

Jan. 23, 1945.

J. J. SHORE

2,367,894

INTERNAL-COMBUSTION ENGINE

Filed April 13, 1942

2 Sheets-Sheet 1

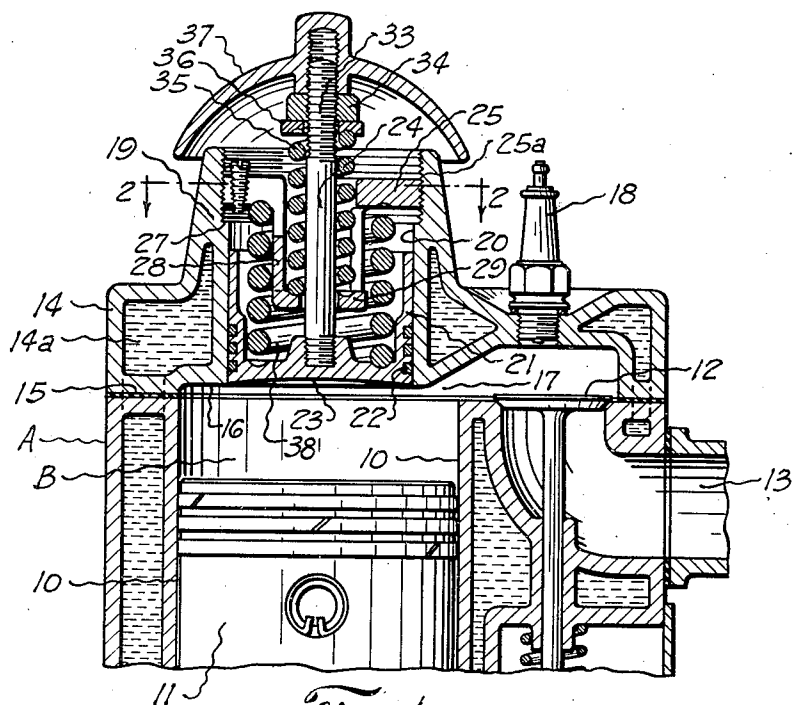


Fig. 1.

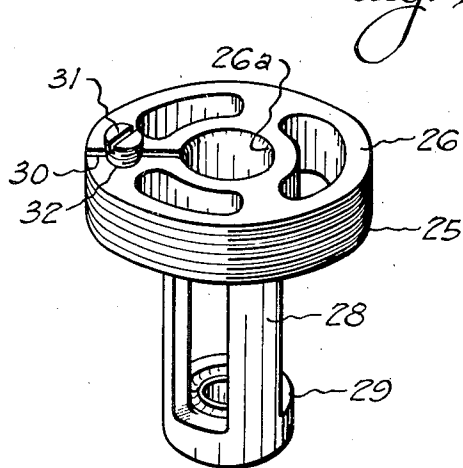


Fig. 3.

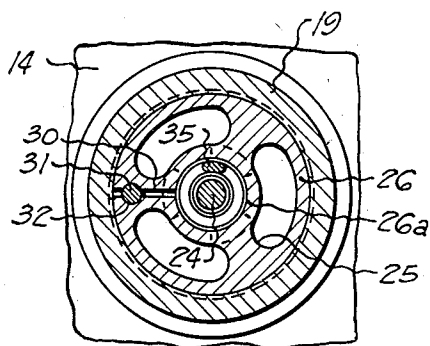


Fig. 2.

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2 Sheets-Sheet 2

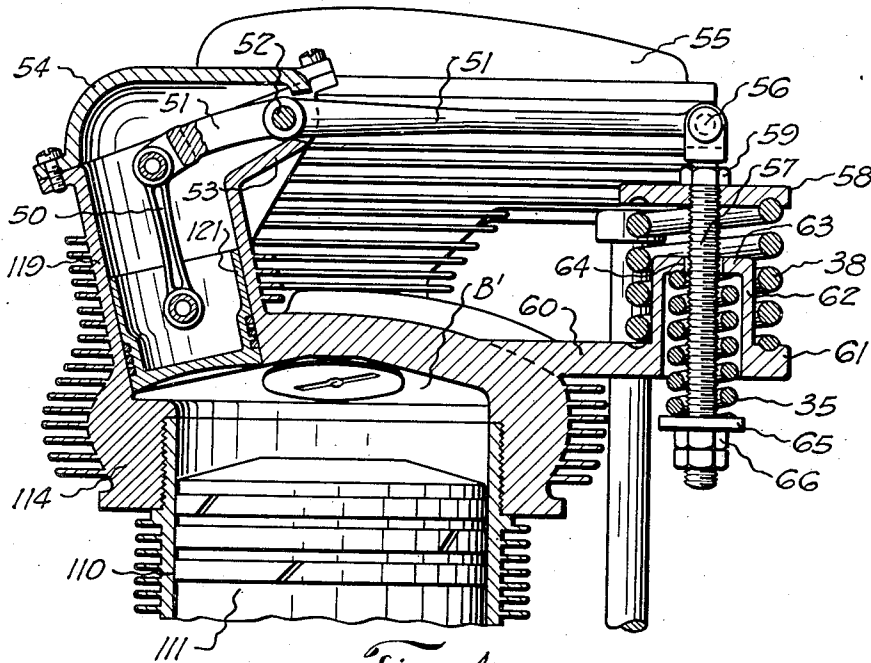


Fig. 4.

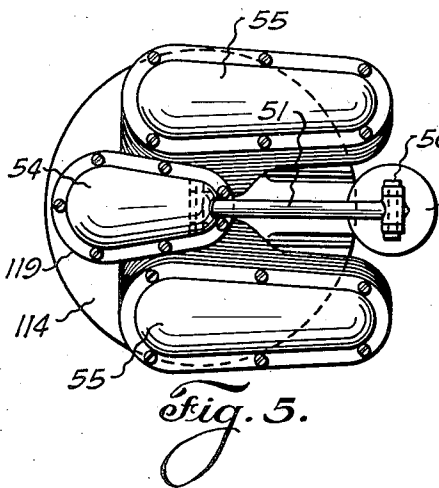


Fig. 5.

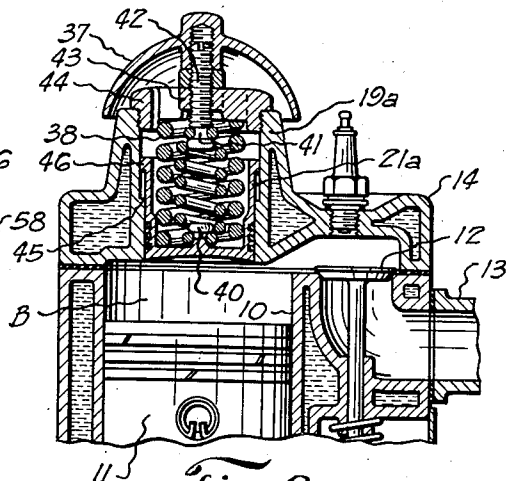


Fig. 6.

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UNITED STATES PATENT OFFICE

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INTERNAL-COMBUSTION ENGINE

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3 Claims. (Cl. 123—48)

This invention relates to new and useful improvements in internal combustion engines.

One object of the invention is to provide an improved engine structure having means for absorbing or cushioning the shock occasioned by the explosion or ignition of the charge in the combustion chamber of the engine, whereby the wrist pins, connecting rods, bearings, and other working parts are relieved of excessive wear due to such shock to which they are normally subjected, and also whereby engine "knock" is substantially eliminated.

An important object of the invention is to provide an engine structure having improved cushioning means which effectively delays the application of excess pressure on the piston until the commencement of the power stroke of the piston, whereby energy dissipation at the instant of explosion is eliminated and the full force of the explosion is utilized to move the piston through its power stroke.

Another object of the invention is to provide an improved engine structure, wherein an auxiliary piston is provided in the combustion chamber and its movement is resisted by a yieldable means, said yieldable means being readily adjustable whereby the piston may be preloaded to adjust the compression ratio and being additionally adjustable to compensate for variation in fuel; the device being particularly adaptable for aircraft engines because maximum power with minimum engine weight, as well as high compression with reduced vibration, may be obtained.

A further object of the invention is to provide an engine structure, of the character described which includes a depressible auxiliary piston which has its end exposed in the combustion chamber, with improved means for yieldably mounting the piston, so that it is full-floating or resiliently suspended in a predetermined position, said piston being so mounted that it is inactive during the compression stroke and is movable to momentarily enlarge the area of the combustion chamber only by the ignition or explosion of the charge, whereby the piston acts to absorb the shock of said explosion and thereby relieves the main piston and its associate of undue wear, the piston returning to its original position during the power stroke and acting to cause the force of the explosion to be directed against the piston to assure maximum power.

Still another object of the invention is to provide an auxiliary piston, of the character described, which has one end exposed in the combustion chamber, and which is urged inwardly

toward said chamber by a primary spring, such inward movement being resisted by a smaller or secondary spring; said springs being adjusted to control the compression ratio and to compensate for variations in fuel and acting to yieldingly maintain the piston in a proper operating position without the necessity of providing stop shoulders or the like which would be subject to excessive hammering or battering.

Still another object of the invention is to provide an improved auxiliary piston, of the character described, which permits further advance of the spark or ignition with the advantages thereof and which is readily applicable to any type of internal combustion engine without any material change in said engine.

A particular object of the invention is to provide an improved engine structure, of the character described, wherein the springs which yieldably mount the piston may be mounted within the engine head with a free circulation of air therearound or which may be disposed beyond or outside of said head with a suitable connection to the piston, whereby said springs are not subjected to the high operating temperatures of the engine; the arrangement also locating the manual adjusting means in a position readily accessible to the operator whereby adjustment of the device is facilitated.

A construction designed to carry out the invention will be hereinafter described together with other features of the invention.

The invention will be more readily understood from a reading of the following specification and by reference to the accompanying drawings, wherein an example of the invention is shown, and wherein:

Figure 1 is a transverse, vertical sectional view showing the upper portion of an engine cylinder having the improved structure, constructed in accordance with the invention, applied thereto,

Figure 2 is a horizontal, cross-sectional view, taken on the line 2—2 of Figure 1,

Figure 3 is an isometric view of the adjusting member for adjusting the tension of the primary spring,

Figure 4 is a view similar to Figure 1, illustrating the invention applied to an airplane engine,

Figure 5 is an end elevation of the engine cylinder shown in Figure 4 and illustrating the exterior mounting of the spring arrangement in this form, and

Figure 6 is a view similar to Figure 1 showing a modification of the invention.

In the drawings, the numeral 10 designates

the cylinder of an internal combustion engine A and the upper portion of the usual piston 11 which reciprocates within the cylinder is shown. The usual intake valve 12 which controls the admission of the combustible mixture through the intake manifold 13 is mounted at one side of the cylinder 10 in the engine block. A cylinder head 14 is mounted on the upper end of the engine block, being fastened thereto in the usual manner by bolts (not shown) and a head gasket 15 is interposed between the head and the block. The head is recessed as indicated at 16 and this recessed portion coacts with the cylinder 10 above the piston 11 to provide a combustion chamber B. A passage 17 extends from the combustion chamber and communicates with the intake passage or manifold, as well as with the exhaust manifold (not shown). A spark plug 18 is threaded into the head in the usual manner and has its lower end exposed within the passage 17.

In carrying out the present invention, the head 14 is formed with an auxiliary cylinder 19 which is integral with said head. The bore 20 of the cylinder is preferably of smaller diameter than the bore of the cylinder 10 although it could be of the same size. The lower end of the bore 20 of the cylinder is open, whereby a communication between said bore and the combustion chamber B is had. As illustrated, the cylinder 19 is in axial alinement with the cylinder 10.

An auxiliary piston 21 is mounted to reciprocate within the bore 20 of the cylinder 19, and this piston is inverted with respect to the piston 11. The piston 21 is hollow with its annular skirt directed upwardly and a plurality of piston rings 22 of the usual construction are mounted on the piston near the lower portion thereof (Figure 1). The bottom or head of the piston which is exposed within the combustion chamber is concave or recessed as indicated at 23.

For retaining the piston in a proper position within the cylinder 19, a stem or rod 24 has its lower end threaded into said piston, with its upper end projecting outwardly from the upper end of the cylinder 19. The stem also extends through a spider element 25, which element is clearly shown in Figure 3. The element 25 is provided with an annular ring 26 at its upper end and this ring is exteriorly screw threaded and is adapted to be screwed into a box or threaded socket 25a which is formed in the upper end of the auxiliary cylinder 19. The threaded box or socket is slightly enlarged with respect to the bore 20 of the cylinder 19, whereby an internal annular shoulder 27 is formed within the upper portion of the cylinder. The spider element 25 also includes depending arms or brackets 28, which are preferably formed integral with the ring portion 26 and a guide collar 29 is made integral with the lower end of the depending arms or brackets 28. The ring portion 26 of the spider element is split radially as indicated at 30 (Figure 3) and a tapered screw 31 is threaded into an opening 32 which extends vertically through the ring portion 26. Obviously, when the screw 31 is moved downwardly within the opening 32, the taper of said screw results in spreading the ring portion 26 to enlarge the diameter thereof. Unscrewing of the screw 31 will result in a reduction in the diameter of the ring portion 26 of the element 25 and manifestly, the tapered screw provides a means whereby the spider element may be locked in various adjusted positions within the screw threaded box or socket 25a, as will be explained.

As is clearly shown in Figure 1, the stem 24 which is secured to the piston 21 extends upwardly through the bore of the guide collar 29 and upwardly through the bore 26a of the ring portion of the spider element. The upper end of the stem is externally screw threaded, as indicated at 33 and a nut 34 is mounted on this threaded portion. A coiled spring 35, which will be hereinafter referred to as a secondary spring 10 surrounds the stem 24 and has its lower end engaging the collar 29 which forms part of the spider element 25. The upper end of the spring 35 engages a washer 36 which is disposed below the adjusting nut 34. A shield 37 which overhangs the upper end of the auxiliary cylinder 19 in spaced relation thereto, is also threaded onto the stem 24 above the adjusting nut 34 and this shield not only encloses or covers the upper end of the cylinder but also acts as a lock nut for preventing the adjusting nut 34 from moving from a set position. The secondary spring 35 constantly exerts its pressure to urge the auxiliary piston 21 upwardly within the auxiliary cylinder 19 and outwardly of the combustion chamber B. For urging the piston 21 downwardly within its cylinder toward the combustion chamber, a large or primary spring 38 is provided. This spring is mounted within the cylinder and has its lower end engaging the piston 21, with its upper end engaging the under side of the ring portion 26 of the spider element. It will be obvious that by adjusting the spider 25 within the threaded socket or box 25a, the tension or pressure of the primary spring 38 acting on the piston may be varied. As explained, the tension on the secondary spring 35 may be varied by adjusting the nut 34. The primary spring 38 constantly exerts its pressure to urge the piston 21 downwardly toward the combustion chamber B and this movement is resisted by the secondary spring 35 which is constantly tending to move the piston upwardly. It is apparent that the piston is yieldably supported in both directions, whereby it is full floating and is maintained in a desired position within the cylinder by the adjustment of the springs 38 and 35.

In the operation of the device, the engine operates in the usual manner. The springs 35 and 38 are adjusted so that the lower end of the piston 21 is opposite or in alinement with the wall of the recess 16 of the head 14 of the engine, whereby the bottom or concave portion 23 of the piston 21 forms one wall of the combustion chamber. The primary spring 38 is preloaded and exerts sufficient tension on the piston 21 to resist any removal of the piston during the compression stroke of the engine piston 11. In other words, as the piston 11 moves upwardly within the engine cylinder 10 during the compression stroke, the auxiliary piston 21 is not moved but is maintained in its present position by the tension of the primary spring 38. Thus, during this period, the compression chamber B is maintained of a predetermined size or area.

As is well-known, the ignition of the charge will occur slightly in advance of the time that the engine piston 11 reaches top dead center and it is this pre-ignition which results in engine knock, as well as in excessive shock and wear on the piston 11, bearings and associate parts. When the charge within the combustion chamber B is ignited or exploded, the sudden force of the explosion will result in the piston 21 moving upwardly within its cylinder 19 against

the pressure of the primary spring 38. Although the primary spring is sufficient to resist any movement of the piston 21 by the compression of the charge, it is not sufficient to resist movement under the force of the explosion and therefore when the explosion occurs, the piston 21 rises within its cylinder to enlarge the area of the combustion chamber. Obviously, since the auxiliary piston is yieldably mounted, the sudden shock of the explosion or ignition is cushioned or absorbed by said piston.

Immediately following the explosion, the piston of the engine will begin its power stroke and when this occurs, the primary spring 38 will immediately return the auxiliary piston 21 to its original or lowered position, with the result that the full force of the charge will be directed downwardly against the engine piston 11. In this manner there is no loss of power and the full force of the explosion is utilized during the power cycle of the engine piston 11. The movement of the auxiliary piston 21 may be very slight and is only sufficient to absorb or cushion the shock occasioned by the explosion or ignition of the fuel charge, whereby the engine piston and its associate parts are relieved of such shock. The secondary spring 35 which is constantly tending to urge the auxiliary piston 21 upwardly is sufficient to prevent the suction which is created by the downward movement of the engine piston 11 from pulling the auxiliary piston into the combustion chamber B on the suction stroke. Thus, after the auxiliary piston 21 has reciprocated in the manner described, said piston is returned to its original set position ready for the next operation. It is noted that when the engine has reached and is operating at a fixed or constant speed and the fuel supply is more or less constant, the auxiliary piston moves only a relatively slight distance upon each power stroke. It is only upon sudden acceleration or increased load that the movement of the piston is increased to cushion the shock occasioned thereby.

From the foregoing it will be seen that a simple and efficient means for absorbing and cushioning the shock occasioned by the explosion or ignition of the charge in the combustion chamber of an engine is provided. The tension on the primary spring 38 may be readily varied by loosening the tapered locking screw 31 and then rotating the spider 25 and moving into another position, after which the locking screw may be tightened to lock the spider in such adjusted position. By changing the adjustment of the primary spring 38, the lower end of the auxiliary piston 21 may be moved upwardly and downwardly with respect to the combustion chamber B so as to vary the size or volume of said chamber and thereby vary the compression ratio of the engine. The secondary spring 35 may be adjusted to compensate for variations in the fuel which is employed in operating the engine and the tension on this spring may be adjusted by merely changing the position of the lock nut 34 on the piston stem 24. The particular mounting of the springs 35 and 38 permits a free circulation of air around said springs, whereby overheating of these elements is obviated, with the result that more efficient operation over a longer period of time is assured. The adjustments may be readily made because the adjustable elements are accessible from above and without disassembling any of the parts, other than to remove the hood 37. The secondary

spring 35 is smaller than the primary spring 38 and the particular relationship between the strength of these springs is subject to variation although it has been found that by making the secondary spring one-half of the size of the primary spring, efficient results have been produced. The yieldable mounting of the piston 21 eliminates the necessity for any stop shoulders or other members to limit the movement of the piston in either direction and thus the battering and pounding incidental to such stop elements is eliminated. It is preferable that the usual water jacket 14a be formed within the head 14 around the auxiliary cylinder 19 to increase the cooling of the parts during operation.

Although it is desirable to mount the springs 35 and 38 in the manner shown in Figures 1 to 3, said springs could be mounted as shown in Figure 6. In this figure, the auxiliary piston 21a is provided with an axial upstanding stud 40. The lower end of the secondary spring 35 is connected to the stud and has its upper end connected to an annular recess 41 formed in an adjusting stem 42. The adjusting stem is threaded through a central collar 43 formed within a spider element or ring 44 which is threaded into the upper end of the auxiliary cylinder 19a. The primary spring 38 is confined between the under side of the spider 44 and the piston 21a. Obviously, the operation of this form of the invention is exactly the same as the first form hereinbefore described, the primary spring 38 tending to urge the piston 21a downwardly, while the secondary spring 35 tends to pull the piston upwardly. In this form, an internal shoulder 45 has been illustrated within the bore of the auxiliary cylinder 19a and is adapted to coact with a flange 46 at the upper end of the piston 21a. However, this is not a stop shoulder 45 for during normal operation, the flange 46 of the piston never strikes said shoulder and the only purpose or function of said shoulder is to prevent the piston 21a from falling inwardly into the combustion chamber B in the event that the secondary spring 35 should rupture or break.

The invention is also applicable to an airplane engine and in Figures 4 and 5, the auxiliary piston and cylinder is illustrated as mounted upon a radial type of airplane engine. As shown in these figures, the cylinder 110 of the engine has the usual piston 111 reciprocating therein. An auxiliary cylinder 119 is mounted in the head 114 of the engine, being preferably integral therewith, and is located at one side thereof so as to be disposed at one side of the combustion chamber B'.

The auxiliary piston 121 which functions to cushion or absorb the shock is mounted to reciprocate within the cylinder 119 and has connection through a connecting rod 50 with the inner end of a lever 51. The lever 51 is pivoted near this inner end on a shaft 52 which is mounted within an extension 53 formed integral with the upper end of the cylinder 119. A suitable cover plate 54 is bolted or otherwise secured to the upper end of the piston and encloses the inner end of the lever 51, as is clearly shown in Figure 4.

The auxiliary cylinder 119 extends at a slight angle from the axis of the engine cylinder 110 and is disposed between the usual valve housings 55 of the engine. (Figure 5.) The outer end of the lever 51 projects laterally above the outer end of the cylinder 110 and has its outer end pivotally connected by a pin 56 with the upper

end of a screw-threaded rod or adjusting screw 57. A circular plate or disk 58 is threaded onto the upper portion of the adjusting screw 57 and is maintained in a predetermined position by means of a lock nut 59. A stationary or fixed bracket 60 which is formed integral with the head 114 of the engine cylinder projects outwardly therefrom and has a flanged portion 61 disposed below the washer or plate 58. This bracket is formed with an upstanding integral sleeve 62 which has an inwardly directed flange 63 at its upper end and which surrounds the screw 57, the flange being formed with a central opening 64 through which said adjusting screw extends. The primary spring 38 is confined between the disk or plate 58 and the fixed brackets 60 and constantly exerts its pressure to urge the adjusting screw 57 upwardly, whereby the outer end of the lever 51 is urged upwardly. This causes the inner end of the lever 51 to be moved downwardly within the cylinder 119 so as to urge the piston 121 downwardly within said cylinder. The downward movement of the piston occasioned by the pressure of the primary spring is resisted by the secondary spring 35, which secondary spring is confined within the sleeve 62, as is clearly shown in Figure 4. The upper end of the secondary spring 35 engages the overhanging flange 63, while the lower end of said spring rests upon a washer 65 which is held in a pre-determined position on the lower end of the adjusting screw 57 by lock nuts 66. Manifestly, the secondary spring is urging the adjusting screw 57 downwardly tending to pull the outer end of the lever 51 downwardly, with the result that the inner end of the lever is being urged upwardly to tend to move the piston 121 upwardly within the cylinder 119. Since the pivot point 52 of the lever 51 is disposed nearer the inner end thereof, the leverage is increased and therefore, relatively smaller springs may be employed for the purpose.

From the foregoing, it will be seen that the form of the invention shown in Figures 4 and 5 operates in the same manner as the other forms hereinbefore described. The primary spring 38 exerts its pressure to urge the piston 121 downwardly within its cylinder, while the secondary spring 35 tends to move the same upwardly within said cylinder. The primary spring 38 may be adjusted, that is, its tension may be varied by changing the position of the plate or disk 58 on the upper end of the screw 57. The tension of the secondary spring 35 may be varied by adjusting the washer 65 at the lower end of the screw 57. It is pointed out that the springs are located exteriorly of the cylinder 113 and are disposed in the atmosphere with a free circulation of air therearound and the possibility of the springs

becoming overheated and fatigued so as to lose their efficiency is obviated. Further, the springs are readily accessible for adjustment to suit the various operative conditions and are also easily replaced when necessary.

The foregoing description of the invention is explanatory thereof and various changes in the size, shape and materials, as well as in the details of the illustrated construction may be made, within the scope of the appended claims, without departing from the spirit of the invention.

What I claim and desire to secure by Letters Patent is:

1. An engine head for the cylinder of an internal combustion engine including, an auxiliary cylinder of smaller diameter than the engine cylinder and communicating with the combustion chamber at the upper end of said engine cylinder, a piston slidable in the bore of the auxiliary cylinder, an adjustable spider element in the upper end of the auxiliary cylinder, a primary spring confined between the spider element and the piston for urging said piston toward the combustion chamber, an upstanding stem on the piston extending through the spider, and a secondary spring confined between the spider and a projection on the stem for urging the piston outwardly away from said combustion chamber.

2. An engine head for the cylinder of an internal combustion engine, including an auxiliary cylinder of smaller diameter than the engine cylinder and communicating with the combustion chamber at the upper end of said engine cylinder, a piston slidable in the bore of the auxiliary cylinder, an adjustable spider element in the upper end of the auxiliary cylinder, a primary spring confined between the spider element and the piston for urging said piston toward the combustion chamber, an adjusting screw threaded through the spider element, and a secondary spring having one end secured to the screw and its opposite end secured to the piston for urging the piston in a direction outwardly of the combustion chamber.

3. An engine head for the cylinder of an internal combustion engine including, an auxiliary cylinder communicating with the combustion chamber of the engine cylinder, a piston slidable in the bore of the auxiliary cylinder, an adjustable reentrant retaining element in the upper end of the auxiliary cylinder, a coiled spring confined between said retaining element and piston for urging the piston toward the combustion chamber, and a second coiled spring disposed concentrically within the first spring and operatively connected between the piston and the reentrant retaining element for urging the piston outwardly away from the combustion chamber.

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