G. W. TEASDALE.

INTERNAL COMBUSTION ENGINE.

APPLICATION FILED JUNE 19, 1920.

1,408,422.

Patented Feb. 28, 1922.

2 SHEETS—SHEET 1.

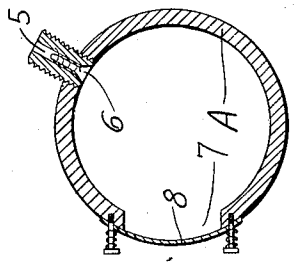


Fig. 3.

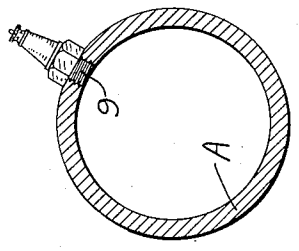


Fig. 2.

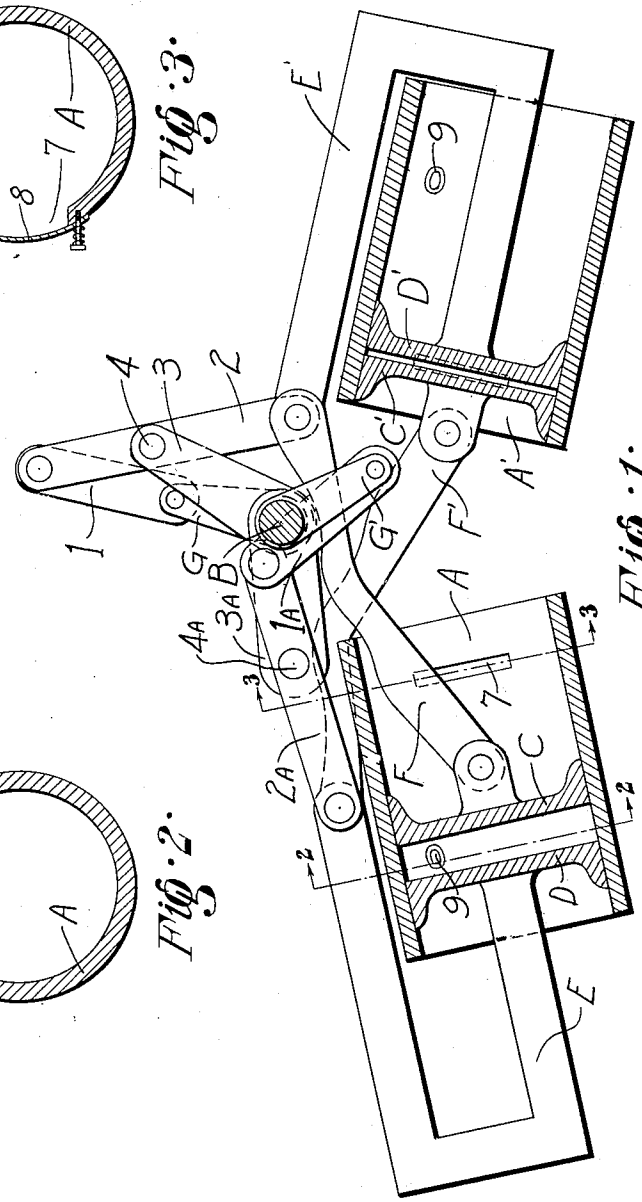


Fig. 1.

INVENTOR
GEORGE W. TEASDALE

BY
Bakewell & Church.
ATTORNEYS

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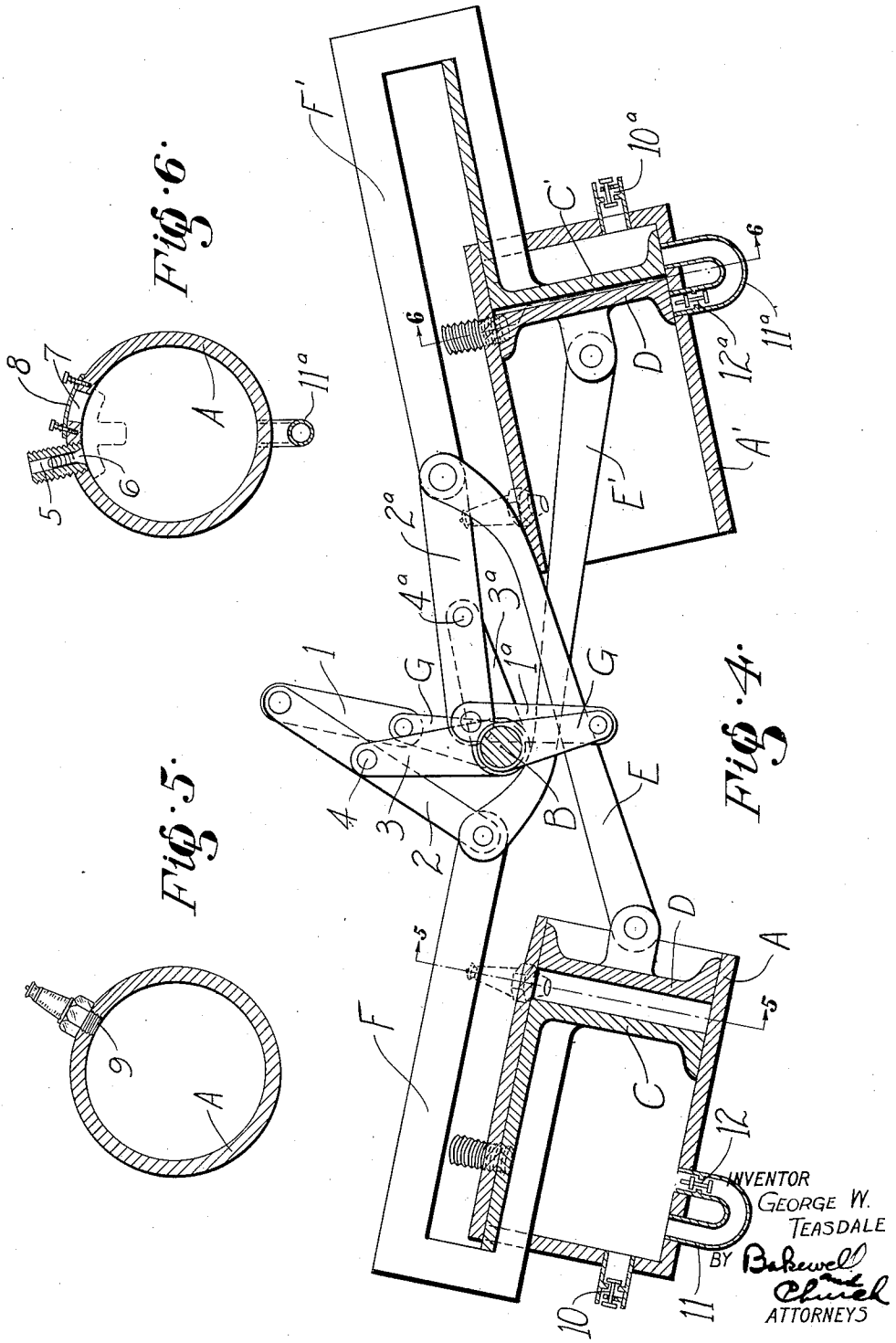


Fig. 4.

Fig. 6.

Fig. 5.

UNITED STATES PATENT OFFICE.

GEORGE W. TEASDALE, OF ST. LOUIS, MISSOURI.

INTERNAL-COMBUSTION ENGINE.

1,408,422. Specification of Letters Patent. Patented Feb. 28, 1922.

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To all whom it may concern:

Be it known that I, GEORGE W. TEASDALE, a citizen of the United States, residing at St. Louis, Missouri, have invented a certain new and useful Improvement in Internal-Combustion Engines, of which the following is a full, clear, and exact description, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to internal combustion engines.

One object of my invention is to provide a multi-cylinder four-cycle engine in which each piston imparts a power impulse to the crank shaft at each complete revolution of the crank shaft.

Another object is to provide a highly efficient four-cycle engine which is of such design that automatic valves can be successfully used for governing the admission and exhaust of the gases to and from the cylinders.

Another object is to provide a four-cycle engine of novel construction whose cylinders are completely scavenged at each cycle of operations by the direct action of pistons which expel the burnt gases from the cylinders.

And still another object is to provide an internal combustion engine in which the pistons are so arranged and connected with the crank shaft that the full expansive force of the gases is utilized during the power strokes of the pistons. Other objects and desirable features of my invention will be hereinafter pointed out.

To this end I have devised an internal combustion engine which in its simplest form consists of two cylinders arranged at an angle to each other on opposite sides of the crank shaft of the engine, two opposed pistons in each cylinder, one of which I will refer to as the operating piston, and the other as the suction piston, and means for connecting the operating piston of each cylinder with the suction piston of the other cylinder and joining said connected pistons to the crank arms on the crank shaft in such a manner that a combustible charge is drawn into each cylinder, compressed between the opposed pistons in the cylinder, then fired or exploded so as to impart a power impulse to the crank arm co-operating with said cylinder and the burnt gases thereafter positively expelled from the cylinder during each complete revolution of the crank shaft. In the engine herein shown which is provided with a pair of cylinders, the cycle of the pistons in each cylinder is as follows: The operating piston remains at rest while the suction piston moves in one direction to draw a charge into the cylinder, thereafter the operating piston moves towards the suction piston so as to compress the charge between said pistons, the charge is then fired, thus creating a pressure in the cylinder which causes the operating piston to move in the opposite direction back to its starting position, and thereafter the suction piston moves towards the operating piston so as to positively expel the burnt gases from the cylinder. The pistons are joined to the crank shaft in such a manner that the operating piston of each cylinder imparts a power impulse to the crank shaft at each complete revolution of the crank shaft, thus causing the crank shaft to receive two power impulses during each revolution of the crank shaft when the engine is provided with two cylinders, and the pistons are preferably so designed and connected with the crank shaft that the pistons of each cylinder move at a materially higher rate of speed during the first portion of their strokes than on the latter portion of their strokes, thereby enabling the full expensive force of the gases to be utilized during the power strokes of the pistons. If desired, means can be provided for supplying each cylinder with a compressed charge of fresh air at each cycle of operations of the engine.

Figure 1 of the drawings is a vertical transverse sectional view of my improved engine, taken through the cylinders.

Figures 2 and 3 are cross-sectional views of one of the cylinders, taken on the lines 2—2 and 3—3, respectively, of Figure 1.

Figure 4 is a vertical transverse sectional view illustrating an engine constructed in accordance with my invention and provided with a supercharger.

Figure 5 is a cross-sectional view, taken on the line 5—5 of Figure 4; and

Figure 6 is a cross-sectional view, taken on the line 6—6 of Figure 4.

In the form of my invention shown in Figures 1 to 3, A and A′ designate two cylinders arranged at a slight angle to each other on opposite sides of a crank shaft B. The left hand cylinder A is provided with an operating piston C and a suction piston D and the right hand cylinder A′ is pro-

vided with an operating piston C′ and a suction piston D′. The suction pistons D and D′ are provided with substantially yoke-shaped rods or actuating devices E and E′, each of which comprises a portion that projects outwardly through the end of the cylinder and a parallel portion arranged on the outside of the cylinder, as shown in Figure 1. The free end of the actuating device E′ of the right hand cylinder is connected by means of a connecting rod F with the operating piston C of the cylinder A and the free end of the yoke-shaped actuating device E of said cylinder A is connected by means of a connecting rod F′ with the operating piston C′ of cylinder A′, thus causing the suction piston D′ and the operating piston C to move in unison and the suction piston D and the operating piston C′ to move in unison, but for different distances, owing to the inclination of the cylinders.

The crank shaft B is provided with two crank arms G and G′ that are joined to the connecting rods F and F′, respectively, by links of such design and arrangement that each of said connecting rods is connected with its co-operating crank arm by a mechanism which, in some respects, is similar to a toggle. As shown in Figure 1, the crank arm G is joined to the connecting rod F by a short link 1 and a long link 2 pivotally connected together and combined with a guide link 3 that oscillates freely on the crank shaft and which is pivotally connected at 4 to the long link 2. The crank arm G′ is connected with the connecting rod F′ of the right hand cylinder by means of a short link 1^a, a long link 2^a, and a guide link 3^a that is pivotally connected at 4^a to said long link.

Each of the cylinders is provided in its side wall, adjacent the inner end of the cylinder, with an inlet port 5 governed by an automatic admission valve 6, and an exhaust port 7 is formed in the side wall of the cylinder adjacent the inner end of same, which exhaust port is controlled by an automatic, outwardly-opening exhaust valve 8. Spark plugs or other suitable ignition devices 9 are arranged in the side walls of the cylinders adjacent the outer ends of the cylinders.

Figure 1 illustrates the operating piston C of cylinder A at the end of its compression stroke and the suction piston D′ of cylinder A′ about to move outwardly on its suction stroke. When the compressed charge in the cylinder A is ignited the pressure produced in said cylinder by the expansion of the gases causes the piston C to move to the right, looking at Figure 1, thus imparting a power impulse to the crank shaft. As the suction piston D′ of cylinder A′ is mechanically connected with the operating piston C of cylinder A, said suction piston D′ will move outwardly or to the right, looking at Figure 1, simultaneously with the piston C and thus draw a combustible charge into the cylinder A′ through the inlet port in said cylinder that is controlled by the inwardly-opening inlet valve 6, the operating piston C′ of cylinder A′ remaining at rest during the main portion of the outward stroke of the suction piston D′ and the suction piston D of cylinder A remaining at rest during the main portion of the power stroke of the operating piston C in said cylinder.

Due to the fact that the connecting rod F of the operating piston C is connected with its co-operating crank arm G by links which virtually form a toggle, instead of being directly connected to said crank arm, the piston C is capable of moving at a different ratio than the crank arm with which is co-operates, thereby making it possible to so design the engine that the pistons will move at a materially greater speed during the first portion of their strokes than during the last portion of their strokes. In the engine herein shown the links which join the connecting rods F and F′ to their co-operating crank arms are so proportioned and arranged that the operating piston C of cylinder A will move instantly upon the firing of the charge and at a relatively greater speed than its co-operating crank arm, the movement of said piston C causing the links 2 and 3 to assume such a position that the short link 1 exerts a downward thrust on the crank arm G just after said crank arm passes its dead center position shown in Figure 1. During the main portion of the power stroke of the piston C and the main portion of the suction stroke of the piston D′, the pistons D and C′ remain at rest, due to the fact that the links 1^a, 2^a and 3^a, which are joined to the connecting rod F′, move or swing relatively to each other during a portion of their cycle without transmitting movement from the crank arm G′ to said pistons D and C′. Before the operating piston C and the suction piston D′ with which it is connected complete their power and suction strokes, respectively, the suction piston D of cylinder A and the operating piston C′ of cylinder A′ start to move to the right, looking at Figure 1, thereby causing the burnt gases in the cylinder A to be positively expelled from said cylinder through the exhaust port 7 and the charge in the cylinder A′ to be compressed between the pistons C′ and D′, said pistons D and C′ moving at a relatively low speed during the first portion of their strokes and very rapidly in the last portion of their strokes, or vice versa. When the charge in the cylinder A′ is fired the pressure that is created in said cylinder causes the operating piston C′ in said cylinder and the suction piston D in the cylinder A to

move to the left, at first very rapidly and then much slower, thus imparting a power impulse to the crank arm G′ and causing a charge to be drawn into the cylinder A. Thereafter, the suction piston D′ in cylinder A′ and the operating piston C in cylinder A move to the left into the position shown in Figure 1, so as to positively expel the burnt gases from the cylinder A′ and compress the charge in the cylinder A.

From the foregoing it will be understood that my improved engine has many features and characteristics that make it superior to the ordinary four-cycle internal combustion engine now in use. For example, it is so constructed that the cylinders are scavenged perfectly at each cycle of operations by the direct action of pistons in said cylinders; it has automatic valves instead of mechanically-operated valves for governing the admission of the combustible mixture into the cylinders and the escape of the burnt gases from the cylinders; and it does not require a water circulating system to keep the cylinders from becoming overheated, due to the fact that the cylinders are perfectly scavenged at each cycle and are of such construction that the interior of each cylinder is exposed directly to the atmosphere for a large portion of the cycle of the pistons in said cylinder.

Another desirable feature of my engine is that the speed of the pistons can be regulated so as to obtain the highest efficiency in operation by changing the length and the pivot points of the links that are interposed between the crank arms and the connecting rods of the operating pistons. For example, by shortening the guide link 3 and attaching it lower down on the link 2, the speed of the piston C during the fore part of its stroke will be reduced; by lengthening the crank arm G or the link 1, the speed of the piston C during the first portion of its stroke will be increased, and by shortening the guide link 3 and attaching it to the center of link 2, together with lengthening the crank arm G and shortening the link 1, the practical dead point can be prolonged to almost half a stroke.

By arranging the cylinders at a slight angle to each other and connecting the operating piston of each cylinder to the suction piston of the other cylinder in such a manner that they move in unison, I obtain a perfect scavenging action, as the opposed pistons of each cylinder are practically together at the end of the scavenging stroke.

It is not essential that the crank arms be of the exact arrangement illustrated in the drawings, as the crank arms could be so arranged that the explosion in each cylinder will occur when the co-operating crank arm of said cylinder is on dead center, thus causing the pivotal connection between the links 1 and 2 that co-operate with cylinder A to move downwardly in a vertical line instead of in an oblique line, as occurs when the link 3 is set at the angle shown in Figure 1.

In my improved engine the operating piston of each cylinder makes as many strokes in one revolution as requires two revolutions in an ordinary four-cycle engine, thus eliminating fly wheel racing and enabling the engine to be directly connected with a member which it is desired to operate at a slower speed than the crank shaft of an ordinary four-cycle internal combustion engine, for example, the propeller of an aeroplane. In my engine two of the dead points of the ordinary four-cycle engine are eliminated, as one piston in each cylinder starts its movement before the other piston in said cylinder completes its stroke. I believe that it is of vital importance in the operation of internal combustion engines that the piston be ready to move on its power stroke with the greatest possible rapidity at the instant of the explosion. In my engine this is possible, as the connecting rod is joined to its co-operating crank arm by links in such a way as to throw all of the piston movement that would normally occupy the entire stroke into the first half of the stroke of the piston, leaving the second half of the stroke a practical dead point. In other words, while I utilize the entire movement normally produced by the crank, the movement is all concentrated into the first half of the revolution; in fact, practically into the first portion of the first half of the revolution.

If desired, the engine can be constructed in such a manner that a supply of fresh air, separate and distinct from the combustible charge, will be drawn into each cylinder, compressed to a high degree, and then admitted to the space between the opposed pistons in the cylinder during the operation of drawing the combustible charge into the cylinder or during the fore part of the compression stroke. In Figures 4 to 6 I have illustrated an engine constructed in the manner last referred to and comprising parts similar to the parts of the engine illustrated in Figures 1 to 3 and designated by similar reference characters. In the engine shown in Figures 4, 5 and 6, however, the cylinders are inclined oppositely to the cylinders of the engine shown in Figures 1 to 3, and the operating pistons C and C′ are arranged in the outer ends of the cylinders, instead of the inner ends of the cylinders and are provided with connecting rods F and F′ which are so constructed that they serve as valves for the exhaust ports 7. Each of the cylinders is provided in its end wall with an automatically-operating air inlet valve, designated by the reference characters 10 and 10^a and substantially U-shaped by-passes 11 and 11^a

equipped with automatic valves 12 and 12ª, respectively, are arranged in the side walls of the cylinders. Figure 4 shows the piston D′ of the right hand cylinder A′ at the end of its scavenging stroke and the operating piston C of the left hand cylinder A at the end of its compression stroke. When the piston C of cylinder A moved to the right on its compression stroke, a charge of air was sucked in through the automatic valve 10 into the space in the cylinder A between its end wall and the piston C. When the compressed charge in the cylinder A between the pistons C and D is fired, the piston C moves outwardly, or to the left, thus causing the charge of fresh air between said piston and the end wall of the cylinder to be compressed to a high degree, the valves 10 and 12 being of such design that they will remain tightly seated. Thereafter, the piston D moves first to the left to expel the burnt gases from the cylinder and then to the right to draw a combustible charge into the cylinder. On the succeeding stroke of the piston C to the right to compress the combustible charge the charge of highly compressed air in the space between the piston C and the end wall of the cylinder A is admitted to the space between the pistons C and D by means of the by-pass 11, the action being as follows: when the piston C is at the end of its power stroke, it coveres the leg or branch of the by-pass 11 which is arranged nearest to the end wall of the cylinder A, but when said piston starts to move to the right, said branch or leg is progressively opened, thereby permitting the compressed air to rush into the space between the pistons C and D, the movement of the piston C over the other branch or leg of the by-pass cutting off communication between the space in the cylinder between the end wall and the piston C and the space in the cylinder between the pistons C and D. The above construction provides an efficient means of simple design for supplying each cylinder with a supercharge of fresh air at each cycle of the pistons in the cylinder. It is obvious that the automatic air inlet valves and the U-shaped by-passes in the outer end portions of the cylinders could be deflected at the inner ends of the cylinders so as to cause a supercharge of air to be admitted to each cylinder during the latter part of the charging stroke of the piston in the cylinder.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent, is:

1. A four-cycle internal combustion engine, comprising a crank shaft, a pair of cylinders arranged at opposite sides of said crank shaft and each provided with a power piston and a suction piston, a crank arm on said shaft for each of said cylinders, and means for mechanically connecting each of said crank arms to the power piston of one cylinder and to the suction piston of the other cylinder whereby a combustible charge will be drawn into each cylinder, compressed, fired and the cylinder scavenged at each revolution of the crank shaft.

2. A four-cycle internal combustion engine, comprising a pair of opposed cylinders, a power piston and a suction piston in each cylinder, a crank shaft provided with a crank arm for each cylinder, and means for mechanically connecting each of said crank arms with the power piston of one cylinder and with the suction piston of the other cylinder in such a manner that on each revolution of the crank shaft the suction piston of each cylinder will move longitudinally in one direction and draw a charge into the cylinder, the power piston of said cylinder will then move longitudinally of the cylinder in the same direction to compress the charge, said power piston will thereafter move longitudinally in the opposite direction when the charge is fired, and subsequently the suction piston of said cylinder will move longitudinally towards the power piston to positively expel the burnt gases from the cylinder.

3. A four cycle internal combustion engine provided with a crank shaft, a pair of angularly-disposed cylinders arranged at opposite sides of said crank shaft, a suction piston and a power piston in each of said cylinders, and means for connecting the suction piston of each cylinder with the power piston of the other cylinder and joining said connected pistons with the crank shaft in such a way as to cause a combustible charge to be drawn into each cylinder, compressed between the pistons therein and the burnt gases thereafter positively expelled from the cylinder, during each complete revolution of the crank shaft, the cylinders being oppositely-inclined so as to cause the simultaneously moving, connected pistons of the respective cylinders to travel different distances.

4. A four cycle internal combustion engine, comprising a pair of cylinders, a suction piston and a power piston reciprocatingly mounted in each cylinder, a crank shaft, and an operating means for actuating said pistons consisting of systems of links connecting the power piston of one cylinder with the suction piston of the other cylinder and joining said connected pistons to a crank arm on the crank shaft in such a manner that the power piston of each cylinder will move instantly upon the firing of the charge in the cylinder, at a materially greater speed than the crank arm to which said piston is connected, thereby enabling the full expansive force of the gases to be utilized during the power strokes of the power pistons.

5. A four cycle internal combustion en-

gine, comprising a crank shaft, a pair of angularly-disposed, oppositely-inclined cylinders arranged at opposite sides of said crank shaft, a suction piston and a power piston arranged in each of said cylinders in opposed relation, means for mechanically connecting the suction piston of each cylinder with the power piston of the other cylinder, and a mechanism interposed between the crank shaft and the connecting means for the pistons in the cylinders for causing said pistons to move at a materially greater speed during the first portion of their strokes than during the last portion of their strokes.

6. A four-cycle internal combustion engine, comprising a pair of cylinders arranged at opposite sides of the crank shaft of the engine, an operating piston in each cylinder connected by a system of links with a crank arm on the crank shaft, a suction piston in each cylinder, and means for connecting the suction piston of each cylinder with the operating piston of the other cylinder.

7. A four-cycle internal combustion engine, comprising a pair of cylinders arranged at opposite sides of the crank shaft of the engine, an operating piston in each cylinder connected by a system of links with a crank arm on the crank shaft, a suction piston in each cylinder, means for connecting the suction piston of each cylinder with the operating piston of the other cylinder, and automatic valves for governing the admission and exhaust of the gases to and from said cylinders.

8. A four-cycle internal combustion engine, comprising a pair of cylinders arranged at opposite sides of the crank shaft of the engine, an operating piston and a suction piston arranged in opposed relation in each of said cylinders, crank arms on the crank shaft, a connecting rod joined to each of said operating pistons, means for causing the suction piston of each cylinder to move in unison with the operating piston of the other cylinder, and means for joining said connecting rods with their co-operating crank arms in such a manner that said operating pistons will move at a materially higher rate of speed than their co-operating crank arms during the first portion of their strokes.

9. A four-cycle internal combustion engine, comprising a pair of cylinders arranged at opposite sides of the crank shaft of the engine in oppositely-inclined positions, an operating piston and a suction piston in each of said cylinders, a connection between each of said co-operating pistons and its co-operating crank arm comprising a connecting rod, a long link and a short link interposed between said connecting rod and crank arm, and a guide link journaled on the crank shaft and connected to said long link intermediate the ends of same, and means for causing the suction piston of each cylinder to move in unison with the co-operating piston of the other cylinder.

10. A four-cycle internal combustion engine, comprising two angularly-disposed cylinders arranged at opposite sides of the crank shaft of the engine, an operating piston in each of said cylinders that moves in one direction to impart a power impulse to the crank shaft and in the opposite direction to compress the charge in said cylinder, a suction piston in each of said cylinders that moves in one direction to draw a charge into the space between the opposed pistons in the cylinder and in the opposite direction to expel the burnt gases from the cylinder, and mechanical connections between the suction piston of each cylinder and the operating piston of the other cylinder.

11. A four-cycle internal combustion engine, comprising a pair of cylinders arranged at opposite sides of the crank shaft of the engine, operating pistons and suction pistons in said cylinders combined in such a manner that the suction piston of one cylinder moves in unison with the operating piston of the other cylinder, and means for supplying each cylinder with a supercharge of compressed air during the cycle of operations of the pistons therein.

12. A four-cycle internal combustion engine, comprising a pair of cylinders arranged at opposite sides of the crank shaft of the engine, operating pistons and suction pistons in said cylinders combined in such a manner that the suction piston of one cylinder moves in unison with the operating piston of the other cylinder, means for admitting air to the space between the end wall of each cylinder and one of the pistons therein when said piston moves in one direction, said air being compressed during the return stroke of said piston, and means for causing said compressed air to be admitted thereafter to the space between the opposed pistons in the cylinder.

13. A four-cycle internal combustion engine, comprising a pair of cylinders arranged at opposite sides of the crank shaft of the engine, an operating piston in each cylinder provided with a connecting rod, a system of links for joining each of said connecting rods to its co-operating crank arm, a suction piston in each of said cylinders, means for causing the suction piston of each cylinder to move in unison with the operating piston in the other cylinder, an automatic valve in each of said cylinders for admitting air to the cylinder, and a by-pass combined with each cylinder in such a manner that the air admitted to the cylinder will be compressed and thereafter admitted to the space between the opposed pistons of the cylinder during a portion of the stroke of the piston.

14. A four-cycle internal combustion engine, comprising a pair of angularly-disposed cylinders arranged at opposite sides of the crank shaft of the engine, automatically-operating inlet and exhaust valves arranged adjacent the same ends of said cylinders for governing the admission of the charge and the exhaust of the burnt gases to and from the cylinders, an operating piston in each cylinder provided with a connecting rod, a system of links for joining each connecting rod to its co-operating crank arm, and suction pistons in said cylinders arranged in opposed relation to said operating pistons and each provided with a substantially yoke-shaped actuating device whose free end is pivotally connected to the connecting rod of the operating piston in the other cylinder.

GEORGE W. TEASDALE.