Oct. 11, 1932. C. R. ROCHE 1,882,448

AVIATION MOTOR

Original Filed Feb. 21. 1928 3 Sheets-Sheet 1

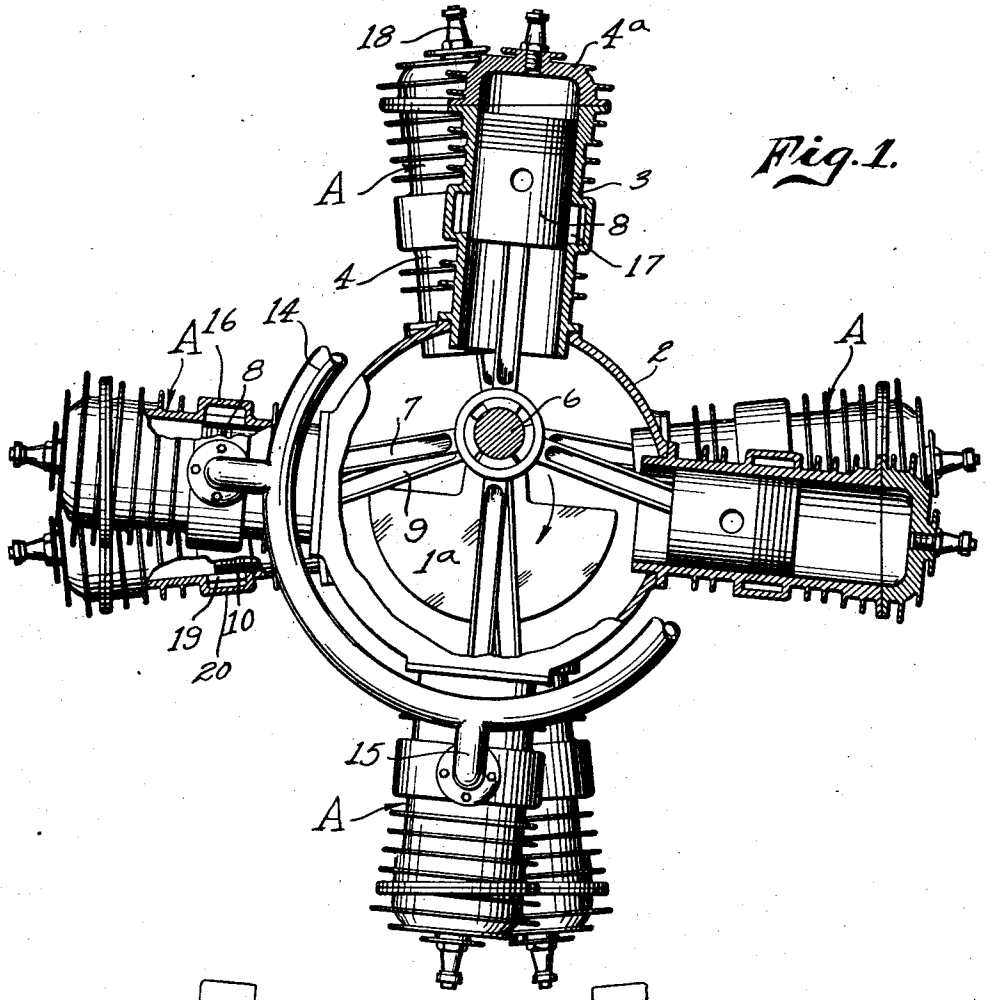


Fig. 1.

Fig. 4.

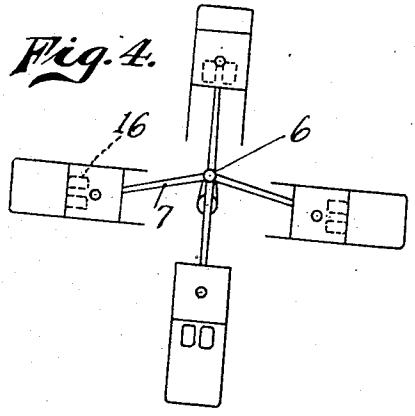
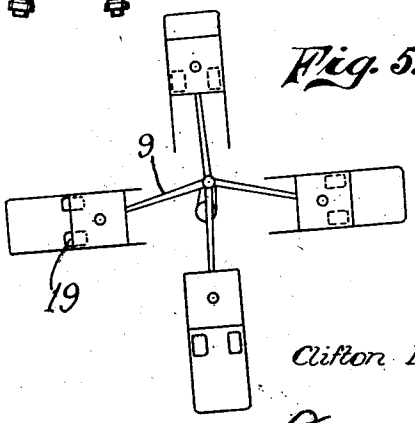


Fig. 5.



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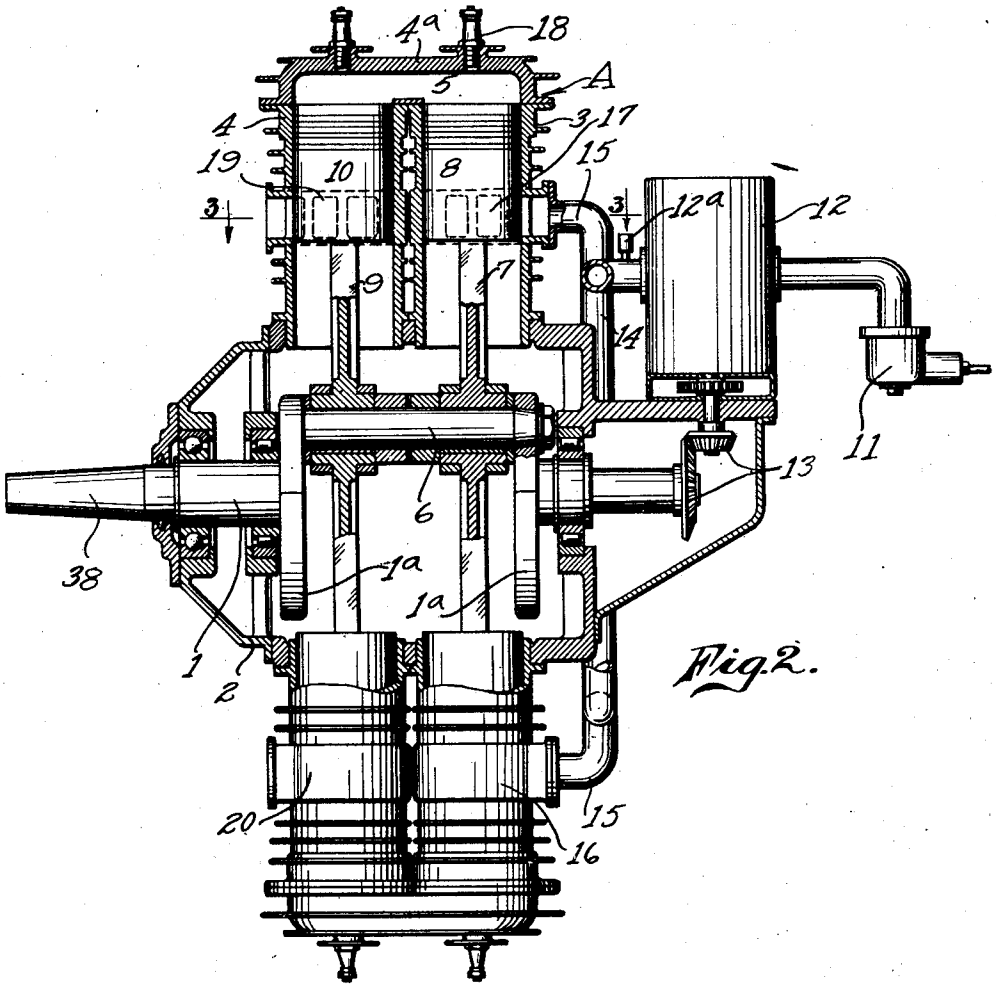


Fig. 2.

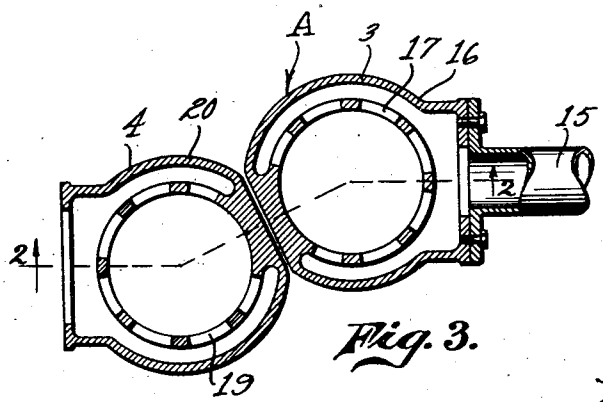


Fig. 3.

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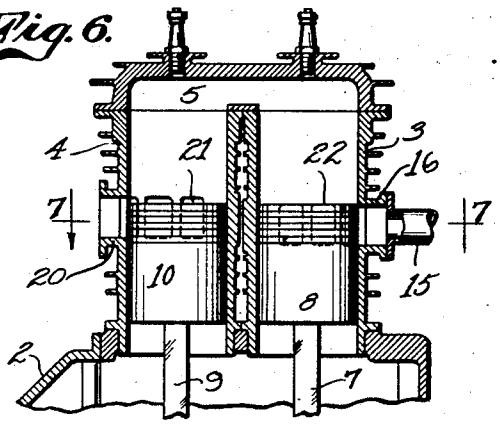
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AVIATION MOTOR

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Fig. 6.



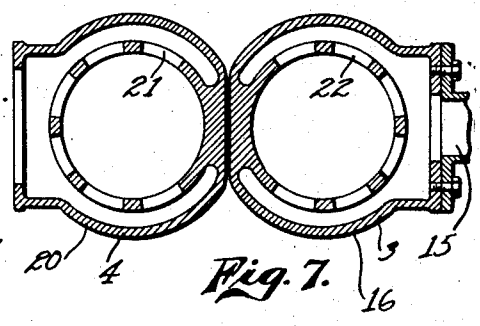
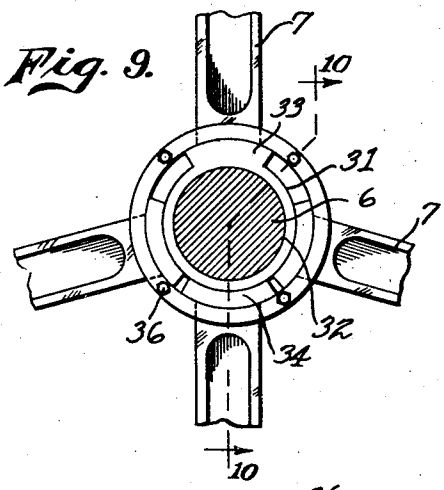


Fig. 7.

Fig. 9.



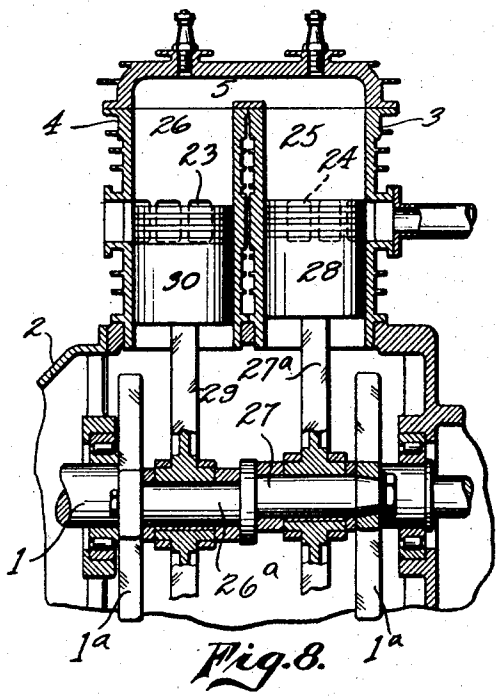
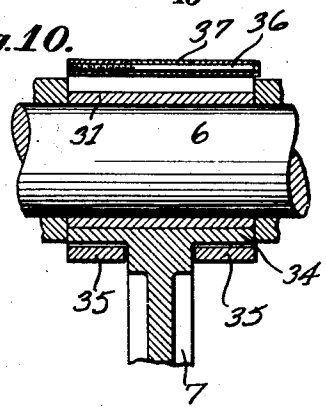


Fig. 8.

Fig. 10.



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UNITED STATES PATENT OFFICE

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AVIATION MOTOR

Application filed February 21, 1928, Serial No. 255,923. Renewed March 2, 1932.

This invention relates to aviation motors and particularly to motors of the internal combustion type. The general object of the invention is to produce an engine for this service which will be capable of generating a relatively great horse power but which is so constructed that the projected area of the cylinders in a front and rear direction is relatively small thereby reducing the wind resistance.

The invention is preferably embodied in a construction employing a plurality of power-cylinders that are disposed circumferentially in a plane transverse to the axis of the shaft. Each power-cylinder consists of a pair of cylinders the individuals of which are disposed one behind the other with respect to the fore and aft line of the aeroplane. One cylinder of each pair may be regarded as an inlet cylinder and the other as an outlet cylinder, because it carries the exhaust ports; the cylinders of each pair have a common combustion chamber; one of the objects of the invention is to provide means whereby the exhaust ports of the outlet cylinders will be open before the admission of fuel occurs into the inlet cylinders. This facilitates the scavenging of the exhaust gases which are driven out in a direction passing from the inlet cylinder through the combustion chamber and thence through the outlet cylinder and the exhaust port or ports.

A further object of the invention is to provide a simple construction for connecting the connecting rods to a common crank-pin on the crank-shaft.

Further objects of the invention will appear hereinafter.

This invention consists in the novel parts and combination of parts to be described hereinafter, all of which contribute to produce an efficient aviation motor.

In the drawings Figure 1 is a front elevation and partial section of an internal combustion engine embodying my invention, certain cylinders being shown in longitudinal section and other cylinders being shown with portions of their wall in cross-section.

Figure 2 is a side elevation looking from the left of Figure 1 with a large portion of the mechanism shown in cross-section with certain parts broken away.

In Figure 2 the two cylinders at the top of the view in section are shown on an ideal section taken on the line 2—2 of Figure 3.

Figure 3 is a horizontal cross-section taken on the line 3—3 of Figure 2.

Figure 4 is a diagram of the inlet cylinders and illustrating the relation of their pistons to the inlet ports.

Figure 5 is a similar diagram of the outlet cylinders and indicating the relation of the pistons to the outlet or exhaust ports.

Figure 6 is a longitudinal section through a pair of associated inlet and outlet cylinders showing a portion of the crank-case broken away and illustrating the modified embodiment of the invention to attain the effect of opening the exhaust ports before the inlet ports.

Figure 7 is a horizontal section through the cylinders shown in Figure 6 and taken on the line 7—7 of Figure 6.

Figure 8 is a view similar to Figure 6 but also illustrating the crank with offset crank-pins that correspond to the inlet and outlet cylinders, constituting another embodiment of the invention to attain the effect of opening the exhaust ports before the inlet ports.

Figure 9 is a view showing the crank-pin in cross-section and illustrating the preferred construction of the inner ends of the connecting rods for connecting the pistons to the crank-shaft.

Figure 10 is a section through the crank-pin and connecting rod heads taken on the line 10—10 of Figure 9.

Before proceeding to a detailed description of this engine it should be stated that the engine belongs to a type in which each power cylinder is composed of two associated cylinders with a common combustion chamber. When the internal combustion or explosion takes place, the pistons in both of these cylinders are driven so as to rotate the crank-shaft to which they connect. One of the cylinders of each pair operates as an intake cylinder and carries the ports through which the charge of fuel or air is admitted

to support the combustion or explosion of the fuel charge thereby scavenging the spent gases which are forced out of the exhaust ports in the other cylinder of the pair which operates as an outlet cylinder. It is highly desirable to provide a construction whereby the exhaust ports will open before the opening of the inlet ports. In this way the exhaust will have commenced and the pressure in the cylinders will already have fallen considerably when the admission of the new charge occurs. This greatly facilitates effective scavenging of the spent gases.

According to my invention I can attain this effect of early opening of the exhaust ports in three ways. In one way I mount the individual cylinders of each pair on different radial lines so that the inlet cylinders constitute one set of cylinders and the outlet cylinders, another set, and mounted so that during the rotation of the crank-shaft the piston of each outlet cylinder will be somewhat more advanced in its cycle than the piston of the corresponding inlet cylinder; another way in which I accomplish this effect is by placing the two individual cylinders of each pair with their axes in the same radial plane in which case I place the exhaust ports at a different point along the length of the outlet cylinder so that they will open before the inlet ports of the other cylinder. A third way of accomplishing the desired effect is to mount the cylinders of each pair in line in the same radial plane but the crank-pins for the inlet and outlet cylinders are slightly offset so that the piston of the outlet cylinder will open the exhaust port before the piston of the inlet cylinder will open the inlet port. I shall now proceed to describe the preferred means for attaining these results. Any combinations of these three methods can be used to obtain the most effective results.

In Figures 1, 2 and 3 I illustrate an embodiment of the invention in which the crank-pins for the two sets of cylinders are in alinement but in which the individual cylinders of each pair are mounted with their axes on different radial lines (see Figure 1). In this embodiment of the invention the outlet cylinder is substantially identical in construction to the inlet cylinder. Referring more particularly to this embodiment of the invention, A represents the power-cylinders which are four in number and disposed circumferentially around a crank-shaft 1 which is mounted to rotate in a crank-case 2. In this way there are two sets of cylinders, one set being inlet cylinders and the other set outlet cylinders, each power cylinder A consisting of an inlet cylinder 3 and an outlet cylinder 4. The longitudinal axes of these cylinders are disposed radially and should be a few degrees apart so that a small angle, for example 10° is formed between the axes of the cylinders as viewed in Figure 1. The inner ends of the cylinders may be bolted to the crank-case 2 and the outer ends are provided with a common head 4*a* so that they have a common combustion chamber 5 (see Figure 2).

The crank-shaft 1 has a crank-pin 6, one half of which is connected to the connecting rods 7 that connect to the positions 8 of the inlet cylinders and the other half of which connects to the connecting rods 9 that connect to the pistons 10 of the outlet cylinders. In other words all the connecting rods connect to a common crank-pin 6.

An engine constructed as described above may be driven on the Diesel principle by injecting liquid fuel into the cylinders. However, if the Diesel principle is employed air should be admitted for combustion into the ends of the inlet cylinders, and to facilitate driving out of the spent gases through the exhaust ports of the outlet cylinders. In the present instance I have illustrated the engine as though operating with an explosive mixture derived from a carbureter 11 in which atmospheric air and volatilized gasoline mix and pass into a blower 12 driven in any suitable manner from the crank-shaft, for example by means of beveled gears 13. This blower or charging device delivers the combustion gas into an inlet manifold 14 which is of annular form and which has necks or inlet branches 15 delivering the explosive mixture to the inlet manifold 16 of each inlet cylinder. The inlet manifold 16 of each cylinder is cast integral with the shell of the cylinder and the wall of the cylinder is provided with a plurality of inlet ports 17 through which the explosive mixture passes into the inlet cylinder when the inlet piston 8 is arriving at the end of its inward or driving stroke. On the outstroke the two pistons 8 and 10 of each power-cylinder compress the charge that has been drawn in in the combustion chamber 5 and the charge is then ignited by any suitable means such as the spark plugs 18. As the power stroke reaches its end the outlet piston 10 of the outlet cylinder uncovers the outlet or exhaust ports 19 in the outlet cylinder which communicate with an exhaust manifold 20 cast in the outlet cylinder from which the spent gases pass to the atmosphere or into an exhaust manifold not illustrated and then into the atmosphere.

The direction of rotation would be that indicated by the arrow in Figure 1. In this direction of rotation it will be evident by referring to the left side of Figure 1 that the outlet piston 10 will be further advanced in phase than the inlet piston both in its outward stroke and its inward stroke than the inlet piston 8 will be. Therefore the exhaust ports 19 will have become open before the inlet ports 17. As soon as the exhaust ports open, the pressure of the spent gases

will begin to drop and as soon as the inlet ports open the charge will commence to flow in and expel the spent gases. This will occur a considerable time before the end of the instroke of the pistons and this will therefore give a considerable time in the cycle which will be spent in forcing the new charge into the cylinders. On account of this it will be evident that this engine is capable of developing relatively high power. Each power cylinder while it has the area of two cylinders does not present the wind resistance area of two cylinders because one of the individuals of each pair of cylinders is disposed behind the other.

Figures 4 and 5 indicate the relation of the inlet and outlet pistons with relation to the intake and exhaust ports.

Instead of mounting the two cylinders 3 and 4 on different radial lines as shown in Figure 1, these two cylinders may be placed in the same radial plane with respect to the axis of the crank-shaft as illustrated in Figures 6 and 7. If this is done, I provide exhaust ports 21 the upper or outer ends of which are disposed further out on the cylinder than the upper ends of the inlet ports 22 (see Figure 6).

If desired instead of placing the ports 21, 22 out of line with each other, I may provide exhaust ports 23 and inlet ports 24 in line with each other in two cylinders 25 and 26 located in the same radial plane and attain the early opening of the exhaust ports by forming the crank-pin of two offset pins 26*a* and 27 the latter of which is connected by its connecting rod 27*a* with the inlet piston 28 (see Figure 8) and the latter of which is connected by its connecting rod 29 with the outlet piston 30.

The preferred means for connecting the connecting rods to the crank-pin is illustrated in Figures 9 and 10. One of the connecting rods for example the inlet piston connecting rod 7 is formed at its inner end with a head 31 of annular form with an opening 32 to receive the crank-pin 6. The wall of the principal portion of this head 31 is of reduced thickness, the same being integral with an arcuate shaped block 33 which is formed integrally with the shaft of the connecting rod 7. Each of the connecting rods is formed at its inner end with an arcuate shoe 34 similar in form to the block 33 and these shoes bear against the outer face of the head 31 where the thickness of the wall of the head is reduced. In this way the thrust through the rods is imparted through the head 31 which acts as bearing or box for all of the rods. Retaining means is provided for holding all of the shoes 34 in contact with the head 31 for which purpose I provide the ends of the shoe 33 beyond the sides of the shaft of the rod with two retaining straps in the form of rings 35. These rings are secured together by through-bolts 36, and pass through distance pieces 37 in the form of sleeves which are received over the bolts (see Figure 10).

The end of the shaft 1 may be provided with a tapered neck 38 to which the propeller of the aeroplane may be attached.

The charger or blower 12 may be of any desired type, for example a Root blower may be employed.

In practice, for an aviation motor, the cyliners should be constructed of an aluminum alloy for lightness each cylinder being provided with a steel liner pressed into place.

The connection from the blower to the manifold should carry a relief valve 12*a*. This valve would be adjusted so that it will not open under any pressure developed by the operation of the blower, but so that it will open under pressure caused by back-firing.

Suitable counterweights 1*a* are provided on the crank-shaft to obtain a good dynamic balance.

Although this motor is particularly adapted for use as an aviation motor, it may be used for any purpose whatever.

By reason of the early opening of the exhaust port, an early closing also occurs. This effects closing of the exhaust before opening of the inlets. This prevents waste of fuel, and also enables a slight pressure to be developed before compression commences on the out stroke. This is accomplished with the embodiments shown in Figs. 1 and 8.

A super-charging effect may be attained by driving the blower at a sufficiently high speed to give a slight compression of the charge or air for combustion in the inlet cylinders. The compression of such a charge in the inlet cylinder is, of course, enhanced by the early closing of the exhaust ports.

If the greatest possible effect in bringing about the early opening of the exhaust port is desired, I may combine any two or three of the different means described above to attain this effect, in the same engine.

Power cylinders having the features of construction described herein may be employed in a type of engine which is now being built, in which there is no connecting rod, but in which the pistons are directly connected to a part that rotates the crank.

If desired to have the engine especially adapted for idling, the inlet cylinders may be made of considerably smaller diameter than the outlet cylinders.

It is understood that the embodiment of the invention described herein is only one of the many embodiments this invention may take, and I do not wish to be limited in the practice of the invention, nor in the claims, to the particular embodiment set forth.

What I claims is:

1. In an internal combustion engine, the combination of a plurality of power cylinders

disposed in pairs located circumferentially in a plane transverse to the axis of the shaft, each pair of cylinders consisting of an inlet cylinder with an inlet port into which the operating charge is admitted and an outlet cylinder with an exhaust port for the spent gases, a common combustion chamber for each pair of cylinders, a piston corresponding to each inlet cylinder, a piston corresponding to each outlet cylinder, a crank-shaft with a crank-pin common to all the cylinders, and a connecting-rod corresponding to each piston and having a head attached to the crank-pin so that the pistons move in in unison and out in unison, said inlet port and said exhaust port co-operating with said pistons so that the exhaust ports become open during the stroke before the inlet ports.

2. In an internal combustion engine, the combination of a crank-shaft with a crank, a plurality of power cylinders disposed in pairs located circumferentially in a plane transverse to the axis of the shaft, in line with the crank, each pair of cylinders consisting of an inlet cylinder with an inlet port into which the operating charge is admitted and an outlet cylinder with an exhaust port for the spent gases, a common combustion chamber for each pair of cylinders, a piston corresponding to each inlet cylinder, a piston corresponding to each outlet cylinder, the crank-shaft having a crank-pin common to all the cylinders, a connecting-rod corresponding to each piston and having a head attached directly to the said crank-pin so that each pair of pistons moves out in unison and in in unison, the outlet cylinder of each pair being disposed in advance of the inlet cylinder of each pair with respect to the direction of rotation of said crank-shaft so that in the movement of each pair of pistons away from the crank-shaft the phase of the piston of the outlet cylinder will be in advance of the phase of the piston of the inlet cylinder, said parts co-operating so that the pistons of the outlet cylinders close the exhaust ports before the pistons of the inlet cylinders have closed the inlet ports, and means for forcing scavenging air into the inlet ports operating to supercharge the cylinders before the exhaust ports close.

3. In an internal combustion engine, the combination of a crank-shaft, a plurality of power cylinders disposed in pairs located circumferentially in a plane transverse to the axis of the shaft, each pair of cylinders consisting of an inlet cylinder with an inlet port, and an outlet cylinder with an exhaust port for the spent gases, a common combustion chamber for each pair of cylinders, a piston corresponding to each inlet cylinder and to each outlet cylinder, a crank-shaft with a crank-pin common to all the cylinders, a pair of connecting-rods corresponding to each pair of pistons and having heads respectively connected directly to the said common crank-pin so that both the pistons of a pair move in in unison and out in unison, the exhaust cylinder of each pair being disposed slightly in advance of its corresponding inlet cylinder with respect to the direction of rotation of the crank-shaft, said exhaust ports and inlet ports being so located that they co-operate with the pistons to open the exhaust ports before the inlet ports on the stroke of the pistons toward the shaft, and to close the exhaust ports on the other stroke of the pistons before the inlet ports.

4. In an internal combustion engine, the combination of a crank-shaft having a single crank, a plurality of power cylinders disposed in communicating pairs located circumferentially in a plane transverse to the axis of the shaft, each pair of cylinders consisting of an inlet cylinder with an inlet port for the charge and an outlet cylinder with an exhaust port for the spent gases, a piston corresponding to each inlet cylinder, a piston corresponding to each outlet cylinder, connecting-rods corresponding to each piston and having heads respectively attached to the said crank, said pistons and said ports co-operating to effect early closing of the exhaust ports, and a blower for directing the operating charge into the inlet cylinders and co-operating with the closed exhaust ports to effect a slight compression of the charge in the cylinders.

5. In an internal combustion engine, the combination of a plurality of power cylinders disposed in pairs located substantially circumferentially in a plane transverse to the axis of the shaft, each pair of cylinders consisting of an inlet cylinder with an inlet port into which the operating charge is admitted and an outlet cylinder with an exhaust port for the spent gases, a common combustion chamber for each pair of cylinders, a piston corresponding to each inlet cylinder, a piston corresponding to each outlet cylinder, a crank-shaft with a crank pin member corresponding to the set of inlet cylinders and a crank pin member corresponding to the set of outlet cylinders, and a connecting rod corresponding to each piston and having a head attached to its corresponding crank pin member so that the pistons move in in unison and out in unison, the crank pin member corresponding to the set of outlet cylinders being located slightly in advance of the crank pin member corresponding to the set of inlet cylinders and cooperating with said inlet port and said exhaust port so that the exhaust ports become open during the stroke before the inlet ports.

Signed at Los Angeles, California this 6th day of February, 1928.

CLIFTON R. ROCHE.