

March 18, 1924.

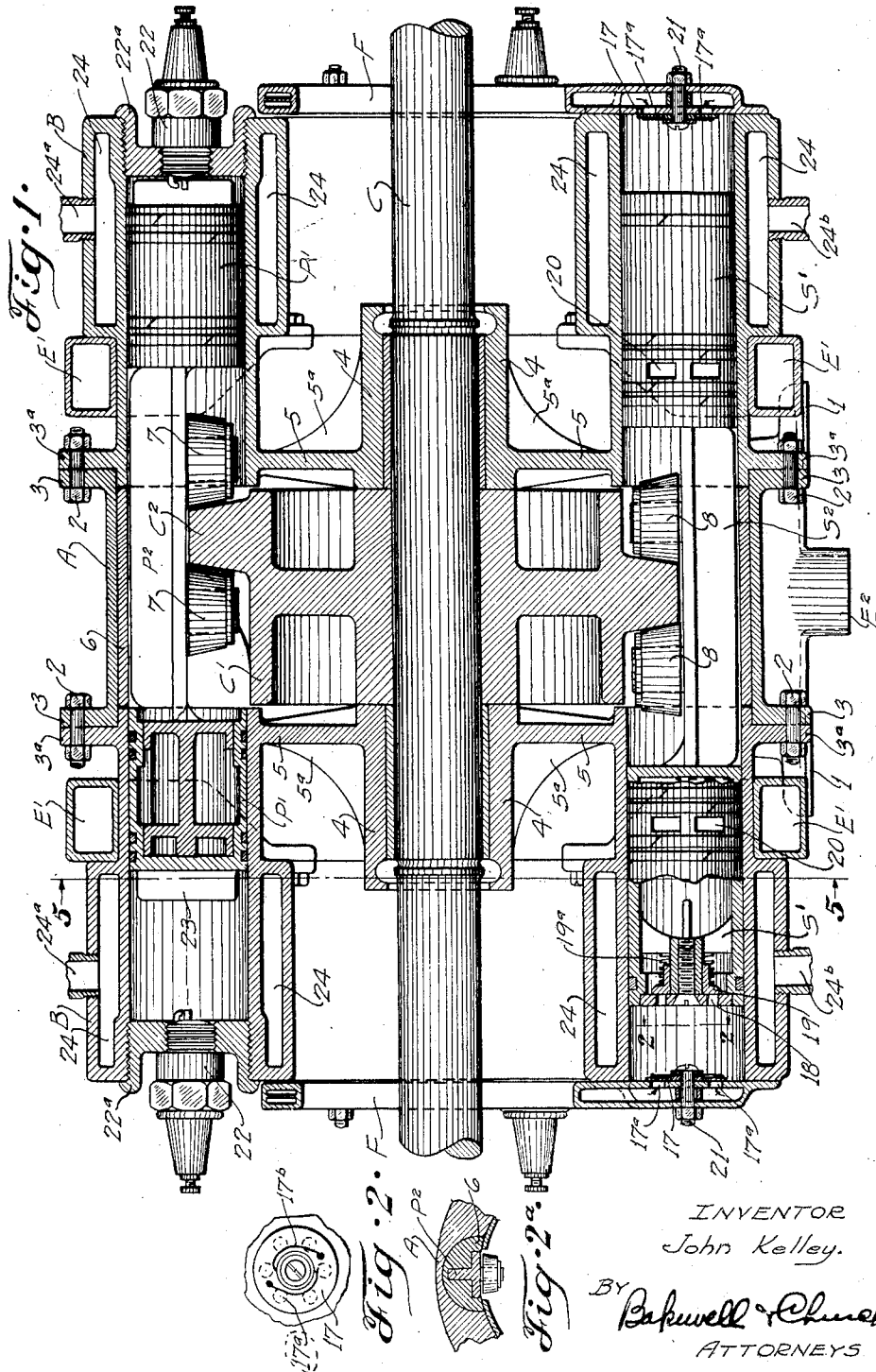
J. KELLEY

1,487,338

TWO-CYCLE INTERNAL COMBUSTION ENGINE

Filed Jan. 10, 1921

3 Sheets-Sheet 1



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BY
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3 Sheets-Sheet 2

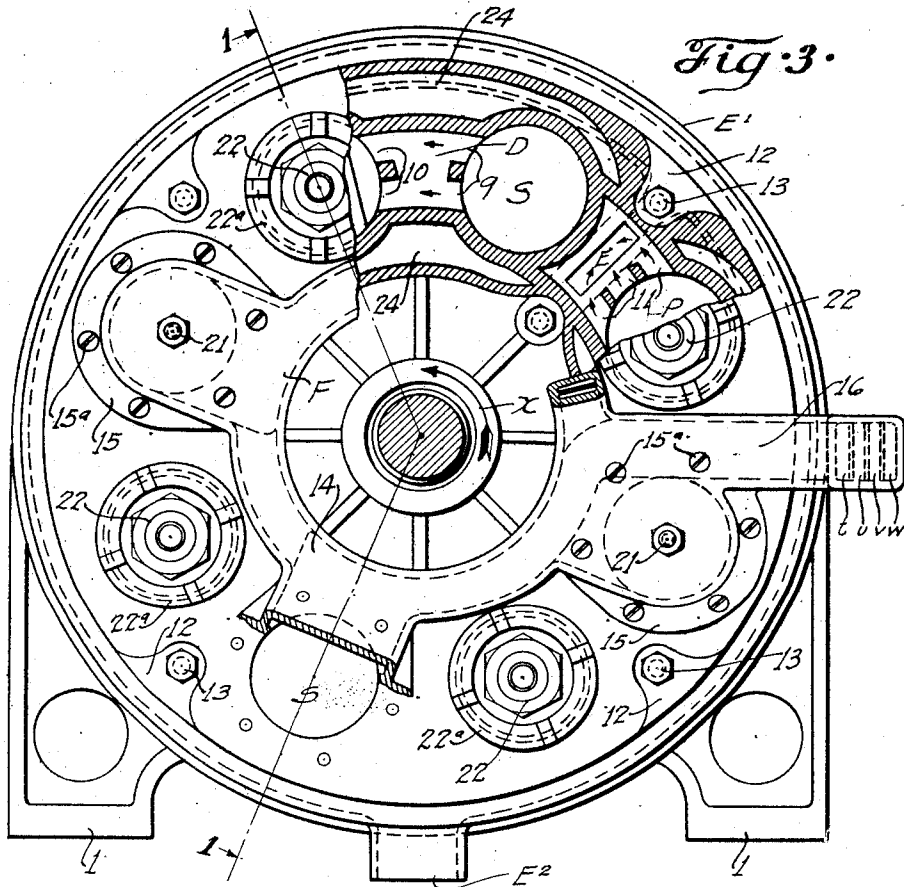
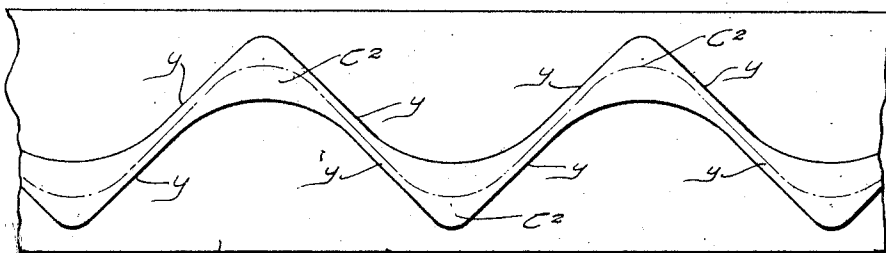


Fig. 4.

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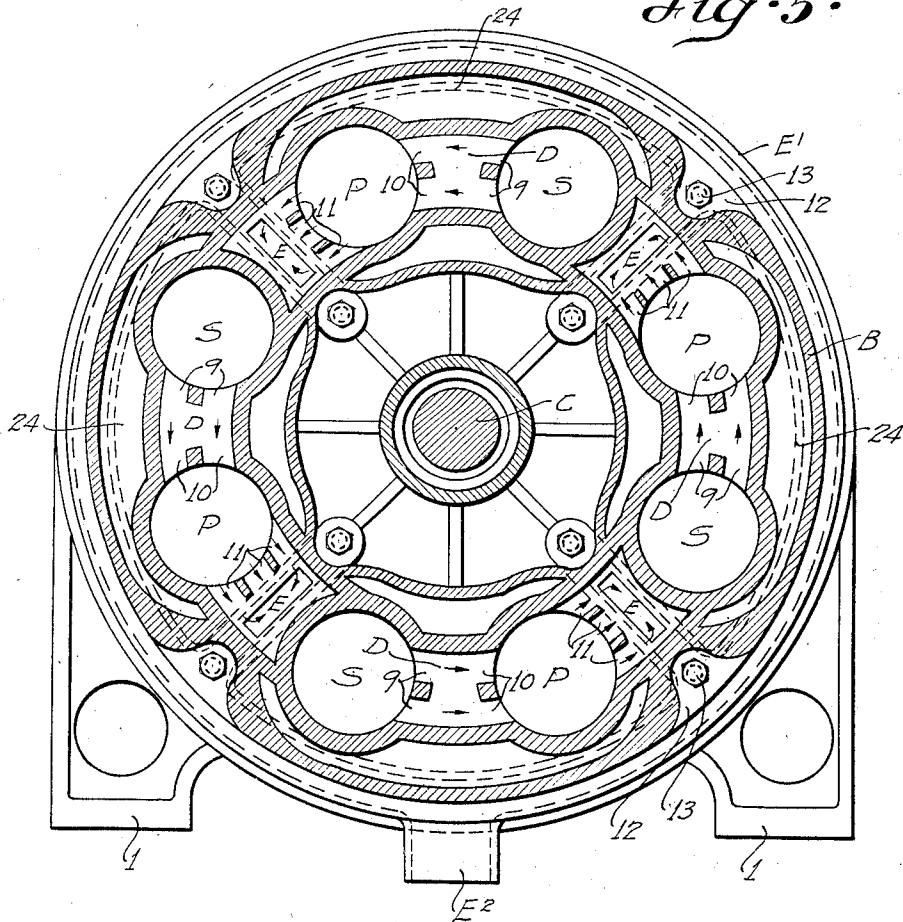
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Fig. 5.



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UNITED STATES PATENT OFFICE

JOHN KELLEY, OF ST. LOUIS, MISSOURI.

TWO-CYCLE INTERNAL-COMBUSTION ENGINE.

Application filed January 10, 1921. Serial No. 436,131.

To all whom it may concern:

Be it known that I, JOHN KELLEY, a citizen of the United States, residing at St. Louis, Missouri, have invented a certain new and useful Improvement in Two-Cycle 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, and has for its main object to provide an efficient engine of simple construction, in which the cylinders are arranged in parallel relation to the axis of rotation of the driving element of the engine and are equipped with reciprocating pistons that co-operate with a means which converts the reciprocating movement of the pistons into rotary motion without the use of crank arms.

Another object is to provide an internal combustion engine of the general type referred to in which the combustible mixture, instead of being admitted directly to the power cylinders, is first drawn into suction cylinders through ports controlled by automatic valves, and thereafter admitted to power cylinders through ports controlled by the pistons in said suction cylinders. Other objects and desirable features of my invention will be hereinafter pointed out.

Figure 1 of the drawings is a vertical longitudinal sectional view of my improved engine, taken on the line 1—1 of Figure 3, looking in the direction indicated by the arrows.

Figure 2 is a detail view of the inlet valve of one of the suction cylinders, taken on the line 2—2 of Figure 1, looking in the direction indicated by the arrows.

Figure 2^a is a cross-sectional view, illustrating one of the connecting rods and the guideway in which it slides.

Figure 3 is an end elevational view of the engine, partly broken away so as to more clearly illustrate the construction of same.

Figure 4 is a development of the cam on the driving member that co-operates with the rollers on the connecting rods; and

Figure 5 is a transverse sectional view, taken on the line 5—5 of Figure 1, looking in the direction indicated by the arrows.

I have herein illustrated my invention embodied in a two-cycle engine having station-

ary cylinders arranged around a rotatable drive shaft that extends parallel to the longitudinal axes of the cylinders, which drive shaft is provided with a member on which the pistons in some of the cylinders exert pressure in a direction causing said drive shaft to rotate. I wish it to be understood, however, that my invention is not limited to a two-cycle internal combustion engine, as many features of my invention are applicable to other kinds of machines equipped with reciprocating pistons and a rotatable driving element operated by the movement of said pistons, it being immaterial what the driving element of the engine consists of, so long as it is a rotating member to which pressure is applied from reciprocating pistons actuated by an expansible medium.

When my invention is embodied in a two-cycle internal combustion engine, as herein shown, the engine is equipped with two groups of cylinders arranged on opposite sides of a rotating driving element and each group made up of a plurality of units or pairs of cylinders, each of which consists of a power cylinder and a suction cylinder. The power cylinders of one group are arranged in longitudinal alignment with and directly opposite to the power cylinders of the other group, and the pistons of longitudinally aligned cylinders are connected together so that they will move in unison. The suction cylinders of the respective groups are arranged in a similar manner, preferably between the power cylinders, and the pistons of the longitudinally aligned suction cylinders are also directly connected together so that they will move in unison, the cylinders of both groups being arranged in symmetrical relation around a rotatable drive shaft that extends parallel to the longitudinal axes of the cylinders.

The suction cylinders are used to draw a combustible mixture from a carburetor or other suitable source of supply and admit said combustible mixture to the power cylinders wherein the mixture is compressed and then fired so as to impart power impulses to the driving element, and the flow of the combustible mixture into the power cylinders and the escape of the burnt gases from said cylinders is controlled by the pistons in said power cylinders.

Referring to the drawings which illustrate the preferred form of my invention, A designates the main supporting frame of the engine which consists preferably of a substantially ring-shaped member provided with feet or base supports 1, and B designates two cylinder blocks arranged at opposite sides of the member A and connected to same by fastening devices 2 that extend horizontally through co-operating flanges 3 and 3^a on the supporting member A and on the cylinder blocks B, respectively, as shown in Figure 1. Each of the cylinder blocks B consists of a casting of annular form in general outline provided with a plurality of horizontally-disposed, parallel bores that form cylinders and also provided with a bearing 4 for a horizontally-disposed drive shaft C, the shaft bearing 4 of each cylinder block being carried by a vertically-disposed web 5 provided with radially-disposed ribs or gussets 5^a so as to reinforce and strengthen the shaft bearing. Each of the cylinder blocks has a plurality of power cylinders P and a plurality of suction cylinders S arranged preferably between the power cylinders in parallel relation to same, as shown in Figure 5, the engine herein illustrated being equipped with eight power cylinders and eight suction cylinders arranged in two groups, each of which groups is made up of four power cylinders and four suction cylinders. The power cylinders and the suction cylinders of the respective groups are arranged in longitudinal alignment with each other and are provided with power pistons P' and suction pistons S', respectively, the aligned power pistons being rigidly connected together by connecting rods P² and the aligned suction pistons being rigidly connected together by connecting rods S², as shown in Figure 1. Said connecting rods are preferably T-shaped in cross section, as shown in Figure 2^a, and each connecting rod slides in a T-shaped guideway formed in a guide member 6, which is connected in any preferred manner to the inner side of the main supporting frame A of the engine. The guide members or blocks 6 are rigidly mounted, and as they take up the working thrusts of the pistons and guide the pistons on a line parallel to the longitudinal axes of the cylinders, they allow the pistons to move freely in their respective cylinders without undue friction or side thrust on the walls of the cylinders, thus reducing wear on the pistons and cylinders to a minimum. The connecting rods can be of any preferred cross sectional shape, and the guide members 6 can be mounted in any preferred manner, so long as they form rigid guideways which hold the connecting rods in parallel relation with each other and parallel to the longitudinal axes of the cylinders.

Movement is transmitted from the power pistons P' to the drive shaft C by devices on the connecting rods P² that co-operate with a member C' rigidly connected to the drive shaft and arranged between the cylinder blocks B. Various means may be used for this purpose, but I prefer to provide the driving member C' with a cam in the form of a spiral rib C² that is arranged between rollers 7 on the connecting rods P², thereby causing the power pistons to exert pressure on the driving member C' in such a direction that the drive shaft C will rotate in the direction indicated by the large arrow *a* in Figure 3. The connecting rods S² that join the longitudinally-aligned suction pistons S' together are also provided with rollers 8 arranged on opposite sides of the spiral rib C², so as to transmit movement from the driving member C' to the suction pistons when the engine is in operation. The spiral rib C² is so constructed that the rollers 7 and 8 which act on one side face of said rib will rotate constantly in one direction, and the rollers 7 and 8 which act on the other side face of said rib will rotate constantly in the opposite direction, thereby eliminating excessive wear on said rollers and rib as would occur if the rollers slid over the rib without turning or if the direction of rotation of each roller were reversed intermittently when the engine is in operation. I accomplish this by making the rib C² of such form that each pair of rollers will remain in saug engagement with the rib at all times, the rib C² being of serpentine shape in general outline, as shown in Figure 4, and having each of its side faces made up of a plurality of oppositely-inclined, straight planes *y* that merge into each other and which are disposed at such angles that each of the rollers which act on same will pass from one inclined plane *y* to the adjacent plane *y* without reversing. Moreover, the oppositely-inclined, straight planes *y* and the intervening ridges and valleys that make up the rib C² are so formed that each of the power pistons will have practically a uniform speed throughout its entire working stroke instead of a variable speed, as in an internal combustion engine of the type in which the piston connecting rod is joined to a crank arm on a rotating drive shaft. This is a very desirable feature of my engine, as it insures each power piston exerting the same turning effort on the driving member (proportional to the pressure of the gases in the cylinder) at all points of its working stroke, thus converting a greater degree of the extremely high temperature that exists at the explosive moment, into actual work instead of driving off an excessive amount of the heat into the water of the cooling system surrounding the cylinders. Accordingly, my engine is economical in the consumption of fuel; the

pistons have a relatively high operating speed and the driving member has a relatively slow operating speed.

The power cylinders and the suction cylinders of the respective groups are arranged in pairs so as to form separate units, each of which is composed of a suction cylinder and a power cylinder, the suction cylinder of each unit being utilized to draw a combustible charge from a source of supply and admit said charge to the power cylinder of the unit, and the piston in said power cylinder being utilized to compress the charge and thereafter impart a power impulse to the driving member when said compressed charge is fired. Accordingly, the engine herein illustrated may be said to comprise eight units arranged in two groups of four units each, one of said groups being located at one side of the driving element C' of the engine and the other group being located at the other side of said driving element. The rib C² on the driving element C' may have any desired number of high points, the driving member of the engine herein shown being so constructed that each piston will make five cycles during each complete cycle of operations of the drive shaft. I also prefer to arrange the cylinders so that cylinders of the respective groups which lie diametrically opposite each other across the drive shaft will fire simultaneously and the cylinders of each group will fire one after the other. In other words, the power cylinders of the respective groups which are disposed at an angle of 180° to each other will fire at the same time and the power cylinders of each group will fire in regular order or in succession. By designing the engine so that the cylinders fire in the manner above described vibration is reduced to a minimum and the side thrust which a power piston of one group exerts on one side of the driving member C' is balanced by the side thrust which the opposed power piston of the other group exerts on the opposite side of said driving member, the power from both pistons being applied in a direction to cause said driving member to rotate.

As all of the units are of the same construction, I will only refer to one unit in the specific description of the units. The suction cylinder and the power cylinder of the unit are connected together by an inlet passageway D provided at its opposite ends with ports 9 and 10 that terminate in the side walls of the suction cylinder and the power cylinder, respectively, adjacent the inner ends of said cylinders. Each unit also comprises a discharge passageway E, shown in Figure 5, which is connected by means of ports 11 with the inner end portion of the power cylinder P of the unit, the discharge passageways E in each cylinder block leading into an exhaust manifold E', shown in

Figure 1, that is of cylindrical shape in general outline and which may be connected either to a separate discharge pipe or to a discharge pipe E² common to both exhaust manifolds, as shown in Figure 1. In the engine herein illustrated each of the exhaust manifolds E' is of ring form in general outline, as shown in Figure 3, and is provided with lugs 12 through which bolts or other suitable fastening devices 13 pass so as to secure said manifold to the particular cylinder block which it surrounds. Each cylinder block or group of units is provided with an intake manifold F preferably constructed so that it will form the heads of the suction cylinders of the particular cylinder block with which it co-operates, each of said intake manifolds comprising an annular portion 14, as shown in Figure 3, provided with a plurality of radially-branching portions 15 that form closures or heads for the ends of the suction cylinders of one group of units. Said intake manifold F is also provided with an inlet portion 16 leading from a carbureter (not shown) or any other suitable supply of combustible gases and divided into a plurality of vertically-disposed ducts or passageways *t*, *u*, *v* and *w* (see Figure 3) that communicate with separate and distinct passageways in the annular portion 14 of the manifold which lead to separate and distinct suction cylinders. In other words, the intake manifold of each cylinder block is so constructed that separate and distinct vertical gas inlet passages are provided for the different suction cylinders in the block and the exhaust manifold of each cylinder block is of ring form or of such shape that the escaping burnt gases can flow in either of two directions after entering the exhaust manifold. I make no claim herein to the divided intake manifold and to the circular exhaust manifold, as these features of my invention are claimed in my co-pending application Serial No. 570,707, filed June 24, 1922.

The suction cylinder of each unit is provided with an automatic inlet valve 17 arranged preferably in the head of the cylinder, as shown in Figure 1, and the piston S' in said suction cylinder is in the form of a hollow member provided in its head or outer end with inlet ports 18 controlled by an automatic valve 19 and provided adjacent its inner end in the side wall portion of same with ports 20 which line up with the ports 9 in the side wall of the suction cylinder in which it reciprocates at a certain point in the cycle of operations of said piston. Various types of automatic valves 17 may be used for governing the admission of the combustible mixture to the suction cylinders, but I prefer to provide each suction cylinder with a valve consisting of a disk-shaped piece of thin metal arranged over inlet ports 17^a in the head of the suction cylinder with which it co-

operates and held against its seat by springs 17^b, as shown in Figure 2, said valve 17 being arranged on the inner side of the head of the cylinder and retained in position by a bolt or other suitable fastening device 21 that passes through the head of the cylinder and through the valve, as shown in Figure 1. The valve 19 in the piston is arranged on the inside of the piston, as shown in Figure 1, and is pressed outwardly against the inner side of the head or top portion of the piston by a spring 19^a. When the suction piston S' moves inwardly or towards the right, looking at Figure 1, the suction that is created in the cylinder S in which said piston moves causes the inlet valve 17 to open automatically and admit a charge to said cylinder from the gas passageway in the intake manifold F that leads to said particular suction cylinder. Thereafter, when said piston moves in the opposite direction, namely, to the left, looking at Figure 1, the inlet valve 17 in the head of the cylinder closes and the inlet valve 19 in the piston S' opens and permits the charge to flow into the interior of said piston. At this time, namely, when the piston S' is moving outwardly on what may be termed its charging stroke, the ports 20 at the inner end of said piston are closed, due to the fact that they are traveling over an imperforate portion of the side wall of the cylinder, but at a certain point in the charging stroke of said piston the ports 20 therein move into alignment with the ports 9 in the inner end portion of the side wall of the suction cylinder, thereby permitting the charge to escape from the interior of the piston through the ports 20 and 9 into the inlet passageway D, and thence into the power cylinder P of the unit through the ports 10 in the inner end portion of said power cylinder. During the outward stroke of the piston in said power cylinder the charge in said cylinder will be compressed and at the completion of the outward or compression stroke of the piston the compressed charge is fired or ignited by a spark plug or other suitable ignition device 22 in the head of the power cylinder, thereby imparting a power impulse to the piston P'. When the power piston P' reaches such a point during its power stroke that it uncovers the ports 11 in the inner end portion of the power cylinder, the burnt gases in said cylinder escape through the ports 11 into the discharge passageway E and thence into the discharge manifold E'. The power piston P' of each unit is preferably provided with a deflector 23 arranged so as to deflect the combustible charge towards the end of the power cylinder when said charge is admitted to said cylinder.

Water jackets 24 are provided for the cylinders of the engine and the pipes 24^a through which the cooled water is supplied

to said water jackets are tapped into the jackets at the upper side of the engine, the return pipes 24^b through which the hot water escapes leading from the jackets at the lower side of the engine, as shown in Figure 1. This method of cooling the cylinders secures an even temperature in all of the cylinders arranged around the drive shaft and causes a rapid circulation through the jackets on account of the tendency of the hot water to rise into the path of the incoming cool water, which incoming cool water carries the hot water downwardly through the jackets.

While the particular details of construction of the engine are immaterial, so far as my broad idea is concerned, I prefer to construct the engine in the manner herein illustrated, on account of its simplicity, low cost of manufacture and the ease with which the various parts can be assembled or disassembled. Thus, in my improved engine the main supporting element of the engine may consist of a ring-shaped member A, to the opposite sides of which the cylinder blocks are bolted. The cylinder blocks are of such design that they can be cast easily and machined with minimum trouble and expense, and while it is immaterial whether the heads of the cylinders in said blocks are integral or removable, I prefer to make the heads of all of the cylinders removable, the heads of the suction cylinders being formed by portions 15 on the intake manifold F that are secured to the cylinder blocks by fastening devices 15^a and the heads of the power cylinders being formed by plugs 22^a that are screwed into said cylinders, as shown in Figure 1, providing ready access to cylinders for the examination and removal of carbon, etc. The exhaust manifolds E' are compact and surround the cylinder blocks in such a way as to utilize the exhaust gases for heating the intake manifold through which the incoming gases pass to the suction cylinders. The suction cylinders through which the gases pass to the power cylinders are surrounded by the cooling water common to the power cylinders and suction cylinders alike and contained in each of the water jackets surrounding all of the cylinders grouped on each of the cylinder blocks. When the engine is in operation the temperature of the cooling water will be maintained as nearly as possible at 180° F. This, in connection with the preheating of the incoming gases by utilizing the waste heat from the exhaust manifold, insures thorough vaporization of the fuel before reaching the power cylinders. Moreover, the exhaust manifolds are of such design that they allow the burnt gases to escape from the cylinders in either direction of least resistance around the cylinder blocks, passage being provided either way to a common opening, thus permitting the burnt

gases to escape without creating back pressure in the power cylinders.

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

1. An internal combustion engine, comprising a rotatable driving member, two groups of opposed cylinders arranged around said driving member in parallel relation to same made up of a plurality of units, each of which comprises a power cylinder and a suction cylinder, reciprocating pistons in said cylinders, devices that connect together the longitudinally aligned pistons of opposed cylinders, a cam on said driving member operatively connected with said devices for reciprocating same, an automatic valve associated with the suction cylinder of each unit for admitting a combustible mixture to same when the piston therein moves in one direction, and means for causing the charge admitted to said suction cylinder to pass through the piston therein and enter the co-operating power cylinder of the unit when said suction piston moves in the opposite direction.

2. An internal combustion engine, comprising a rotatable driving member, two groups of cylinders arranged in longitudinal alignment with each other and in parallel relation to the axis of rotation of said driving member, each of said groups being made up of a plurality of units composed of a suction cylinder and a power cylinder equipped with pistons, connecting rods joined to the pistons of longitudinally aligned cylinders, means for transmitting movement from said connecting rods to said driving member, and means whereby when the engine is in operation combustible charges will be drawn into the suction cylinders of opposed units of said groups and then introduced into the power cylinders of said units and fired.

3. A two cycle internal combustion engine, comprising a plurality of power cylinders, a plurality of suction cylinders arranged intermediate said power cylinders, reciprocating pistons in said cylinders, automatic valves for admitting charges to said suction cylinders when the pistons therein move in one direction, means for permitting the

charges in said suction cylinders to pass through the pistons therein and enter the power cylinders when said suction pistons move in the opposite direction, and admission and exhaust ports in the power cylinders controlled by the pistons in said power cylinders.

4. A two cycle internal combustion engine, comprising power cylinders, suction cylinders arranged intermediate said power cylinders, automatic valves for admitting a combustible mixture to said suction cylinders, each of said suction cylinders being connected with one of said power cylinders by ports through which the charge can pass from the suction cylinder into the power cylinder, pistons in said suction cylinders for drawing the combustible mixture into said suction cylinders and thereafter controlling the escape of said mixture into the power cylinders, and pistons in said power cylinders for cutting off the admission of said mixture to said cylinders and the escape of the burnt gases from said power cylinders.

5. A two cycle internal combustion engine, comprising a rotatable drive shaft, a group of cylinders arranged in the form of an annular ring around said drive shaft and comprising power cylinders and suction cylinders arranged in alternate relation, pistons in said suction cylinders for drawing charges into same and thereafter admitting said charges to the power cylinders, pistons in said power cylinders for governing the admission of the combustible mixture to said power cylinders and the escape of the burnt gases from same, and an exhaust manifold arranged in such a manner that the gases escaping through same heat said suction cylinders.

6. A two cycle internal combustion engine provided with a cylinder block of annular form equipped with a plurality of suction cylinders and a plurality of power cylinders, an intake manifold having portions that form heads for the suction cylinders, and an exhaust manifold of annular shape surrounding said cylinder block and communicating with exhaust ports leading from said power cylinders.

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