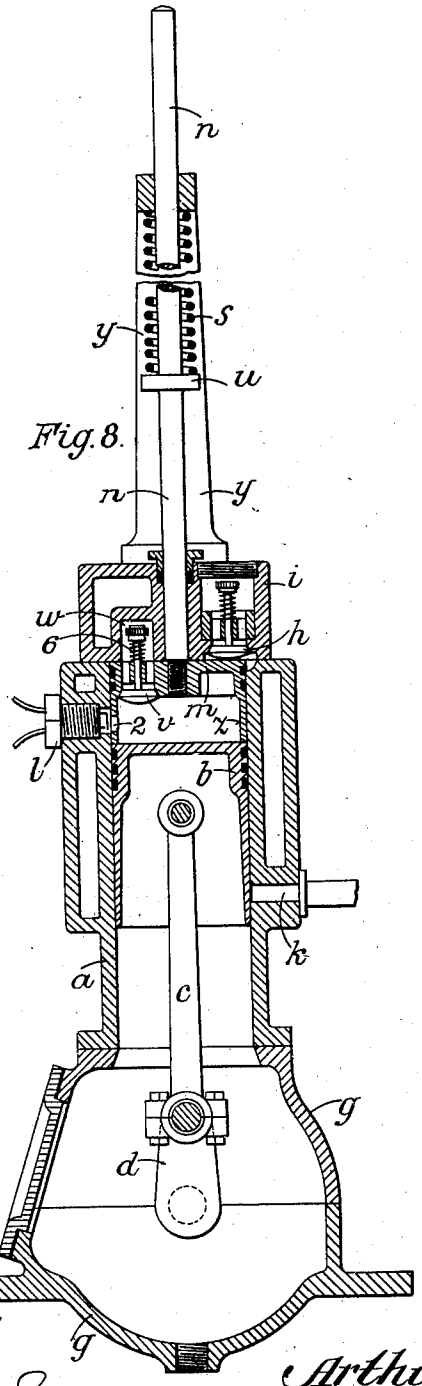
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INTERNAL COMBUSTION ENGINE.

APPLICATION FILED FEB. 16, 1903.

NO MODEL. 3 SHEETS—SHEET 3.

Fig. 8.



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No. 731,995. Patented June 23, 1903.

UNITED STATES PATENT OFFICE.

ARTHUR T. COLLIER, OF ST. ALBANS, ENGLAND, ASSIGNOR OF ONE-THIRD TO ARNOLD ELWORTHY WILLIAMS, OF LONDON, ENGLAND.

INTERNAL-COMBUSTION ENGINE.

SPECIFICATION forming part of Letters Patent No. 731,995, dated June 23, 1903.

Application filed February 16, 1903. Serial No. 143,716. (No model.)

To all whom it may concern:

Be it known that I, ARTHUR THOMAS COLLIER, a subject of the King of Great Britain, residing at St. Albans, in the county of Herts, England, have invented certain new and useful Improvements in Internal-Combustion Engines, of which the following is a specification.

This invention relates to internal-combustion engines, and provides an improved form of two-stroke-cycle single-acting engine which is simple in construction, economical in operation, and comparatively light for the power developed.

According to my invention I provide in the working cylinder behind the main piston an auxiliary piston for discharging the burned or inert gases by driving the same before it through the exhaust-port, which is near the forward end of the cylinder and which is opened or uncovered when the main piston has nearly reached the forward end of its travel. Simultaneously the auxiliary piston draws in behind it through an inlet near the rear end of the cylinder the charge for the next explosion. A valve is provided in the auxiliary piston to allow the fresh charge to pass through the said piston during the return stroke thereof. The arrangement or construction of the pistons is such that when they have returned to the rear end of the cylinder they inclose between them the requisite space for the explosion-chamber. The auxiliary piston may be worked in various ways. For example, it may be driven in both directions by a crank or by a cam or by a belt, or it may be moved in the backward direction by the main piston and in the forward direction by a spring.

Referring to the accompanying drawings, which illustrate my invention, Figure 1 is a longitudinal central section of the engine on a plane containing the crank-shaft. Fig. 2 is a longitudinal section on the line X X, Fig. 1. Figs. 3 to 7 are diagrammatic views showing the relative positions of the two pistons at different parts of the stroke. Fig. 8 is a view similar to Fig. 2, but illustrating a modification; and Fig. 9 is a view illustrating a further modification.

Like characters of reference denote corresponding parts in the several figures.

a is the cylinder; *b*, the main piston; *c*, the connecting-rod; *d*, the crank; *e*, the crank-shaft, rotating in bearings *f f* in the frame *g*, to which the cylinder is secured.

h is the inlet-valve, mounted in the cylinder-head *i*, which is secured to the cylinder and detachable therefrom.

k is the exhaust-port, which is opened and closed by the movements of the main piston *b*.

l is the firing-plug.

Behind the main piston *b* is an auxiliary piston *m*, connected to a rod *n*, passing out at the rear end of the cylinder, as shown. Suitable means, such as a feather-key 7, Fig. 1, may be employed to prevent the auxiliary piston from turning. In the arrangement illustrated in Figs. 1 and 2 this auxiliary piston is actuated as follows—that is to say, *o* is an arm sliding on a guide-rod *p*, fixed to the cylinder in a position parallel to the rod *n*. Such arm *o* is reciprocated by a link *q*, connecting it to a crank *r* on the shaft *e*. One end of the arm *o* is forked or formed with an eye capable of sliding on the rod *n*. *s* is a spring compressed between the arm *o* and adjustable nuts *t* on the rod *n* and tending to press the arm *o* against a collar *u* on the rod *n*. The throw of the crank *r* is such that the auxiliary piston arrives at the rear end of the cylinder before the arm *o* has completed its backward movement, and the crank then completes its throw by compressing the spring *s*. By this arrangement the auxiliary piston remains at rest for a considerable period at the rear end of the stroke, and so gives time for the main piston to complete the greater portion of its working stroke before the auxiliary piston begins to move. The cycle of operations is as follows: Assuming the explosion takes place when the pistons are in the position indicated in Figs. 1 and 2 and in the diagrammatic view Fig. 3, the main piston is forced forward, the crank being rotated in the direction indicated by the arrow. Just before the exhaust-port is opened (see Fig. 4) the auxiliary piston begins its forward movement and sweeps out

the spent gases through the exhaust-port when the latter is opened. Fig. 5 shows the main piston just beginning its return stroke, and Fig. 6 shows the auxiliary piston just beginning its return stroke. It is near this latter position when the pistons come closest together. Fig. 7 shows the auxiliary piston having just reached the cylinder-head and the main piston still moving rearwardly, and Fig. 3 represents the completion of the cycle, the main piston being ready to advance again. It should be noted that simultaneously with the sweeping out of the spent gases through the exhaust-port the auxiliary piston draws in a fresh charge through the inlet-valve *h*, and during the return stroke of the auxiliary piston this new charge passes through an inwardly-opening valve *v*, arranged in the auxiliary piston, and enters the combustion-chamber between the two pistons, ready to be fired by the electric igniter or other firing means. The compression of the spring 6 of the valve *v* is so regulated that the pressure of the charge behind the auxiliary piston operates as a cushion and in combination with the elastic connection between the arm *o* and the rod *n* prevents a knock or jar when the auxiliary piston reaches the cylinder-head. A recess or pocket *w* is made in the cylinder-head *i* for receiving the stem of the valve *v*, so that the auxiliary piston may bear up close against the cylinder-head.

With the above-described construction the spent gases are almost entirely swept out at each forward stroke of the auxiliary piston and a very small fraction thereof remains to dilute the fresh charge. No exhaust-valve is required other than the main piston itself, and an explosion is obtained each revolution, thus securing a more uniform turning effort than is possible with a four-stroke cycle.

I do not confine myself to the above-described mode of working the auxiliary piston, as it may be actuated by any other suitable means—for example, by a cam acting on its rod or by a belt, or it may be actuated by a spring, as shown in Fig. 8. In this arrangement the spring *s* is compressed between the collar *u* on the rod *n* and an abutment formed by a standard *y*, fixed on the cylinder-head. Moreover, the auxiliary piston is constructed with a cylindrical extension *z*, which limits the minimum distance between the two pistons and forms the combustion-chamber. In the extension *z* is an opening 2, which is opposite the firing-plug *l* when the auxiliary piston is in its rearmost position and through which the firing is effected. In this arrangement the auxiliary piston is advanced by the spring *s* as soon as the exhaust-port is opened and sweeps out the spent gases. It is then returned by the main piston bearing on the end of the cylindrical extension *z*. If necessary, a spring may be arranged between the pistons. The firing of the charge may be advanced or retarded, as may be required, as is usual in quick-running engines.

I may modify the construction in detail without departing from the spirit of my invention. For example, if desired the exhaust may be further controlled by a valve operated mechanically. Moreover, the fresh charge instead of being passed through the auxiliary piston may be passed around it by a passage 3 independent of the piston, as indicated in Fig. 9. This passage is controlled by a valve *v*, opening toward the forward end of the cylinder. The rear end of the passage opens into the cylinder a short distance from the rear end thereof, and the forward end of the passage is preferably so arranged as not to be completely closed by the main piston when the latter is at the rear end of its stroke. With this arrangement the auxiliary piston on its return stroke drives the fresh charge through the valve *v* until it closes the rear end of the passage 3, and so locks a portion of the charge in the rear end of the cylinder. This locked portion of the charge serves as a cushion and prevents the auxiliary piston from coming into contact with the cylinder-head, and so obviates knock.

What I claim is—

In an internal-combustion engine, the combination with the cylinder, of a main piston, an auxiliary piston, a piston-rod to said auxiliary piston, an arm or cross-head having an aperture to receive said piston-rod, a guide for said cross-head, collars on said piston-rod on opposite sides of said cross-head, a spring arranged between the outer collar on said piston-rod and said cross-head, and a crank and connecting-rod for reciprocating said cross-head through a distance greater than the travel of said auxiliary piston, substantially as described and for the purpose specified.

In testimony whereof I have hereunto set my hand in presence of two subscribing witnesses.

ARTHUR T. COLLIER.

Witnesses:
GEO. HARRISON,
HENRY W. LYNDEN.