Jan. 4, 1949. R. SOLTESZ 2,458,111

MULTIPLE PISTON FOR INTERNAL-COMBUSTION ENGINES

Filed Feb. 11, 1947 2 Sheets-Sheet 1

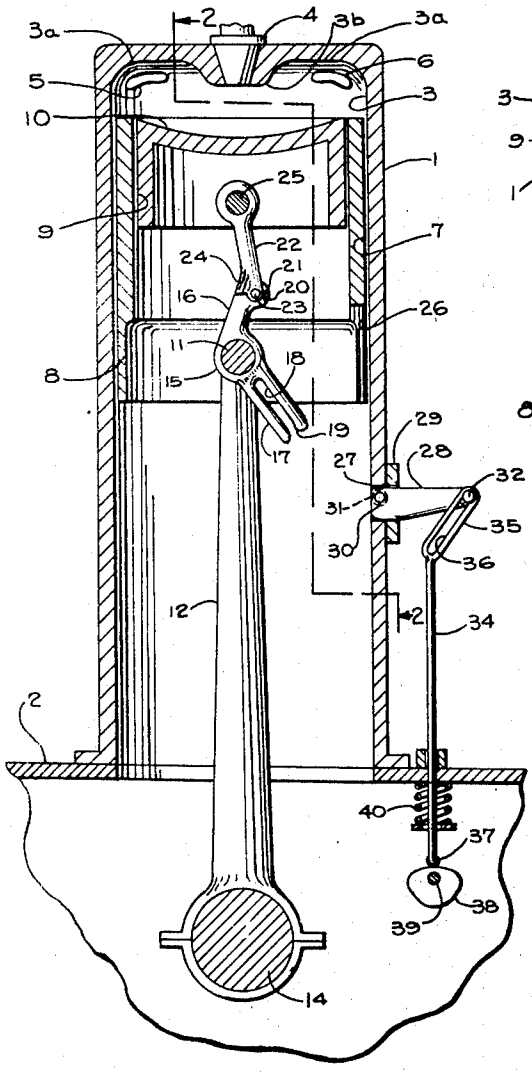


Fig. 1

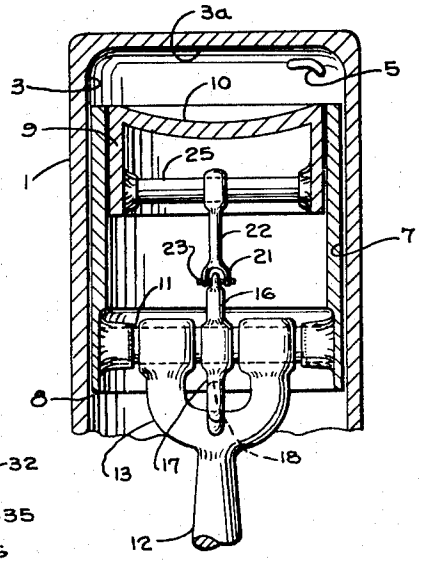


Fig. 2

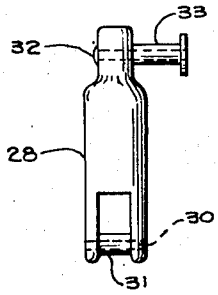


Fig. 1a

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START OF INTAKE STROKE

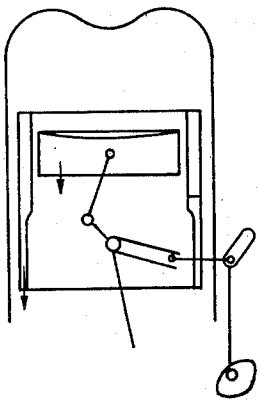


Fig. 3

START OF COMPRESSION STROKE

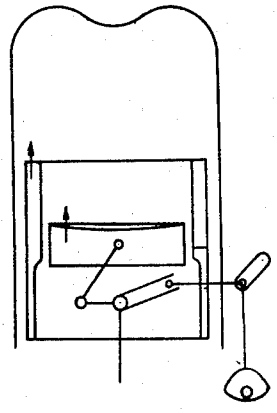


Fig. 4

END OF COMPRESSION STROKE

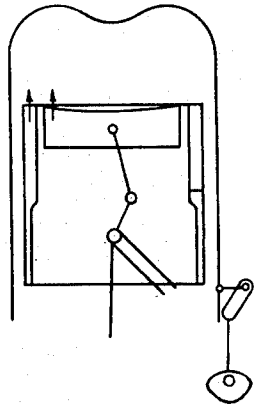


Fig. 5

POWER STROKE

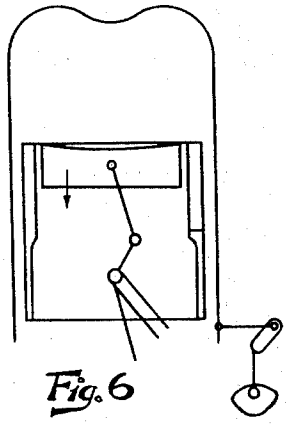


Fig. 6

EXHAUST STROKE

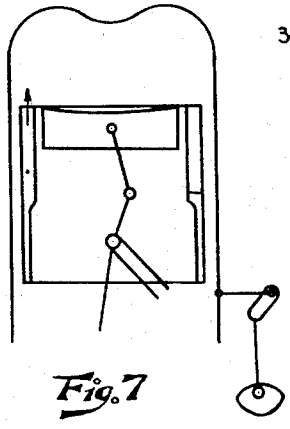


Fig. 7

MIDPOINT OF COMPRESSION STROKE

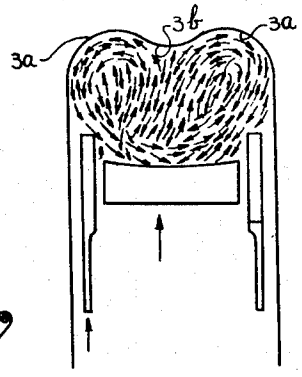


Fig. 8

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2,458,111

MULTIPLE PISTON FOR INTERNAL-COMBUSTION ENGINES

Rudolph Soltesz, Wheeling, W. Va.

Application February 11, 1947, Serial No. 727,903

5 Claims. (Cl. 123—78)

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This invention relates to internal combustion engines and more particularly to engines of this type having a sleeve piston and an inner piston adapted to move within the sleeve piston.

There have been numerous attempts to improve the efficiency of internal combustion engines, many of which have comprised efforts to increase the compression pressure of the engine by introducing larger volumes of air into the cylinder during the intake stroke. Such efforts have ordinarily necessitated increasing the cylinder bore or lengthening the stroke, both of which expedients are undesirable. In recent years the art has relied upon the use of superchargers to accomplish the desired result. The weight of superchargers imposes serious limitations upon the application of these devices and their use is not always practical. Furthermore, the cost of a supercharger makes it an expensive adjunct to an internal combustion engine.

The foregoing objections are overcome by this invention which, briefly stated, comprises providing an internal combustion engine with a main sleeve piston and an inner piston adapted to move within the main sleeve piston. During the intake stroke the main sleeve piston moves downwardly in the conventional manner while the inner piston moves downwardly within the main sleeve piston at about twice the speed of the latter. At the completion of the intake stroke, the inner piston is positioned below the uppermost horizontal surface of the main sleeve piston with the result that the volume in the cylinder above the pistons is approximately one-third greater than if both pistons had moved as a unit. During the compression stroke the main sleeve piston moves upwardly in the usual manner while the inner piston moves upwardly at about twice the speed of the main sleeve piston. At the completion of the compression stroke the uppermost horizontal surfaces of both the main sleeve piston and the inner piston coincide or fall in the same plane to provide a continuous piston head surface. In this position the inner piston forms a head for the main sleeve piston and this relationship remains fixed during the power and exhaust strokes. Thus, during the power and exhaust strokes there is no relative movement between the main sleeve piston and the inner piston. The foregoing operation introduces approximately one-third greater volume of air into the cylinder during the intake stroke which increases the compression, improves the efficiency of the engine and provides other advantages as well.

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It is the principal object of this invention to increase the compression of an internal combustion engine and to maintain the increased pressure throughout the power and exhaust strokes.

Another object of this invention is to provide an internal combustion engine having a main sleeve piston and an inner piston which are relatively movable and adapted to increase the compression of the engine by introducing a large volume of air into the cylinder during the intake stroke.

Still another object of this invention is to provide an internal combustion engine having relatively movable inner and outer pistons adapted to afford improved cooling of the piston surfaces during engine operation.

A further object of this invention is to provide an internal combustion engine having relatively movable inner and outer pistons adapted to increase the compression of the engine by increasing the operating pressure of the engine throughout the power and exhaust strokes and afford improved exhausting of waste gases.

A still further object of this invention is to provide an internal combustion engine in which the uppermost end of the combustion chamber and the head of the piston are curved to afford increased turbulence of the combustible gases in cylinder.

It is also an object of this invention to provide an internal combustion engine having a main sleeve piston and inner piston which move with respect to each other during the intake and compression strokes to afford high compression and which remain immovable with respect to each other during the power and exhaust strokes to maintain the increased pressure.

Other objects and advantages will appear from the following description and the drawings in which:

Fig. 1 is a side elevational view partly in cross-section of an internal combustion engine embodying the invention;

Fig. 1*a* is a detailed plan view of the rocker arm catch;

Fig. 2 is a vertical sectional view taken on line 2—2 of Fig. 1;

Figs. 3 to 7 are diagrammatic views showing main sleeve piston and inner piston positions at a series of successive points in the engine cycle; and

Fig. 8 is a diagrammatic view showing the turbulence of the combustible gases in the cylinder during the compression stroke.

Referring to the drawings, the type of internal

combustion engine shown embodying this invention is a Diesel engine comprising a cylinder 1 having a crank case 2 secured thereto. The cylinder 1 contains a combustion chamber 3 provided with a fuel charge injector 4, an air intake port 5 and an exhaust port 6. The combustion chamber is formed with upperwardly extending curved portions 3a—3a and a centrally located downwardly curved portion 3b. A main sleeve piston 7 having a skirt portion 8 of reduced thickness is mounted within the cylinder 1 and adapted to reciprocate therein. Mounted within the main piston 7 is an inner piston 9, the head of which is provided with a depression 10. The main sleeve piston 7 and the inner piston 9 are adapted to reciprocate longitudinally in the cylinder 1 as well as with respect to one another. A pair of bearings within the main sleeve piston 7 support a wrist pin 11. A connecting rod 12 having a clevis 13 formed in the head thereof engages the wrist pin 11 and connects the main sleeve piston 7 and a crank shaft 14.

A rocker arm 15 is pivotally mounted on the wrist pin 11 between the arms of the clevis 13. The rocker arm 15 comprises a vertically extending portion 16 and a downwardly extending portion 17 which is inclined toward the wall of the cylinder 1. The lowermost portion 17 is provided with a longitudinally extending slot 18, the upper edge of which is slightly rounded at its outer end 19. The vertical portion 16 has a drilled offset 20 to which a clevis 21 formed on the lowermost end of a connecting rod 22 is pivotally connected by a pin 23 extending through an opening formed in the clevis 21 and the drilled opening in the offset 20. The connecting rod 22 is provided with stop 24 which bears upon the uppermost horizontal surface of the vertical portion 16 when the latter is in a vertical position. The uppermost end of the connecting rod 21 is pivotally engaged to a wrist pin 25, mounted within the inner piston 9. The pistons 7 and 9, the connecting rod 22 and the rocker arm 15 are so constructed that the centers of rotation of the latter two elements about their respective wrist pins 25 and 11 coincide with the vertical center line of the sleeve and inner pistons. The pivotal point 23 between adjacent ends of the connecting rod 22 and the rocker arm 15 are beyond dead center with the result that when the vertical portion 16 of the arm 15 is in its uppermost position these elements assume a fixed relationship and no relative movement between the main sleeve piston 7 and the inner piston 9 occurs.

The skirt 8 of the main sleeve piston 7 is provided with a recess 26 which is aligned with plane of rotation of the rocker arm 15. The wall of the cylinder 1 is provided with an opening 27 which registers with the sleeve piston recess 26. The cylinder wall opening 27 is adapted to receive a rocker arm catch 28 which is slidably supported by a bushing 29. The innermost end of the catch 28 is bifurcated and provided with a pin 30 adapted to support a roller 31 between the bifurcated members. The outermost end of the catch 28 is provided with a laterally extending pin 32 which supports a roller 33. A vertically movable control rod 34 extending from the crank case 2 is provided with an upwardly and outwardly extending angular portion 35 having a slot 36 formed therein. The roller 33 of the catch 28 is positioned within the slot 36 of the angular extension 35. The lowermost end of the control rod 34 is provided with a roller 37 which engages a cam 38 mounted on a shaft 39. A spring 40 on

the control rod 34 is adapted to force the latter downwardly and into engagement with the cam 38.

The cam 38 is rotated and periodically moves the control rod 34 upwardly causing the roller 33 on the rocker arm catch 28 to follow the slot 36 in the angular extension 35. This action produces a periodic reciprocating movement of the rocker arm catch 28. In its innermost position, the roller 31 between the bifurcated portions of the catch engages the rounded edge 19 of the slot 18 in the downwardly extending portion 17 of the rocker arm 15 as the latter is moved longitudinally in the cylinder 1. The relative movement of the rocker arm 15 and the rocker arm catch 28 causes the rocker arm to pivot about the wrist pin 11 as the roller 31 moves in the slot 18. The pivotal movement of the rocker arm 15 produces, in turn, pivotal movement of the connecting rod 22 and relative longitudinal movement between the main sleeve piston 7 and the inner piston 9. It will be apparent that, as the main sleeve piston 7 moves downwardly and the rocker arm 15 and the catch 28 are engaged, the throw of the vertical portion 16 of the rocker arm 15 will cause the inner piston 9 to move downwardly at a greater rate of speed than that of the sleeve piston 7. At the end of the downward stroke of the sleeve piston 7 the inner piston 9 has moved downwardly within the sleeve piston 7, thus providing approximately one-third greater volume in the combustion chamber. During the upward stroke of the sleeve piston 7 the rocker arm 15 and the catch 28 remain engaged producing rotation of the rocker arm in the opposite direction which, in turn, causes the inner piston 9 to move upwardly at a greater rate of speed than that of the sleeve piston. At the end of the upward stroke of the sleeve piston 7 the rocker arm 15 and the catch 28 are disengaged and the pivot point 23 between the connecting rod 22 and the vertical portion 16 of the rocker arm 15 passes dead center represented by the center line of the wrist pins 11 and 25. The inner piston 9 then functions as a head for the main sleeve piston 7 and relative movement therebetween does not occur during the power and exhaust strokes. The cam 38 is designed to provide for progressive engagement and disengagement of the rocker arm catch 28 with the rocker arm 15 during the intake and compression strokes. During the power and exhaust strokes the rocker arm catch 28 rests in the wall of the cylinder 1 out of engagement with the rocker arm 15 and the latter remains in the over dead center position described with the result that relative movement between the main sleeve piston 7 and the inner piston 9 does not occur.

The operating sequence of the engine embodying this invention is shown diagrammatically in Figs. 3 to 7 inclusive. In Fig. 3 the beginning of the intake stroke is shown during which phase the main sleeve piston 7 has moved downwardly until the roller 31 of the rocker arm catch 28 has moved into the slot 18 of the downwardly extending portion 17 of the rocker arm 15. The rotation of the rocker arm 15 has begun moving the pivot point 23 between the connecting rod 22 and the vertical portion 16 from its over dead center position thus causing the inner piston 9 to move downwardly within the main sleeve piston 7. The movements described continue until the main sleeve piston 7 and the inner piston 9 reach their bottom dead center positions shown in Fig. 4. At this point the volume of the combustion chamber above the piston will be approximately

one-third greater than if both pistons had moved as a unit or as would be obtained in engines having a conventional style of piston. Accordingly, during the intake stroke an internal combustion engine embodying this invention may introduce at least one-third more air into the combustion chamber than is possible in the usual form of internal combustion engine. The air which is introduced by the construction described not only fills the space in the combustion chamber above piston 7, but also the space within the main sleeve piston 7 vacated by the inner piston 9. This produces the added advantage of increased cooling of the main sleeve piston resulting from the flow of cool air along the innermost wall of the main sleeve piston.

The compression stroke begins with the movement of the main sleeve piston 7 and the inner piston 9 upwardly from their lowermost dead center positions shown in Fig. 4. The rocker arm 15 rotates in the opposite direction as the main sleeve piston 7 moves upwardly. The rocker arm catch 28 is gradually retracted into the wall of the cylinder 1, but remains engaged with the rocker arm 15 until the sleeve piston 7 and the inner piston 9 reach their uppermost dead center position shown in Fig. 5. As this point is reached the rocker arm 15 and the catch 28 are disengaged and the pivot point 23 between the connecting rod 22 and the vertical portion 16 of the arm 15 moves over dead center represented by the center line of the sleeve and inner pistons. The stop 24 rests on the uppermost horizontal surface of the vertical portion 16 of the rocker arm 15 and prevents relative movement between the main sleeve piston 7 and the inner piston 9. During the intake and compression strokes the rocker arm catch 28 is moved laterally inwardly and outwardly and the roller 31 between the bifurcated portions of the catch 28 therefore moves inwardly in the slot 18 as the intake stroke is performed and outwardly therein as the compression stroke is accomplished.

The beginning of the power stroke is shown in Fig. 6. In this cycle of operation no relative movement is permitted between the main sleeve piston 7 and the inner piston 9. The rocker arm catch 28 remains in its retracted position in the wall of the cylinder 1. This relationship is also maintained during the exhaust stroke shown in Fig. 7. It will be apparent that the increased compression brought about by introducing a larger volume of air during the intake stroke than is obtained by ordinary single piston engines will produce more efficient scavenging of the products of combustion formed during the power stroke.

In Fig. 8 a diagrammatic showing indicates the advantage of increased turbulence of the combustible gases within the combustion chamber brought about by the depression 10 in the head of the inner piston 9 and the upwardly and downwardly extending curved portions 3a and 3b formed in the uppermost end of the combustion chamber. During the compression stroke the inner piston 9 moves upwardly with greater speed than the main sleeve piston 7. The depression 10 tends to direct a concentrated stream of compressed gases on the downwardly extending curved portion 3b. As the stream of gas strikes this curved projection it is deflected into the upwardly curved sections 3a—3a where the direction of flow of the compressed gases is completely reversed and redirected into the stream directed by the depression 10. This action continues throughout the compression stroke with the result that, at the end of the compression stroke, the gases have been thoroughly and homogeneously mixed to provide a uniform mass which facilitates rapid combustion of the injected fuel charge.

The invention has been described as applied to a four-stroke Diesel engine, but it is obvious that the invention is equally applicable to all internal combustion engines of the two-cycle and four-cycle type.

I claim:

1. An internal combustion engine comprising a working cylinder, a main sleeve piston reciprocating in said cylinder, an inner piston reciprocating within said sleeve piston, a rocker arm pivotally supported by said sleeve piston, a connecting rod journaled at opposite ends to said inner piston and said rocker arm, and a reciprocating catch supported by said cylinder and adapted to engage said rocker arm at predetermined points in the movement thereof.

2. An internal combustion engine comprising a working cylinder, a main sleeve piston reciprocating in said cylinder, an inner piston reciprocating within said sleeve piston, a rocker arm pivotally supported by said sleeve piston, a connecting rod journaled to said inner piston and said rocker arm, a reciprocating rocker arm catch supported by said cylinder, and timing means for moving said catch into engagement with said rocker arm during the intake and compression strokes of said sleeve piston.

3. An internal combustion engine comprising a working cylinder, a crank case attached to said cylinder, a crank shaft journaled in said crank case, a main sleeve piston reciprocating in said cylinder, a wrist pin mounted in said main sleeve piston, a connecting rod journaled at opposite ends to said crank shaft and said wrist pin, an inner piston reciprocating within said sleeve piston, a rocker arm pivotally supported by said wrist pin, a connecting rod journaled at opposite ends to said inner piston and said rocker arm, and a reciprocating catch supported by said cylinder and adapted to engage said rocker arm at predetermined points in the movement thereof.

4. An internal combustion engine comprising a working cylinder, a crank case attached to said cylinder, a crank shaft journaled in said crank case, a main sleeve piston reciprocating in said cylinder, a wrist pin mounted in said main sleeve piston, a connecting rod journaled at opposite ends to said crank shaft and said wrist pin, an inner piston reciprocating within said sleeve piston, a rocker arm pivotally supported by said wrist pin, said rocker arm having a vertical extension and a downwardly depending bifurcated extension, a connecting rod journaled at opposite ends to said inner piston and said vertical extension of said rocker arm, and a reciprocating catch supported by said cylinder and adapted to engage said bifurcated extension of said rocker arm at predetermined points in the movement thereof.

5. An internal combustion engine comprising a working cylinder, a crank case attached to said cylinder, a crank shaft journaled in said crank case, a main sleeve piston reciprocating in said cylinder, a wrist pin mounted in said sleeve piston, a connecting rod journaled at opposite ends to said crank shaft and said wrist pin, an inner piston reciprocating within said sleeve piston, a rocker arm pivotally supported by said wrist pin, said rocker arm having a vertical extension and

a downwardly depending bifurcated extension, a connecting rod journaled at opposite ends to said inner piston and said vertical extension of said rocker arm, said last named connecting rod having a stop adapted to engage said vertical extension, a reciprocating catch supported by said cylinder and adapted to engage said bifurcated extension of said rocker arm, and cam controlled means to move said catch whereby the inner piston has a greater intake and compression stroke than that of the main sleeve piston.

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