P. G. TACCHI.

INTERNAL COMBUSTION ENGINE.

APPLICATION FILED JULY 12, 1916.

1,264,580.

Patented Apr. 30, 1918.

4 SHEETS—SHEET 1.

Fig. 2.

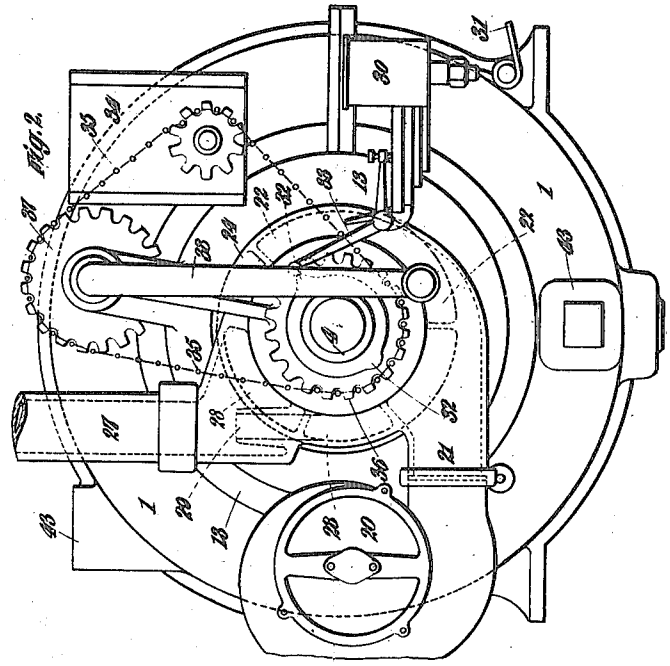
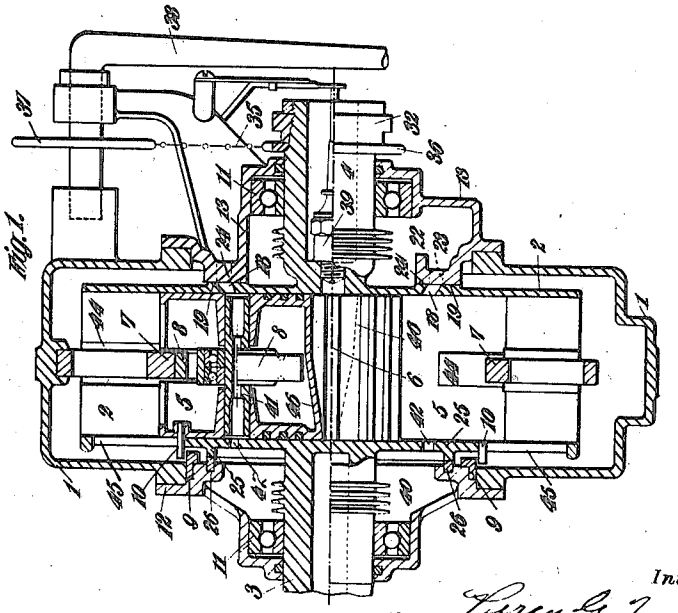


Fig. 1.



Inventor.

Percy G. Tacchi

By Dennis Goldstrough & Neill

Attys

P. G. TACCHI.

INTERNAL COMBUSTION ENGINE.

APPLICATION FILED JULY 12, 1916.

1,264,580.

Patented Apr. 30, 1918.

4 SHEETS—SHEET 2.

Fig. 4.

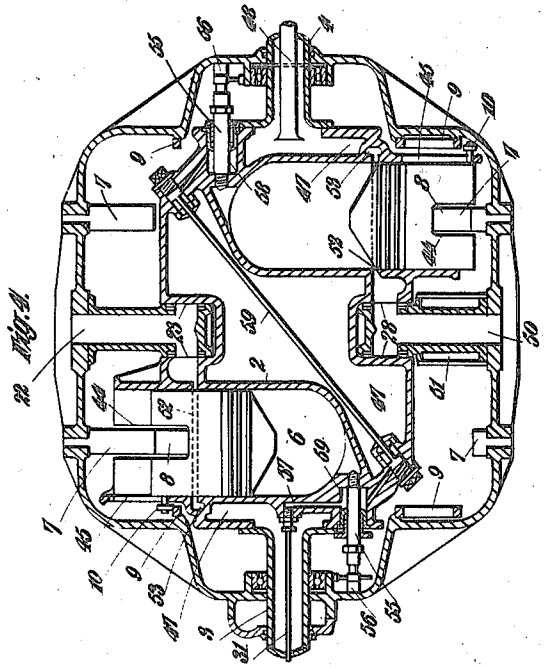
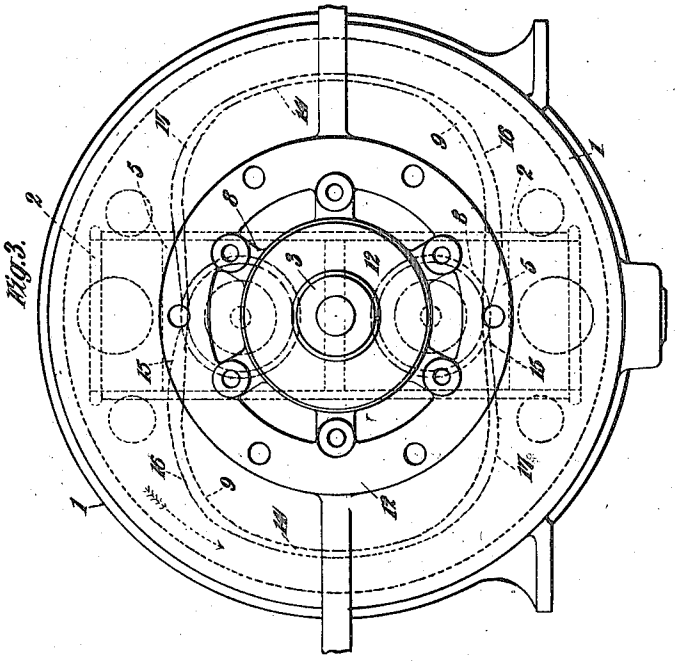


Fig. 3.



Inventor.

Percy G. Tacchi

By Kenrick Goldsborough & Neill

Attys.

P. G. TACCHI.

INTERNAL COMBUSTION ENGINE.

APPLICATION FILED JULY 12, 1916.

1,264,580.

Patented Apr. 30, 1918.

4 SHEETS—SHEET 3.

Fig. 5.

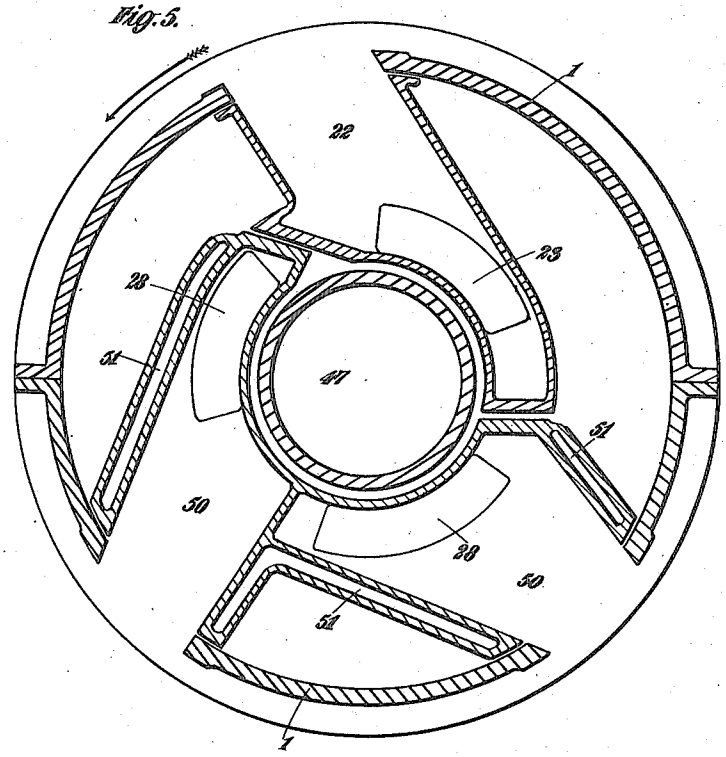
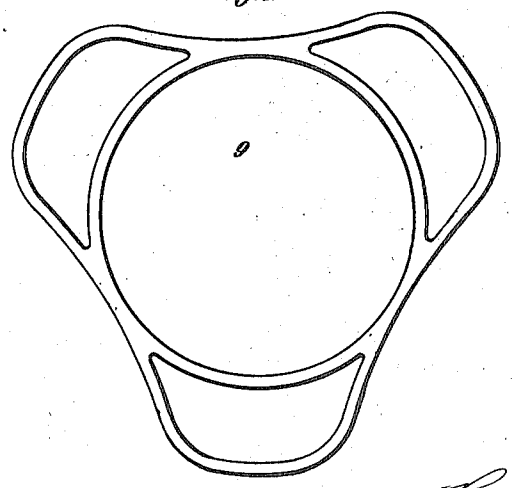


Fig. 7.



Inventor.

Percy G. Tacchi

by Pennie Goldsborough & Hull

Attys

P. G. TACCHI.

INTERNAL COMBUSTION ENGINE.

APPLICATION FILED JULY 12, 1916.

1,264,580.

Patented Apr. 30, 1918.

4 SHEETS—SHEET 4.

Fig. 6.

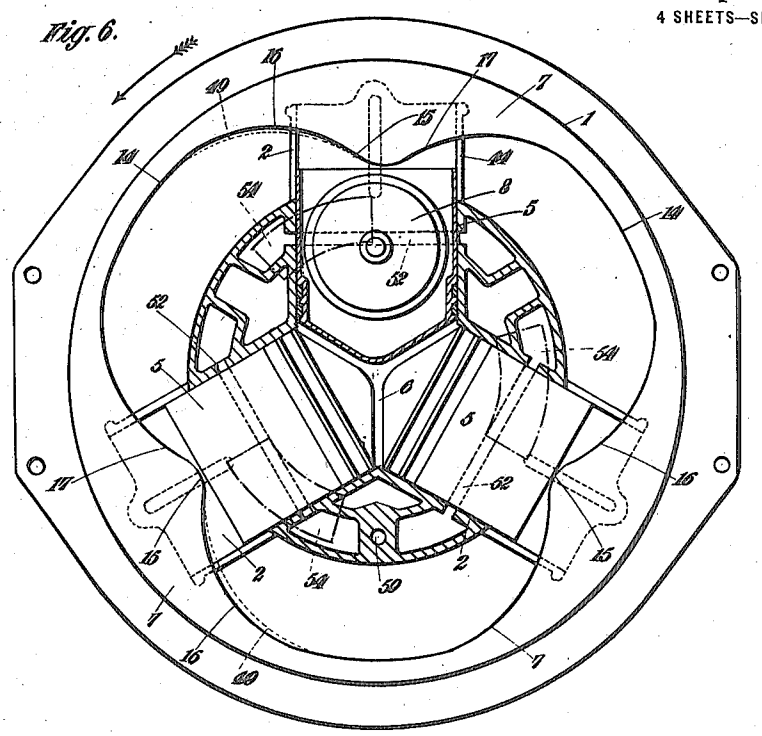
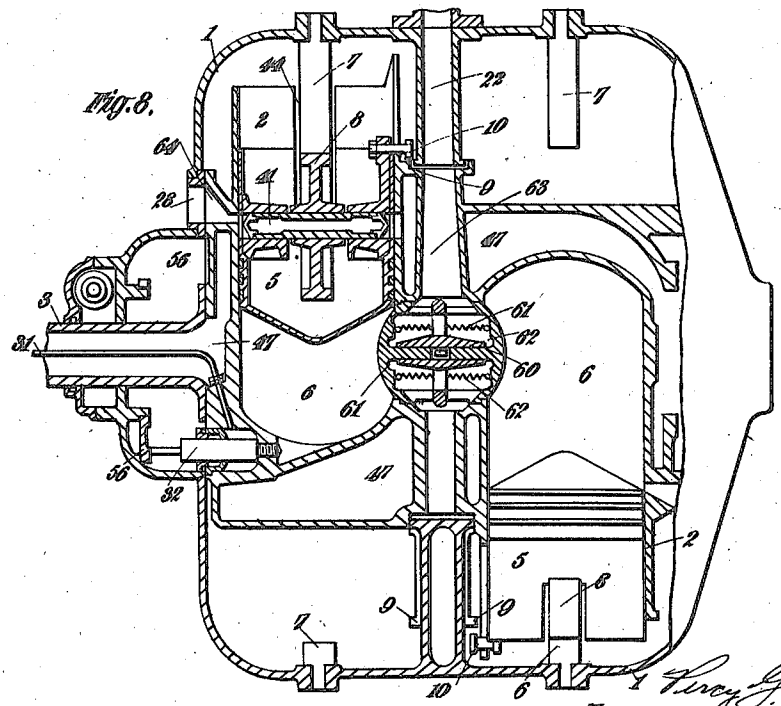


Fig. 8.



Inventor.

Luigi G. Tacchi

by

Kenyon Goldsborough & Neil

Attys

UNITED STATES PATENT OFFICE.

PERCY GEORGE TACCHI, OF NEW WANSTEAD, ENGLAND, ASSIGNOR TO THE CENTRUM SYNDICATE LIMITED, OF LONDON, ENGLAND.

INTERNAL-COMBUSTION ENGINE.

1,264,580. Specification of Letters Patent. Patented Apr. 30, 1918.

Application filed July 12, 1916. Serial No. 108,858.

To all whom it may concern:

Be it known that I, PERCY GEORGE TACCHI, a subject of the King of Great Britain, residing at Bay Tree House, New Wanstead, in the county of Essex, England, have invented certain new and useful Improvements in Internal-Combustion Engines, of which the following is a specification.

This invention relates to two stroke internal combustion engines of the type in which radial or tangential rotating cylinders carry pistons operating through rollers or like bearing members against an external cam ring or track which controls the piston movements and causes rotation of the cylinders and the shaft on which they are mounted

According to this invention two, three or more outwardly driven and similarly acting pistons are provided in corresponding open ended rotating cylinders with a common combustion chamber between the said pistons, which act simultaneously against the fixed external cam track that causes rotation of the pistons and cylinders and controls the port opening in the cylinders through the movement of the pistons. In the case of a multi-cylinder engine two or more engine elements or units of the above type may be fixed side by side upon the same shaft and staggered or angularly displaced so as to cross each other in end elevation.

The inlet may be placed centrally and the exhaust at the outer ends of the combustion chamber, the exhaust ports being uncovered by the pistons at the end of their stroke. Or the ports may all be lateral and at the outer ends of the central combustion chamber, registering with suitably formed concentric passages in an annular projection or partition of the casing over which slides a ring belonging to the cylinder casting.

In order that the said invention may be clearly understood and readily carried into effect, I will describe the same more fully with reference to the accompanying drawings, in which:—

Figure 1 is a longitudinal section, or section through the axis, of a double piston construction of engine embodying my invention.

Figs. 2 and 3 are elevations of opposite ends of the said engine.

Fig. 4 is a longitudinal section of a six cylinder engine comprising two units of three cylinders each.

Figs. 5 and 6 are cross sections respectively through the central distribution ring and the center of the cylinders of one unit of the said six cylinder engine.

Fig. 7 is an elevation of a cam ring employed to move the pistons outwardly on turning the engine by hand, and

Fig. 8 is a longitudinal section of a modification of the six cylinder engine.

1 is the fixed engine casing. 2, 2 are the rotating and radiating cylinders. 3, 4 are respectively the left and right hand members of the engine shaft on which the cylinders are mounted. 5, 5, are the piston. 6 is the common combustion chamber, shown as centrally placed between the radiating cylinders. 7 is the cam ring or track over which run rollers 8 mounted in the pistons 5. 9 is an auxiliary cam ring or track to prevent the pistons dropping toward the center when the engine is not running, a small side roller or pin 10 on each piston riding on the cam ring 9 when the piston is unsupported by pressure.

Referring to the construction illustrated in Figs. 1, 2 and 3, the two cylinders 2 are parts of a single open-ended tube, the central part of which forms the common combustion chamber 6. The tube is made in one with or rigidly fixed upon the two shaft members 3, 4, which are mounted in the ball bearings 11 in the end plates or covers 12 and 13 of the casing 1. The two pistons 5 move radially in opposite directions and the rollers 8, which are of substantial diameter, run over the cam ring or track 7, which is arranged to give two working strokes per revolution. The track surface, as shown in Fig. 3, comprises two opposite concentric elements 14 each extending for about one sixth of the complete circle with a contracted portion or neck 15 between the two concentric elements at each side. The curves connecting the concentric parts to the neck

are not quite symmetrical but are arranged to give a lead to the exhaust port, the inlet opening and closing a little later. The portions of the track marked 16 and 17 in Fig. 3 control respectively the outward or working stroke and the inward or compresion stroke of the pistons. The cylinder ports 18, shown at the right hand side of the cylinders in Fig. 1 and passing through a ring 19 on the cylinder casting, serve alternately for inlet and exhaust according to the position of the rotating cylinders, the ports being covered and uncovered by the pistons. In the special construction shown scavenging and charging air is supplied from the fan or blower 20 (Fig. 2) through the air inlet passage 21 and air chamber 22 in the cover 13 of the casing, an air inlet port 23 passing through the ring 24 of the cover, over which ring the ring 19 on the cylinder casting slides. At the opposite side a ring 25 on the cylinder casting slides over a spring ring 26 in a channel in the casing cover 12, so that in the case of an air cooled engine the outer part of the casing is divided from the air inlet and outlet chambers formed by the covers 12 and 13.

27 is the exhaust pipe (Fig. 2) into which the exhaust passes through the port 28 placed opposite to the inlet port 23. The first part of the exhaust may pass through a small ejector tube 29 so as to cause suction during the later stages of the exhaust.

At the proper point of the stroke liquid fuel is supplied from the chamber 30 to which the fuel pipe 31 is connected, a cam 32 on the shaft member 4 controlling the fuel injection into the port through the lever arm 33. A magneto 34 is driven through the chain 35 by the chain wheel 36 on the shaft member 4, the chain passing also over a wheel 37 on the shaft of the starting handle 38. 39 is the sparking plug screwed centrally in the shaft member C'.

The engine illustrated is an air cooled one, the air from the fan or blower 20 passing into the air chamber 22 at one side of the combustion chamber 6 and escaping through the air outlet chamber 40 formed by the cover 12 at the other side of the said combustion chamber. The cooling air passes intermittently through the gudgeon pin 41 of each piston, this pin as shown in Fig. 1 being made hollow and adapted to register at the inner part of the piston stroke both with one of the ports 18 and with one of the outlet ports 42 at the other side of the cylinder. The gudgeon pin is therefore cooled by the same air supply as the combustion chamber. The outer part of the casing may also be air cooled by means of an air inlet and outlet 43, Fig. 2, open to the atmosphere and so arranged that the action due to the rotating cylinders and pistons causes a continuous circulation of air through the external part of the casing. Two separate cooling systems are, therefore, provided.

The cylinders are formed with deep notches or slots 44 to receive the track 7 and slots 45 are also provided at one side to allow the pins 10 to pass through to the small auxiliary track 9 placed at the side of the casing. The contour of this track is shown in Fig. 3 and is arranged in accordance with that of the main track 7 so that when the engine is standing the upper piston is not free to drop toward the center as would be the case if no support were provided. The auxiliary cam track, however, takes no part in the actual working of the engine but merely keeps the pistons in position.

The general operation of the double piston engine above described is as follows:—

When the pistons are in the position shown in Fig. 1 the air charge is under full compression in the central combustion chamber 6 and on igniting the fuel charge already injected the pistons are driven outwardly so that the rollers 8 bear against the curves 16 of the track 7, causing a torque to be exerted on the pistons and cylinders during the outward stroke. When the pistons approach the end of the working stroke the rollers 8 enter on the concentric parts 14 of the track, the ports 18 having just been uncovered by the pistons. The port 18 which is open to the exhaust port 28 in the ring 24 of the cover 13 is uncovered slightly before the opposite port 18 owing to the shape of the cam track, so that exhaust occurs just before the air inlet is opened. The piston ends 46 are made with a sloping channel as shown in Fig. 1 so that the entering air from the inlet chamber 22 is directed toward the outlet, the form of the piston ends facilitating the sweeping action of the scavenging air and reducing the eddying motion. The exhaust, scavenging and finally injection take place throughout the period covering the concentric portion 14 of the track 7, but when the piston rollers enter upon the curves 17 the port 18 serving for exhaust is first closed, the second port 18 serving for inlet being closed shortly after, when compression begins, the pistons being driven together by the contracting part of the track until they again reach the position shown in Fig. 1, when the next cycle of operations begins.

In the construction of engine shown in Figs. 4 to 7, the cycle of operations is substantially similar to that described for the double piston engine, but each engine unit, of which two are shown mounted on the shaft elements 3, 4 consists of three radiating cylinders 2 with the central common combustion chamber 6 open to all the cylinders, as shown more especially in Fig. 6 of the draw-

ings. The six cylinder engine is shown as a water cooled engine, a water jacket 47 surrounding the inner ends of the cylinders and occupying the space between, as shown especially in Figs. 4 and 5. The cooling water is supplied through the pipe 48 entering the hollow shaft member 4, while the hollow left hand shaft member 3 allows the cooling water to escape after it has passed through the jacket from side to side. The outer part of the casing, as in the two cylinder engine, may be air cooled.

The cam track 7 is similar in type to that described for the double piston engine, but it has three practically concentric parts 14 and is separated by three contracted parts 15 to correspond to the three pistons which it controls. The curves 16 controlling the outward piston strokes are arranged as in the first case to give the desired lead to the exhaust; the dotted lines at 49 show the difference between the curves controlling the exhaust and the curve for the inlet.

The air inlet and exhaust are both placed centrally between the two units, one inlet 22 and two exhausts 50 being shown, as indicated in Fig. 5, the exhausts being surrounded by a cooling air jacket 51 supplied by a by-pass from the air fan. To obtain a large passage for the entering air and the exhaust we provide each cylinder with a port 52 extending completely around it, the cylinder being made with a channeled ring 53 (Fig. 4) to allow of the elongated port, which opens into the enlarged port 54 communicating with the ports 23 and 28 and placed somewhat in advance of the cylinder as shown in Fig. 6.

In the construction illustrated the fuel is sprayed into the combustion chamber 6 by means of pumps 55 carried by the cylinders, the pumps being operated as the cylinders rotate by means of adjustable pump cams 56 fitted in the ends of the casing, rollers on the pump plungers running over the faces of the cams, which are provided with suitable surfaces to time the fuel injection, which may be varied by adjustment of the cams. Each unit may be provided with one fuel pump or, if desired, two fuel pumps may be carried by two of the cylinders, while the third has a sparking plug placed in a corresponding position to the pump in the other cylinder or cylinders.

The fuel supply pipe 31 passes centrally through the shaft member 3 and is connected to the cylinder casting, a fuel passage 57 passing through the cylinder wall to the pump chamber 58. To supply the pump or pumps for the second engine unit a cross pipe 59 passing through the central water jacket connects the two opposite pump chambers 58 so that both are kept full of fuel to be drawn upon by the pump at each suction stroke. The pumps are of the usual plunger type and the suction stroke may be effected by a spring causing the plunger to draw in the fuel from the chamber 58 through a suction valve, the cam 56 giving the compression stroke to the plunger and driving the fuel through a spraying valve or nozzle at the end of the pump.

The general operation of the six cylinder engine is as follows:—

Each unit is arranged to work alternately with the other so that while one set of pistons is driven outwardly to give the working stroke the other set is moved inwardly by the track 7 to give the compression stroke. The large cylinder port 52 of each cylinder is uncovered by the piston at the outer end of its stroke and during the period of uncovering the communicating port 58 is registering with either the inlet port 23 or exhaust port 28 in the casing 1, the cam track as already described being so formed that the exhaust pistons open the corresponding ports 52 slightly before the piston controlling the inlet uncovers its port 52. When both exhaust and inlet ports are open scavenging air passes through the inlet port 23 in the one cylinder and sweeps through the cylinders and central combustion chamber, escaping through the two exhaust ports 28, and the exhaust channels 50. In the meantime the second unit has compressed its air charge until near the end of the compression stroke the fuel is injected and the mixture ignited. After the end of the outward stroke in the first unit and the completion of the exhaust and scavenging, the return of the pistons closes the ports 52 and compression begins, while the second unit completes its working stroke, the cycle being completed by the injection of fuel, ignition and expansion in the first unit. Owing to the fact that a cycle is completed for each unit three times in every revolution six explosions are obtained per revolution and for any increase in the number of units a corresponding increase in the number of explosions per revolution can be obtained.

In the modification shown in Fig. 8, the general arrangement is similar to that already described for the six cylinder engine, but the air enters the combustion chambers of the two units through two central valves 60 connected together by springs 61 which act to close both valves but allow them to be opened alternately by a central oscillating arm 62 actuated by the engine and meeting either valve stem as it moves to one side or the other. The arm, the end only of which is shown, may be mounted and connected in any convenient manner, for instance, it may be mounted on the end of an oscillating rod or spindle terminating in a striker meeting a fixed cam which times the

valve operations. The valve casing forms part of the rotating cylinder casting and the air enters the central space between the valves through the inlet port 63 which registers with the fixed air inlet 22. The exhaust is at the outer sides of the cylinders through the cylinder ports 64 and fixed exhaust ports 28 in the casing. The cooling of the gudgeon pin 41 may be provided for as in Fig. 1, the hollow pin registering toward the end of the piston stroke with the exhaust at one side of the cylinder and with an air port at the opposite side.

The auxiliary tracks 9 can be in this construction placed at the center of the engine instead of at the outer ends as in the six cylinder engine first described. The general operation of the two engines is similar except for the fact that the air inlet is in Fig. 8 under the control of the central valve instead of a port uncovered by the piston and the exhaust can take place through all the cylinders, the scavenging air entering directly into the central combustion chamber and radiating through the rotating cylinders.

What I claim and desire to secure by Letters Patent of the United States is:—

1. In a rotating cylinder engine, a plurality of outwardly driven and similarly acting pistons, corresponding cylinders having a common combustion chamber between the pistons, a fixed external cam track against which the pistons operate, and inlet and exhaust means whereby the engine operates on the two-stroke cycle, the said cam track having an unsymmetrical form such as to cause the pistons to open the exhaust before the inlet is opened.

2. In a rotating cylinder engine, a plurality of outwardly driven and similarly acting pistons, corresponding cylinders having a common combustion chamber between the pistons, a fixed external cam track against which the pistons operate, lateral ports in the cylinders open to the common combustion chamber, inlet and exhaust passages in the engine casing with which the lateral cylinder ports are adapted to communicate, the said ports being uncovered by the pistons, and the cam track having an unsymmetrical form, such as to cause the pistons to open the exhaust passage after the inlet passage is opened.

3. In a rotating cylinder engine, a pair of co-axial interconnected engine units each comprising a plurality of outwardly driven pistons, corresponding cylinders having a main combustion chamber between the pistons, and a fixed external cam track against which the pistons operate, the said units being arranged with their cylinders in staggered relation, and inlet and exhaust ports in the cylinders of each unit, the said ports being covered and uncovered by the pistons and the cam track in each unit having an unsymmetrical form such as to cause the piston to open the exhaust means before the inlet means is opened.

4. In a rotating cylinder internal combustion engine, a fixed external cam track, a plurality of outwardly driven and similarly acting pistons operating against the said track, a plurality of rotating cylinders having a common combustion chamber between the said pistons, an auxiliary fixed guiding cam track and piston members adapted to ride upon the outer face of the said auxiliary cam track.

5. An internal combustion engine comprising two interconnected engine units side by side in the same casing, each unit comprising a plurality of rotating pistons and cylinders with a common combustion chamber and an external cam track for the said pistons, and common inlet and exhaust channels in the casing between the said engine units, adapted to be opened alternately to the two combustion chambers.

6. In a rotating cylinder two stroke internal combustion engine, a fixed external cam track, a plurality of outwardly driven and similarly acting pistons operating against the said track, a plurality of rotating cylinders having a common combustion chamber between the said pistons, means for admitting a charge of air to the said combustion chamber and means for injecting liquid fuel into the air compressed in the said chamber.

PERCY GEORGE TACCHI.