Oct. 29, 1935. J. E. CASTLE 2,018,944

INTERNAL COMBUSTION ENGINE

Filed May 15, 1933 2 Sheets-Sheet 1

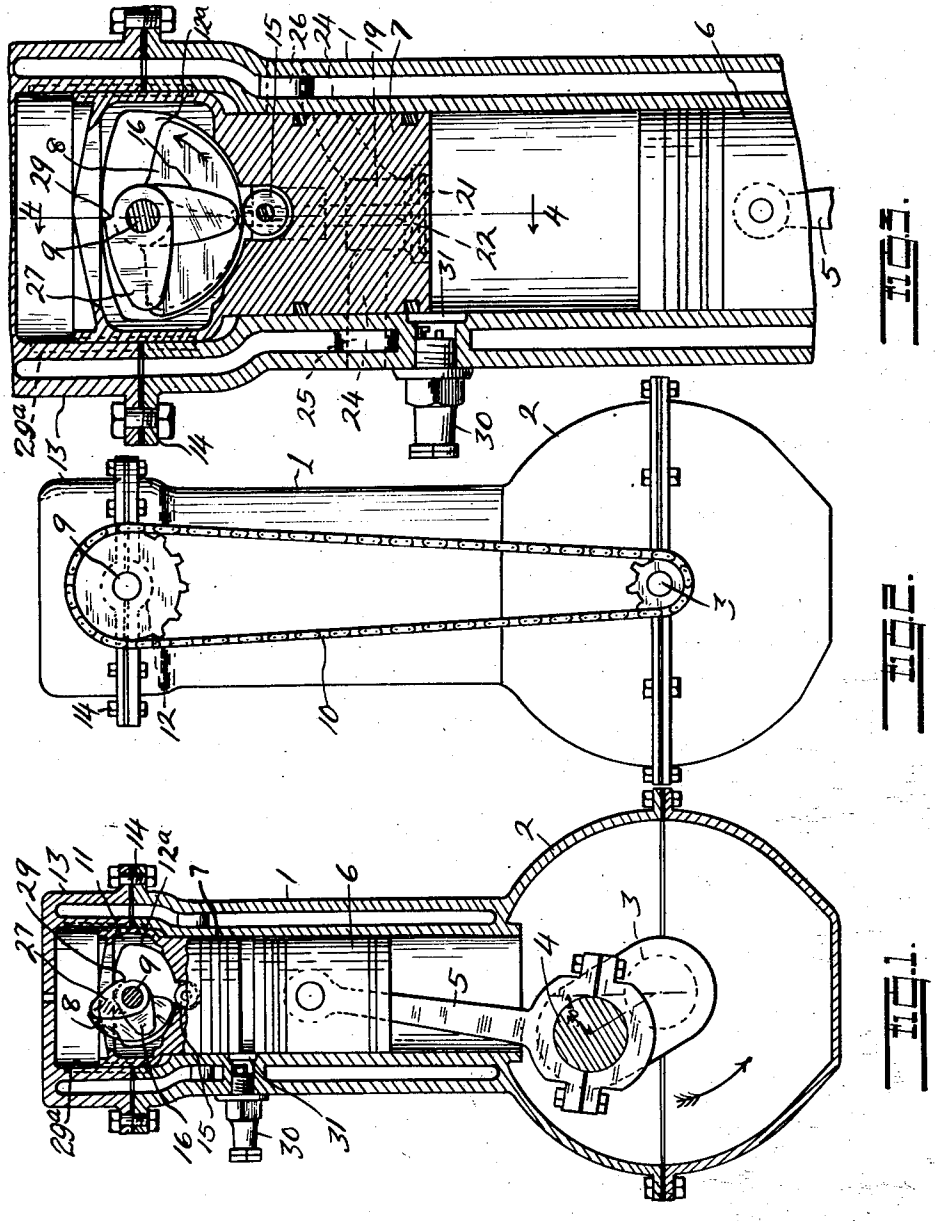


Fig. 3.

Fig. 2.

Fig. 1.

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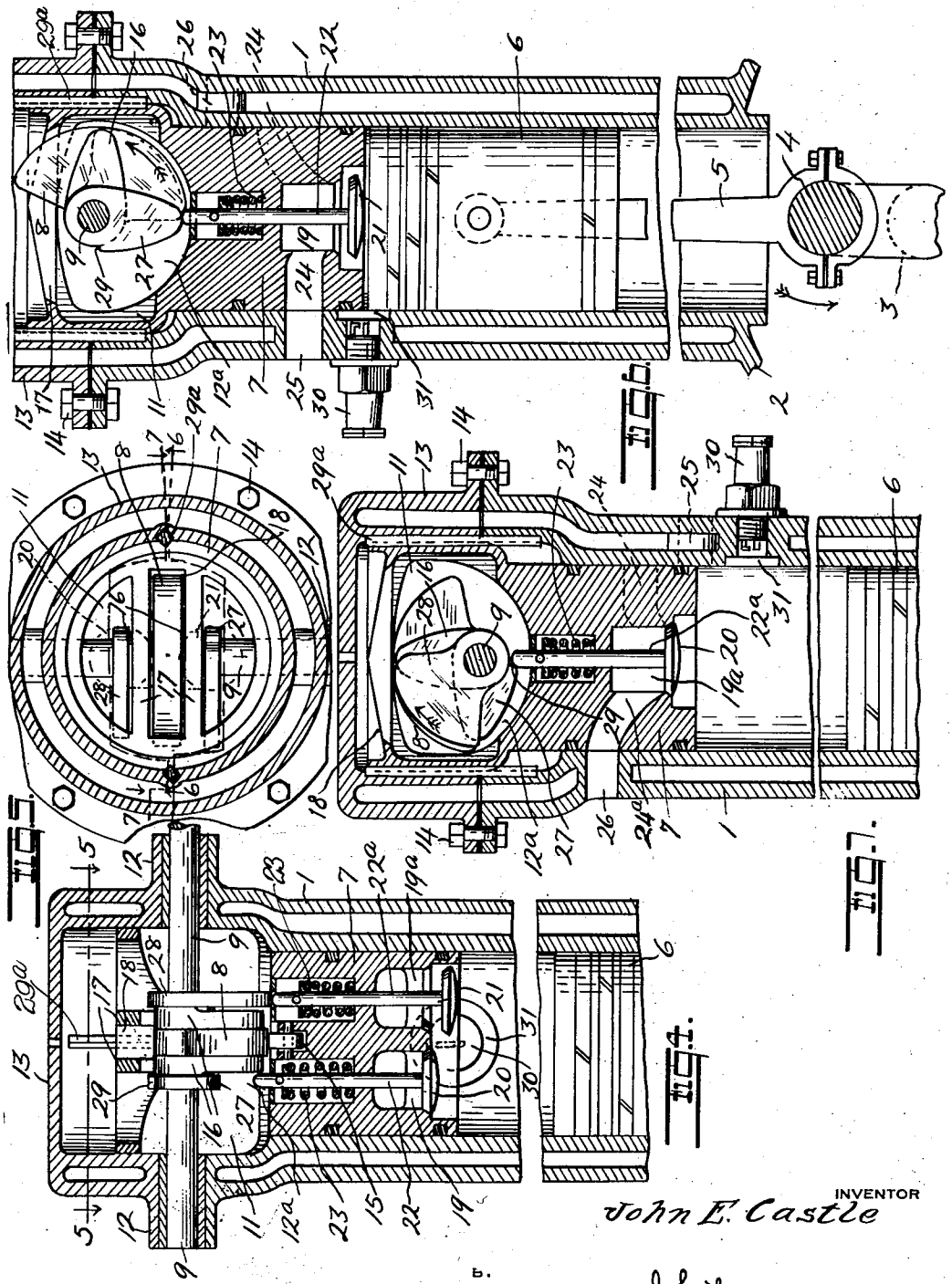


FIG. 7.

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INTERNAL COMBUSTION ENGINE

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2 Claims. (Cl. 123—78)

This invention relates to engines and particularly to internal combustion engines.

Under present practice, ignition of the compressed charge occurs either immediately on completion of the compression stroke or with a quite slight advancement or retardation relative to such completion. Consequently the crank shaft is on dead center, or substantially so, at the moment of ignition and does not afford adequate leverage to the expanding gases. The leverage increases as the shaft advances a quarter turn from dead center position but, in the meantime, the gases rapidly lose energy through expansion.

Sufficient retardation of the spark to establish ample crank shaft leverage upon ignition is prohibited, in present constructions, by the resultant loss of compression.

An object of the invention is to increase the engine efficiency by effecting ignition when the crank shaft is sufficiently beyond dead center to offer ample leverage to the explosive force, while maintaining compression at its maximum.

Another object is to provide for increasing the volume of the charge over present practice.

Still another object is to increase the efficiency, as aforesaid, by forming the combustion chamber between the usual piston, which drives the crank shaft, and an auxiliary piston driven thereby, the latter being timed in its travel to recede from the former on the suction stroke, thus increasing the charge-receiving space, and to follow up the usual piston as it recedes from the limiting position of its compression stroke, to a position in which ignition concurs with adequate crank shaft leverage.

A further object is to adapt said auxiliary piston to be cam operated by a shaft, which also carries cams for actuating the intake and exhaust valves of the engine.

A still further object is to employ said auxiliary piston as a mounting for the intake and exhaust valves.

These and various other objects, the invention attains by the construction hereinafter described and illustrated in the accompanying drawings, wherein:

Fig. 1 is a view of the improved engine in axial vertical section, showing the pistons in firing position.

Fig. 2 is a view of the same in end elevation.

Fig. 3 is an enlarged vertical sectional view, showing the position of the parts at completion of the working stroke.

Fig. 4 is an axial vertical section taken on the line 4—4 of Fig. 3.

Fig. 5 is a cross sectional view of the engine cylinder, taken on line 5—5 of Fig. 4.

Fig. 6 is a vertical section taken on line 6—6 of Fig. 5, and showing the position of the parts on completion of the exhaust stroke.

Fig. 7 is a vertical section taken on line 7—7 of Fig. 5 and showing the position of the parts on completion of the intake stroke.

In these views, the reference character 1 designates a cylinder of an internal combustion engine, 2 the crank case thereof, 3 the crank-shaft, formed with a crank 4, and 5 a connecting rod adapting said shaft to be driven by the usual piston 6 working in said cylinder.

The cylinder is elongated to accommodate an auxiliary piston 7 having a comparatively short stroke and timed in its travel to recede from the piston 6 during the intake stroke, and to follow up the piston 6 following compression and preceding ignition, to remain fixed during the working stroke and assume a position during the exhaust stroke to barely clear the piston 6 as it completes such stroke.

Thus the piston 7 is driven by a cam 8, fixed on a cam shaft 9, which is driven from the crank shaft through a drive chain 10 or the like, at half the crank shaft speed. The shaft 9 preferably passes through a chamber 11 formed in the upper portion of the piston 7, and is journaled in suitable bearings 12 oppositely formed on the cylinder. Openings 12a are oppositely formed in the wall of the chamber 11 to accommodate the shaft 9 and to provide for initial insertion or replacement of the cam 8 and the other cams hereinafter described.

The cylinder has a removable head 13 bolted at 14 to the cylinder block, and seating on the latter preferably in the axial plane of the cam shaft. The cam 8 has a leading segment of constant radius extending preferably through seventy-five degrees, and a trailing spiral segment extending through ninety degrees, peripherally merging with the leading segment and progressively increasing in radius reversely to its direction of rotation. The lower wall of the chamber 11 is concaved to a radius slightly exceeding that of the leading portion of said cam, and projecting from said wall, centrally thereof is a roller 15 for engagement by the cam 8.

The timing is such that the cam 8 actuates the piston 7 toward the piston 6 during the major portion of the compression stroke and during the initial portion of the working stroke, establishing the lowermost position of said piston 7 when the crankshaft has rotated a desired distance be-

yond dead center, as for example thirty degrees. (See Fig. 1.) The charge is then fired and the upper piston is maintained in said position during the working stroke of the piston 6.

As the piston 6 enters upon its exhaust stroke, (Fig. 3), the trailing spiral segment of the cam 8 engages the roller 15 on the piston 7, effecting a slight further advance of the latter toward the piston 6. Thus, as the latter completes its exhaust stroke, only a very slight clearance is afforded between the two pistons and there is hence assured a substantially complete scavenging of the spent gases.

For retracting the piston 7, there is mounted fast on the shaft 9 a pair of cams 16, positioned one at each side of the cam 8, and similarly elongated radially of said shaft. Said cams have their longitudinal axes in the meeting plane of the leading and trailing portions of the cam 8 and are effective during the suction stroke to move the piston 7 to the raised position shown in Fig. 7. In performing said function said cams engage bridging members 17 which extend diametrically across the top of the piston 7, said members being centrally slotted at 18 to freely accommodate the cam 8, when raised.

In the lower face of the piston 7 there are formed a pair of valve chambers 19 and 19a within which exhaust and intake valves 20 and 21, respectively, are adapted to seat upwardly. Said valves are individually carried by stems 22 and 22a, respectively, vertically slidable in the piston and acted upon by springs 23 to normally seat said valves. Passages 24 and 24a respectively lead from the chambers 19 and 19a, respectively and open in opposite side faces of the piston and respectively communicate in predetermined positions of the piston with intake and exhaust passages 25 and 26 respectively which open through the cylinder wall.

For opening the valves 20 and 21 at the proper times, the shaft 9 carries cams 27 and 28 at opposite sides of the lifter cams 16. The intake valve cam 27 is radially elongated with its longitudinal axis in the radial plane of the trailing edge of the cam 8 and the exhaust valve cam 28 forms a quadrant conforming in radius to the leading segment of the cam 8, and registering substantially with the trailing segment of said cam, lengthwise of the shaft.

Thus as the piston 6 begins its intake stroke, the cam 27 rides upon the stem 22 to open the intake valve 20 and serves to hold said valve open throughout the intake stroke, the piston 7 in the meantime being lifted by the cams 16. A shoulder 29 on the cam 27 permits the intake valve to snap shut as the intake stroke is completed, (see Fig. 7).

The exhaust control cam 28 rides upon the exhaust valve stem 22a as the piston 6 begins its exhaust stroke, moving the exhaust valve 21 to open position, and maintaining such position throughout said stroke. As the exhaust stroke is completed, the cam 28 rides clear of said stem 22a, permitting the exhaust valve to snap shut, (see Fig. 6).

It is preferred to form the top portion of the cylinder of slightly enlarged diameter and to correspondingly increase the diameter of the chambered top portion 11 of the piston 7, whereby said portion may more readily accommodate the described cams.

Rotation of the piston 7 is prevented by a suitable arrangement which, as illustrated, comprises a pair of splines 29a driven vertically in grooves in the enlarged upper portion of the cylinder 1 and having a sliding fit in corresponding grooves diametrically opposite each other in the enlarged portion of the piston 7.

A spark plug 30 is so mounted in the side wall of the cylinder 1 that when the pistons 6 and 7 are in firing position, the space therebetween containing the fully compressed charge will register with a recess 31 in said wall, which receives the points of said plug.

Since the described engine is adapted to receive and compress a larger charge than in present practice and affords a considerable leverage to the explosive force at the moment of ignition while establishing maximum compression at such moment, it is apparent that a large increase of engine efficiency is accomplished.

The invention is presented as including all such modifications and changes as come within the scope of the following claims.

What I claim is:

1. An internal combustion engine comprising a cylinder, a primary piston working in said cylinder, a shaft, a driving connection from said piston to said shaft, an auxiliary piston working in said cylinder and forming with the primary piston an expansible pressure chamber, a cam shaft diametrically journaled in said cylinder, cams upon said shaft for raising and lowering the auxiliary piston in timed relation to the travel of the primary piston, intake and exhaust valves mounted in the auxiliary piston, means for delivering fuel to said pressure chamber under control of said intake valve, means for discharging combustion gases from said pressure chamber under control of said exhaust valve, and cams on said cam shaft for actuating said intake and exhaust valves.

2. An internal combustion engine comprising a cylinder, a primary piston working in said cylinder, a main shaft, a driving connection from said piston to said shaft, an auxiliary piston working in said cylinder and forming with the primary piston an expansible pressure chamber, the end portion of the auxiliary piston adjacent to the primary piston conforming in diameter to the primary piston and the other end portion of the auxiliary piston having an increased diameter and forming a cam chamber, and having diametrically opposed openings into said chamber through its wall, a cam shaft journaled in said cylinder and diametrically extending through said cam chamber, said openings accommodating said shaft and affording the auxiliary piston reciprocation relative to said shaft, a driving connection to the cam shaft from said main shaft, and cams on said cam shaft within said cam chamber, effective to raise and lower the auxiliary piston in timed relation to the primary piston.

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