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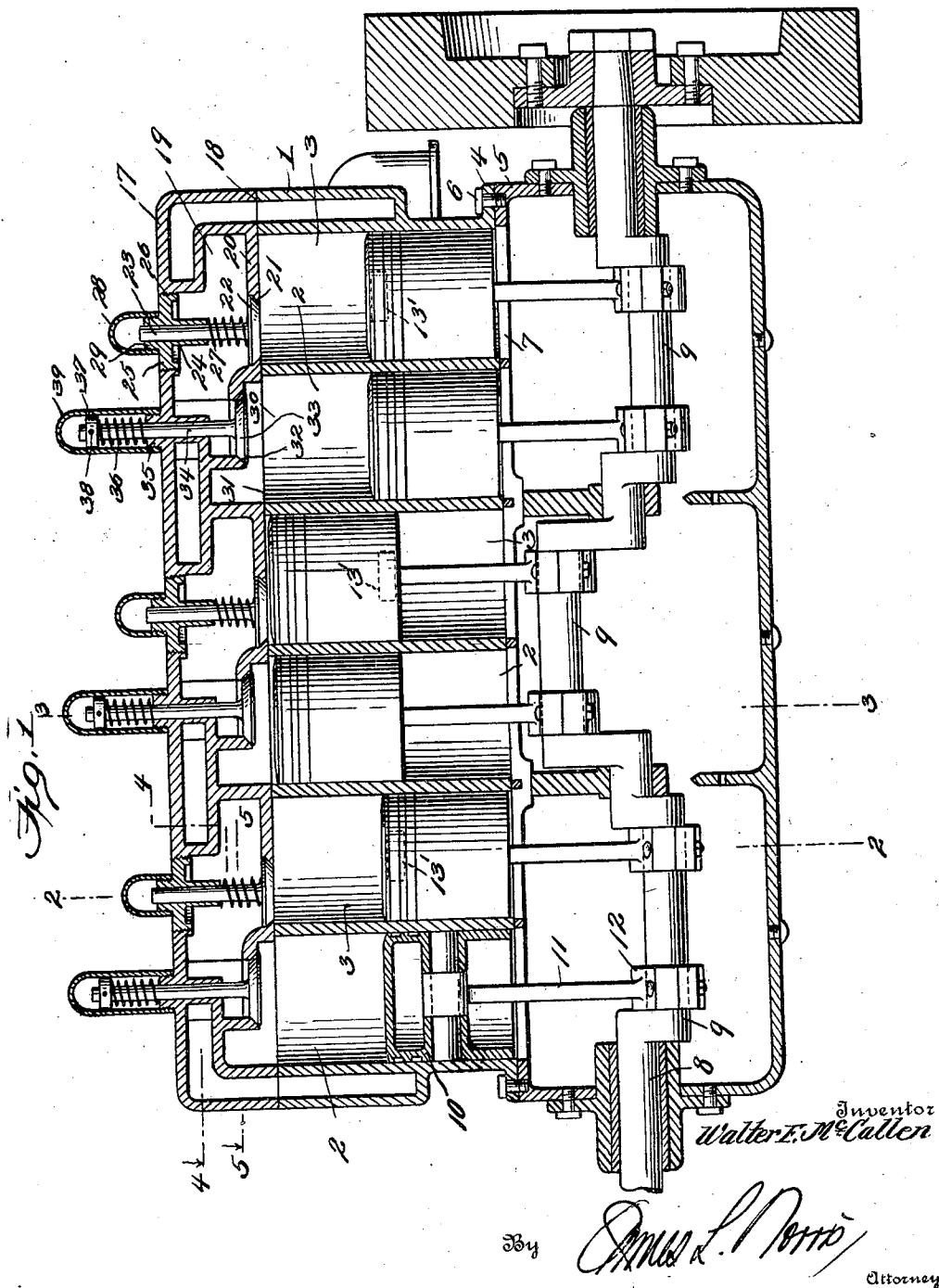
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W. F. McCALLEN

INTERNAL COMBUSTION ENGINE

Filed March 3, 1922

3 Sheets-Sheet 1



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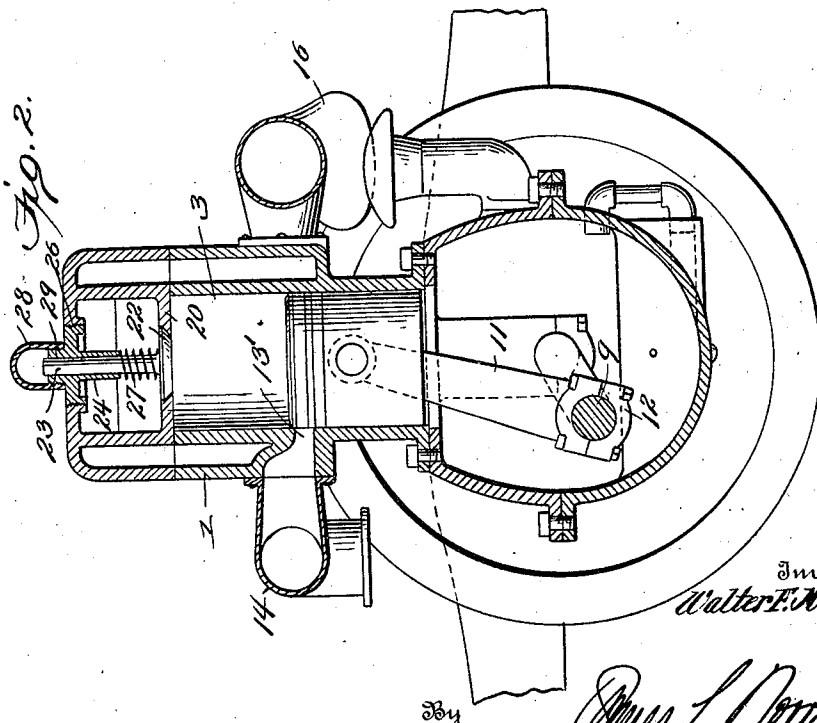
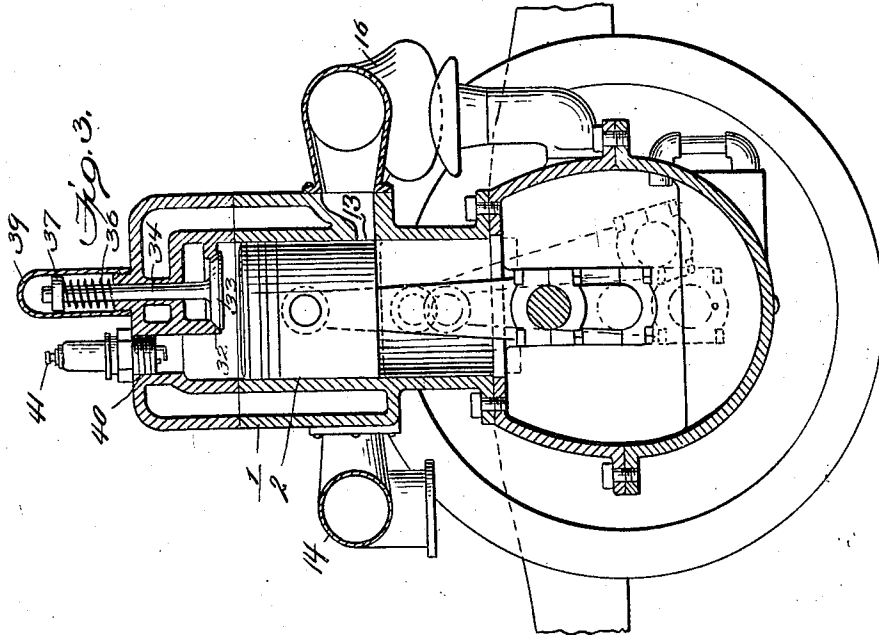
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Filed March 3, 1922

3 Sheets-Sheet 2



Inventor
Walter F. McCallen

James L. Norris,
Attorney

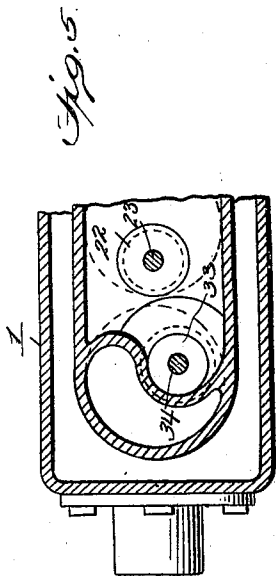
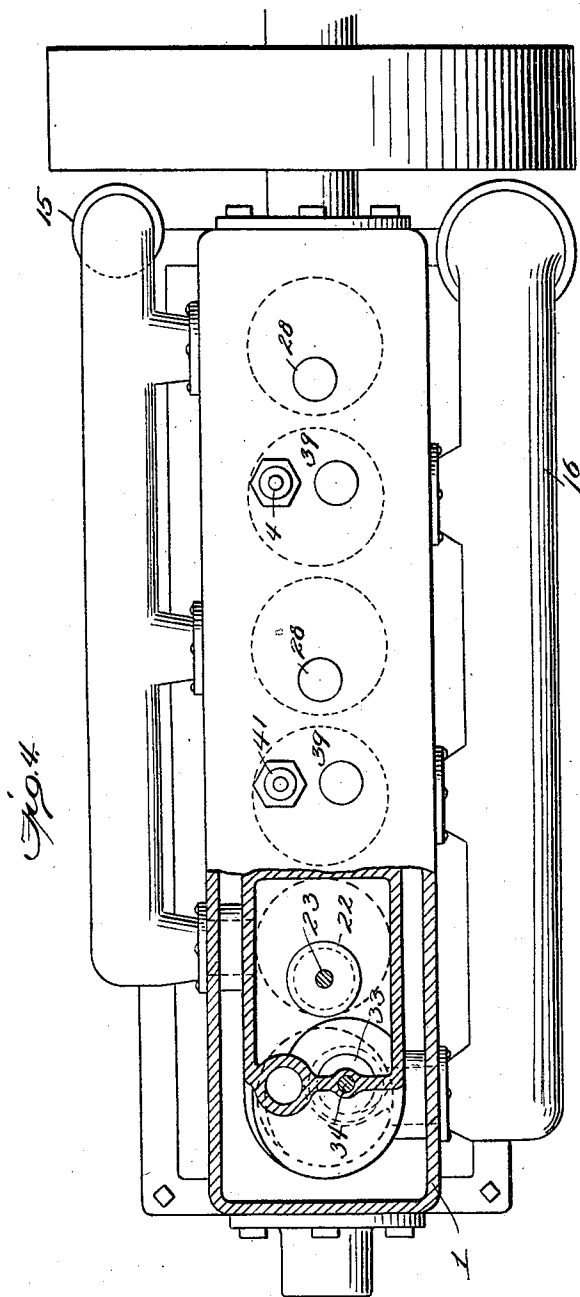
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INTERNAL COMBUSTION ENGINE

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3 Sheets-Sheet 3



Inventor
Walter F. McCallen

By *James L. Norris*

Attorney

UNITED STATES PATENT OFFICE.

WALTER F. McCALLEN, OF INDEPENDENCE, MISSOURI, ASSIGNOR OF ONE-HALF TO
AMBROSE E. ELLIOTT, OF INDEPENDENCE, MISSOURI.

INTERNAL-COMBUSTION ENGINE.

Application filed March 3, 1922. Serial No. 540,739.

To all whom it may concern:

Be it known that I, WALTER F. McCALLEN, a citizen of the United States, residing at Independence, in the county of Jackson and State of Missouri, have invented new and useful Improvements in Internal-Combustion Engines, of which the following is a specification.

This invention relates to internal combustion engines and proposes the construction of a multi-cylinder engine of the two cycle, pump compression type in which each explosion cylinder is provided with an individual pump, the pistons of said explosion cylinder and pump being mounted upon the same throw of the crank so as to travel together in the same phase of stroke.

One of the objects of the invention is the provision in an engine of the class described, of a valved transfer chamber between the pump cylinder and explosion cylinder through which fuel is forced into the explosion cylinder by the piston of the pump cylinder on its compression stroke, and from which scavenging fuel is drawn into said explosion cylinder, as needed, on the exhaust stroke of the latter due to the relative sub-pressure in said explosion cylinder occasioned by the recession of the piston therein and the opening of the exhaust port near the end of the stroke.

Another object of the invention is the provision of a two-cycle pump compression engine in which the clearance space within the explosion cylinder is greater in volume than the clearance space within the pump cylinder for the purpose of ensuring an excess pressure in the pump cylinder when the pistons in both said cylinders are at the top of their stroke, thus permitting the passage into said explosion cylinder of a full fuel charge compressed in the compression cylinder.

Still another object of the invention is the provision of a multi-cylinder internal combustion engine having a three throw crank shaft as in ordinary six cylinder engines, the cranks being spaced angularly 120° apart, the cylinders being arranged in co-operating pairs each comprising an explosion cylinder and a fuel compression cylinder, the connecting rods for the pistons of each pair being secured to the same crank.

A further object of the invention is the

provision of a two-cycle pump compression engine comprising a cylinder block and a detachable cylinder head therefor, the explosion cylinders and the pump cylinders in said cylinder block being undifferentiated from one another, and the structural features which give to each class of cylinders its distinctive function being carried solely by said cylinder head.

Another object of the invention is the provision of a six cylinder internal combustion engine of the two cycle type having the same manner of explosion impulses per revolution of the crank shaft as the ordinary four cycle six cylinder engine and therefore having the same smoothness of stroke, and which shall be free from the complication and noise of rocker arms or other crank shaft actuated valve operating mechanism.

With the above and other objects in view, my invention consists in the improved internal combustion engine illustrated in the accompanying drawings, described in the following specification, and particularly claimed, and in such variations and modifications thereof as will be obvious to those skilled in the art to which my invention relates.

In the drawings accompanying and forming a part of this specification, and wherein the preferred embodiment of my invention is illustrated:

Figure 1 is a side elevation in cross section showing a six cylinder internal combustion engine embodying my invention.

Figure 2 is a cross sectional view taken along the line 2—2 of Figure 1, through a compression cylinder.

Figure 3 is a similar view to Figure 2, taken along the line 3—3 of Figure 1, through an explosion cylinder.

Figure 4 is a plan view taken partly in cross section along the line 4—4 of Figure 1.

Figure 5 is a detail plan view in cross section taken along the line 5—5 of Figure 1.

Referring in detail to the several figures the numeral 1 represents a water jacketed cylinder block bored out to form cylinders 2 and 3. The bores for all six of the cylinders in the cylinder block are alike, but the alternate cylinders beginning on the left hand side of Figure 1 and designated by the numeral 2 are explosion cylinders while the remaining cylinders 3, function as mixture

compression pumps. The cylinder block 1 is outwardly flanged along its lower peripheral edge as shown at 4 and is bolted to the crank case 5 by means of the bolts 6. The crank case is bored with circular openings 7 which register with the cylinder bores and is provided with a three-throw crank shaft 8 having the cranks 9 which are arranged 120° apart as in the ordinary six cylinder construction. Within each of the cylinders reciprocates a piston 10, all of said pistons being identical in size and weight, so as to give perfect balance to the engine. The pistons are furnished with the usual connecting rods 11, provided with the divided bearings 12 which encircle the crank shaft and are secured rotatably thereto. The connecting rods of each pair of cylinders 2 and 3 are in operative engagement with one crank of the crank shaft so that the pistons reciprocate together.

Each of the cylinders is provided at a point just above the position occupied by the piston at the lower end of its stroke with a port, the ports 13' for the explosion cylinders 2 being on the right hand side of the cylinder block as shown in Figure 3 and the ports 13' for the pump cylinders 3 being on the left hand side, as shown in Figure 2. The three ports serving the pump cylinders are intake ports and are in communication with the intake manifold 14 which leads from the carbureter indicated at 15 in Figure 4. The three ports belonging to the explosion cylinders 2 communicate with the exhaust manifold 16, shown in Figure 4, said exhaust manifold being made larger than the intake manifold, as is customary in the art, to ensure a capacity for carrying away the expanded products of combustion.

It will be observed that the construction of the cylinder block and crank case as above described is, with the possible exception of the location of the ports, more or less standard, the six cylinders being all of the same bore, and cylindrical throughout, making the cylinder block a simple casting which may be readily and cheaply manufactured. The construction which distinguishes my engine from existing types of engines, and which results in what I believe to be an entirely novel principle of operation, is carried solely by the cylinder head 17 which is an integral water jacketed casting having the lower surface thereof machined as at 18 in order to fit closely a correspondingly machined upper surface of the cylinder block. The casting 17 is cored out over each of the compression cylinders 3 to form a transfer chamber 19, separated from the compression space of said compression cylinder by a flat partition wall 20. This wall is provided with an upwardly beveled valve aperture 21 with which the poppet valve 22 cooperates. The stem 23 of the

poppet valve 22 extends through a hollow sleeve 24 made integral with a plug 25 which threadedly engages an aperture 26 in the upper wall of the cylinder head casting. A spiral spring 27 surrounds the valve stem 70 and abuts at its respective ends against the valve 22 and plug 25, holding the valve normally closed when the piston 10 is on its downward stroke, but yielding to the compression within the compression cylinder on the upward stroke of the piston thereof, permitting the filling of said transfer chamber with compressed mixture. A dust cap 28 screws upon the outer wall of a threaded boss 29 which forms an outer extension of the sleeve 24, and provides means for the exclusion of dust or other foreign matter to the exposed end of the valve stem 23. The tension of the spring 27 determines the compression pressure within the cylinder 3 at which the valve 22 will open, and there is a small clearance space between the under surface of the flat wall 20, in which the mixture is compressed until the degree of pressure is reached at which said valve will be opened.

That portion of the cylinder head casting which lies above the explosion cylinder is recessed as at 30, and more deeply recessed at 31, forming a clearance space for said explosion cylinder, which is additional to the clearance space formed between the upper face of the piston and the plane of separation between the cylinder head and cylinder block when the piston is in its highest position. The object of having this additional clearance space will presently be explained.

A downwardly beveled valve aperture 32 is provided in that part of the wall of the cylinder head casting which overlies each of the explosion chambers, said aperture being normally closed by a valve 33 having a stem 34 which passes upwardly through a hollow boss 35 and extends beyond the upper wall of said cylinder head casting. The extending portion of said valve stem is surrounded by a spiral spring 36 held in compression between the outer face of the hollow boss 35 and a collar 37 which is fastened to the outer end of said valve stem by means of a pin 38.

A hollow dust cap 39 fits over the exposed portion of said valve stem and spring and threadedly engages the hollow boss 35. The valves which control the compression cylinders are preferably located in the median longitudinal line of said cylinder block as shown in Figure 2 but are preferably set to that side of the compression cylinder which lies adjacent the explosion cylinder which is served by said compression cylinder. The valves which control the inlet to the explosion cylinders are placed to one side of the longitudinal median line of the cylinder block in order to make room for the spark plug apertures 40, in which are inserted the spark plugs 41.

In the operation of my improved internal combustion engine, and referring particularly to a single pair of cylinders, the pistons in both the compression and explosion cylinders descend together opening the intake port of the compression cylinder and the exhaust port of the explosion cylinder. The valve 22 will remain closed during the descent of the piston 13 creating a high degree of vacuum in the compression cylinder so that when the intake port is put into communication with said cylinder a large volume of mixture will be drawn thereinto. On the compression stroke, this charge will be passed into the transfer chamber by forcing open the valve 22. It will be presumed that this is the initial stroke of the engine and that the transfer chamber has previously been empty. Very little of the compressed charge will therefore pass by the valve 33 into the explosion chamber. On the second downward stroke of the pump piston an additional charge of mixture will be taken into the compression cylinder, compressed upon the upper stroke of said piston and forced through the valve 22 into the transfer chamber which is already filled with the charge forced into it by the first stroke of said piston. In the meantime the piston in the explosion cylinder 2 will have descended, opening the exhaust port and will have returned to the upper end of its stroke compressing whatever gas or air that it may contain into the clearance space represented by the depressions 30 and 31 and the clearance between the top of the piston and cylinder head. Since the clearance space in the explosion cylinder is greater than that in the compression cylinder, the gas compressed in the former cylinder is at a lower pressure than the mixture in said transfer chamber. Consequently there will be a flow of highly compressed mixture past the valve 33 into the clearance space of the explosion cylinder on the upstroke of both pistons, continuing until the pistons reach the upward limit of their stroke. The ignition of the mixture then takes place and the pistons descend. But as the piston 10 of the explosion cylinder travels downward the pressure within said cylinder gradually becomes reduced below the pressure of the body of mixture remaining in the transfer chamber so that the valve 33 again opens after the explosion and admits a scavenging flow of gas which follows the exhaust products of combustion down to the end of the explosion stroke. On the upward return of the piston 10 in the explosion cylinder, said gas will be compressed to form the initial part of the next firing charge. The pressure within the transfer chamber having been brought up to its original value by the new charge compressed within the compression cylinder, it

is forced through the valve 22, to become the final part of the firing charge which is then exploded at the beginning of the next downward stroke of the piston.

In a six cylinder engine constructed according to my invention all the advantages in the smoothness of torque of the ordinary six cylinder four cycle internal combustion engine are realized because there are three explosions to each revolution of the crank shaft. Moreover, the present construction embodies an engine of much simpler design than the present type of four cycle engine since no rocker arms or other crank shaft actuated valve operating mechanism are required. The novel feature of operation by which scavenging mixture is supplied to the cylinder only in such quantity as is permitted by the gradual drop in pressure of the exploded charge in the explosion mixture is an advance in economy over constructions in which the charge is forcibly blown into the cylinder, part of which usually escapes through the exhaust port except at a single "efficient" speed of the engine, and finally, the design of an engine in which all of the operating elements except the provision of the cylinder ports are carried in the head, adapts the application of the invention to existing forms of internal combustion engine by merely substituting a new cylinder head therefor and performing the single mechanical operation of cutting the ports in the cylinder block.

It will be understood that various changes may be made in the form and relation of parts to suit different requirements of use, and that the invention, therefore, is not limited to the precise details of construction and arrangement shown.

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

1. In a two cycle internal combustion engine, an explosion cylinder having an exhaust port adjacent its lower end, a piston within said cylinder adapted to control said exhaust port, means for admitting an explosive charge to said cylinder on the up stroke of said piston and means for admitting a scavenging charge of mixture on the downward stroke of said piston subsequent to the explosion of said explosive charge.

2. In a two cycle internal combustion engine, an explosion cylinder having an exhaust port in its lower end, a piston within said cylinder adapted to control said exhaust port, means for admitting an explosive charge to said cylinder on the up stroke of said piston, and means for admitting a scavenging charge of mixture to said cylinder on the down stroke of said piston subsequent to explosion of said explosive charge, said admission means being responsive to

drop in pressure in said cylinder due to recession of the piston and opening of said exhaust port.

3. An internal combustion engine comprising a cylinder block, including an explosion cylinder and a compression cylinder, a crank shaft having a crank, pistons in said cylinders connected to said crank and operating within their respective cylinders in the same phase, and a transfer chamber communicating with said cylinders having inlet and outlet valves opening toward said explosion cylinder.

4. An internal combustion engine comprising a cylinder block, including an explosion cylinder and a compression cylinder, a crank shaft having a crank, pistons in said cylinders connected to said crank and operating in their respective cylinders in the same phase, and a transfer chamber communicating with said cylinders having pressure actuated inlet and outlet valves opening toward said explosion cylinder.

5. An internal combustion engine comprising a cylinder block including an explosion cylinder and a compression cylinder of equal diameters, a crank shaft having a crank, pistons in said cylinders connected to said crank, said pistons operating within their respective cylinders in the same phase and having equal limits of travel in said cylinders, a transfer chamber communicating with said cylinders having pressure actuated inlet and outlet valves opening toward said explosion chamber, the latter being provided with a larger clearance space than the compression cylinder.

6. An internal combustion engine comprising a cylinder block including an explosion cylinder and a compression cylinder of equal diameter, a crank shaft having a crank, pistons in said cylinders connected to said crank, said pistons having equal limits of travel in said cylinders, a transfer chamber within said cylinders having pressure actuated inlet and outlet valves opening toward said explosion chamber, the latter being provided with a larger clearance space than the compression cylinder, and inlet and outlet ports adjacent the inner limits of travel of the pistons of the compression cylinder and explosion cylinder respectively.

7. An internal combustion engine comprising a cylinder block including six cylinders, a crank shaft mounted in operative relation to said cylinder block, said crank shaft being provided with three cranks set angularly 120° apart, pistons for said cylinders, a pair of said pistons being secured to each crank, one cylinder of each pair being an explosion cylinder and the other a compression cylinder, a transfer chamber for each pair of cylinders, and inlet and outlet valves for said transfer chamber affording

the communication between said cylinders and opening toward said explosion cylinder.

8. A multi-cylinder two cycle internal combustion engine comprising a cylinder block provided with a plurality of cylinder bores, a cylinder head for said cylinder block constructed with upper and lower walls defining between them a mixture transfer chamber the lower wall having a flat portion closing the top of one of a pair of adjacent cylinder bores and a recessed portion closing the other of said pair, valves carried by said cylinder head and controlling communication between said cylinder bores and the transfer chamber, one of said valves opening toward said transfer chamber through the flat portion of said lower wall, the other of said valves opening outwardly from said transfer chamber through the recessed portion of said wall and a spark plug carried by the head and extending through said recessed portion.

9. A multi-cylinder two cycle internal combustion engine comprising a cylinder block provided with a plurality of cylinder bores, a cylinder head for said cylinder block constructed with upper and lower walls defining between them a mixture transfer chamber the lower wall having a flat portion closing the top of one of a pair of adjacent cylinder bores and a recessed portion closing the other of said pair, pressure controlled valves carried by said cylinder head and controlling communication between said cylinder bores and the transfer chamber, one of said valves opening toward said transfer chamber through the flat portion of said lower wall, the other of said valves opening outwardly from said transfer chamber through the recessed portion of said wall and a spark plug carried by the head and extending through said recessed portion.

10. A multi-cylinder two cycle internal combustion engine comprising a cylinder block provided with a plurality of cylinder bores of uniform diameter and cylindrical throughout, pistons for said cylinder bores, said bores being provided with ports adjacent the lower limit of travel of said pistons, a cylinder head for said cylinder block constructed with upper and lower walls defining between them a mixture transfer chamber the lower wall having a flat portion closing the top of one of a pair of adjacent cylinder bores and a recessed portion closing the other of said pair, valves carried by said cylinder head and controlling communication between said cylinder bores and the transfer chamber, one of said valves opening toward said transfer chamber through the flat portion of said lower wall, the other of said valves opening outwardly from said transfer chamber through the

recessed portion of said wall and a spark plug carried by the head and extending through said recessed portion.

11. A multi-cylinder two cycle internal combustion engine comprising a cylinder block provided with a plurality of cylinder bores of uniform diameter and cylindrical throughout, pistons for said cylinder bores, said bores being provided with ports adjacent the limit of travel of said pistons, the ports of alternate cylinders opening laterally on opposite sides of said cylinder block, a cylinder head for said cylinder block constructed with upper and lower walls defining between them a mixture transfer chamber the lower wall having a flat portion closing the top of one of a pair of adjacent cylinder bores and a recessed portion closing the other of said pair, pressure controlled valves carried by said cylinder head and controlling communication between said cylinder bores and the transfer chamber, one of said valves opening toward said transfer chamber through the flat portion of said lower wall, the other of said valves opening outwardly from said transfer chamber through the recessed portion of said wall and a spark plug carried by the head and extending through said recessed portion constituting the cylinder with which it communicates an explosion cylinder, the other cylinder being a compression cylinder, an exhaust manifold connected to the ports of said explosion cylinders and an intake manifold communicating with the ports of the compression cylinders.

12. An internal combustion engine comprising a compression and an explosion cylinder lying side-by-side in parallelism, a transfer chamber forming communication between said cylinders, a crank-shaft, a piston in each cylinder and piston rods connecting both of said pistons with the same crank of said crank-shaft, means controlling the flow of gas to and from said chamber, the arrangement of the means and the capacity of said cylinders being such that there will be a flow of gas from the compression chamber to the transfer chamber and from the transfer chamber to the explosion chamber during a portion of the compression stroke of the pistons.

13. In an internal combustion engine, a compression and an explosion cylinder, pistons operating in said cylinders, a transfer chamber forming communication between said cylinders, a valve automatically operated to permit the passage of gas from the compression cylinder to the transfer chamber during the compression stroke of the piston in the compression chamber, a valve automatically operated to permit passage of gas from the compression chamber to the explosion cylinder toward the end of

the expansion stroke of the piston in the explosion chamber, said valves being adapted to be operated under influence of pressure in the compression cylinder and transfer chamber respectively.

14. In an internal combustion engine a compression and explosion cylinder, a transfer chamber having passages forming communication with said cylinders, pistons adapted to operate in said cylinders so as always to be in the same phase, valves between said chamber and each cylinder operable under pressure of gas in the compression cylinder and transfer chamber respectively for opening the respective valves one upon the compression stroke and the other toward the end of the expansion stroke of said pistons.

15. In an internal combustion engine, a compression and explosion chamber lying side-by-side in parallelism to each other, pistons adapted to operate in said cylinders so as to always be in the same phase, a transfer chamber adapted to be brought into communication with said cylinders, means operable by pressure in the compression cylinder and transfer chamber respectively for forming said communications, the proportional capacity of said cylinders and chamber being such that there will be a flow of gas from the compression cylinder to the transfer chamber during the compression stroke of the pistons and from the transfer chamber to the explosion chamber during the expansion stroke and a portion of the compression stroke.

16. In an internal combustion engine, a compression cylinder and an explosion cylinder, pistons operable in both cylinders with uniformity of phase, a transfer chamber forming communication between said cylinders, valves controlling the flow of gas from said compression cylinder to the transfer chamber and from the transfer chamber to the explosion chamber, the capacity of said cylinders and chamber and the arrangement of the valves being such that there will be a transfer of gas from the compression cylinder to the chamber upon the compression stroke of said pistons, a transfer of a scavenging charge of gas from the chamber to the explosion chamber during the expansion stroke and a further charge during the compression stroke.

17. In an internal combustion engine, a compression cylinder and an explosion cylinder, pistons operable in both cylinders so as to always be in the same phase, a transfer chamber forming communication between said cylinders, valves controlling the flow of gas from said compression cylinder to the transfer chamber and from the transfer chamber to the explosion chamber, the capacity of said cylinders and chamber and

the arrangement of the valves being such that there will be a transfer of gas from the compression cylinder to the chamber and from the transfer chamber to the explosion
5 cylinder during the simultaneous stroke of said pistons.

In testimony whereof I have hereunto set

my hand in presence of two subscribing witnesses.

WALTER F. McCALLEN.

Witnesses:

E. H. ELY,

G. W. EASTWOOD.