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(56) Documents cited
GB 1333971 A GB 1205584 A GB 0759110 A
GB 0499553 A GB 0334674 A WO 86/01255 A1
US 4035111 A US 3937187 A

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UK CL (Edition K) F1F FD
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(54) **Rotary piston internal combustion engine or compressor**

(57) A curved piston or pistons (1) rotating or oscillating in a toroidal ring type cylinder (2) form the essential components of a rotary piston internal combustion engine or an oil/gas positive displacement compressor. A piston disc (3) on which piston(s) (1) is (are) fixed allows the rotation or oscillation of the piston(s) and provides the power input/output to or from a shaft (4). Many types of engines such as single disc, single acting or double disc double acting oscillating type or fully rotating type engines are described. Lubrication of the or each piston is achieved through an oil tube (5) in the piston disc (3), oil being fed to a piston groove (17). The cylinder is defined by cylinder half bodies (8) between which the disc 3 rotates with the interposition of O-ring seals (11) and a labyrinth arrangement (12).

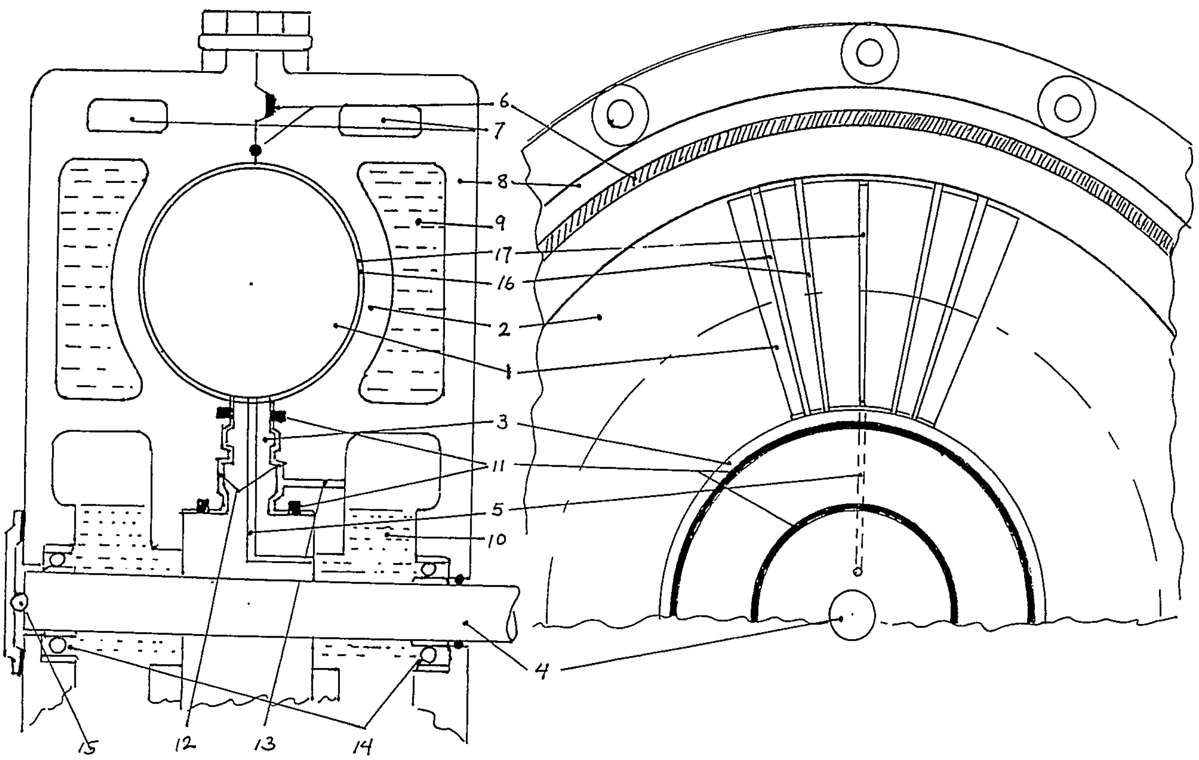

Figure 1

This print takes account of replacement documents submitted after the date of filing to enable the application to comply with the formal requirements of the Patents Rules 1990.

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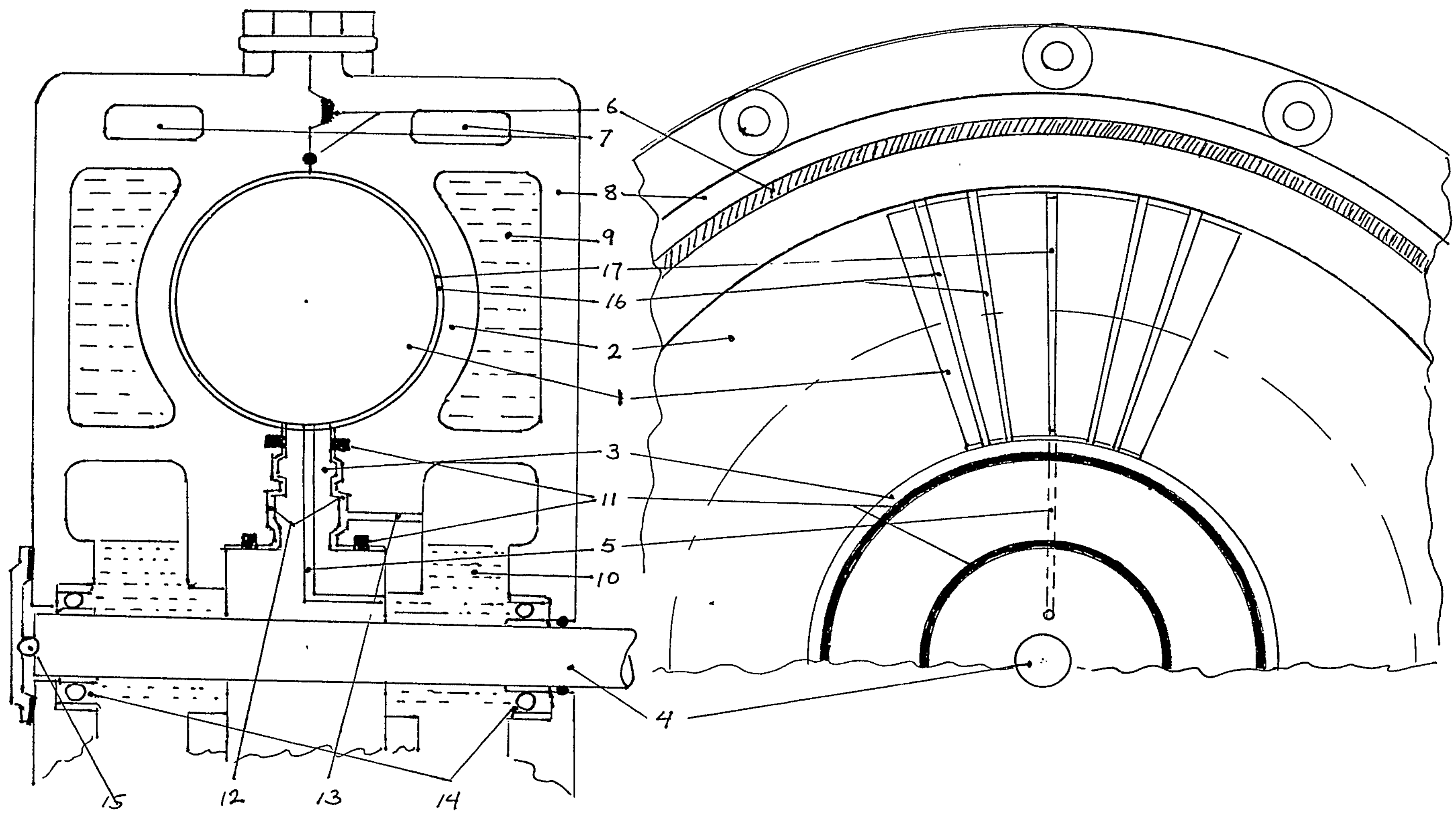

Figure 1

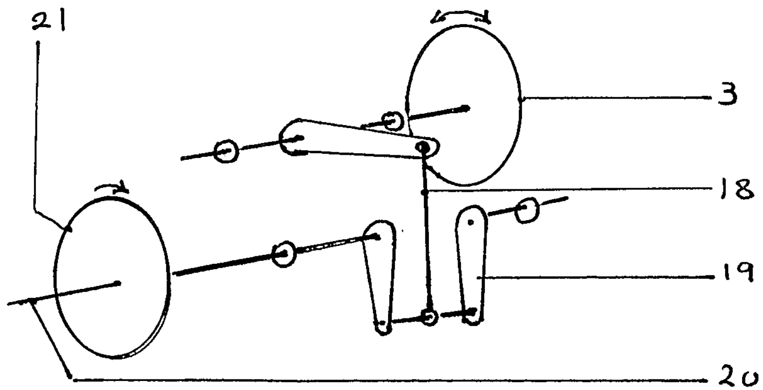

Figure 2

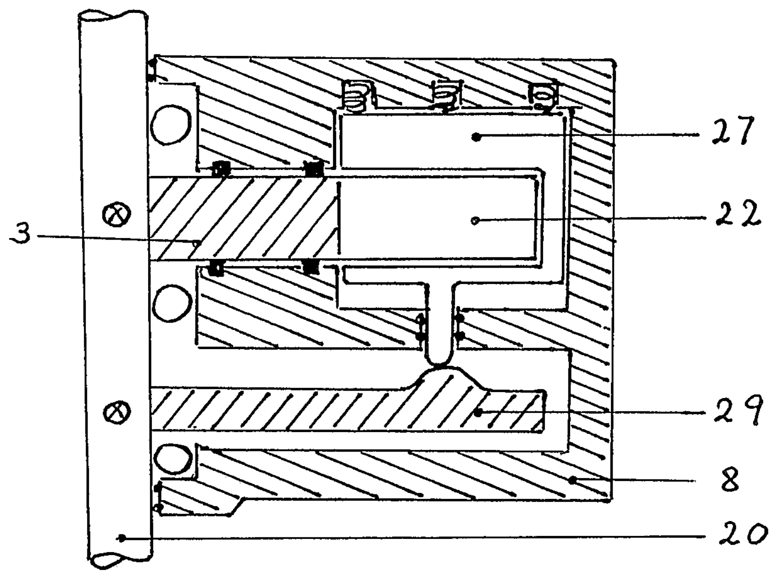

Figure 3

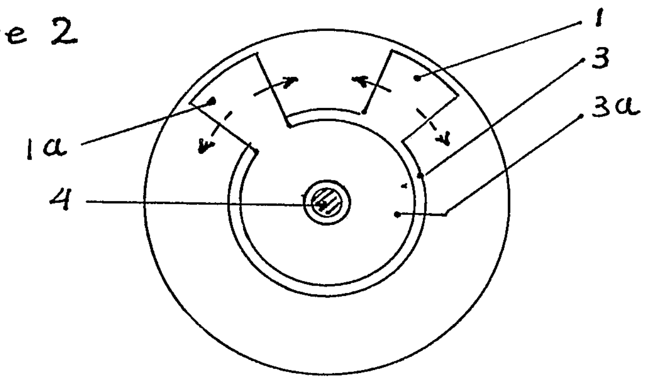

Figure 5

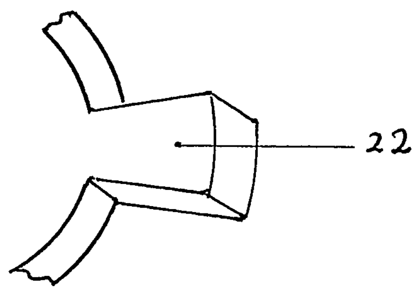

Figure 4

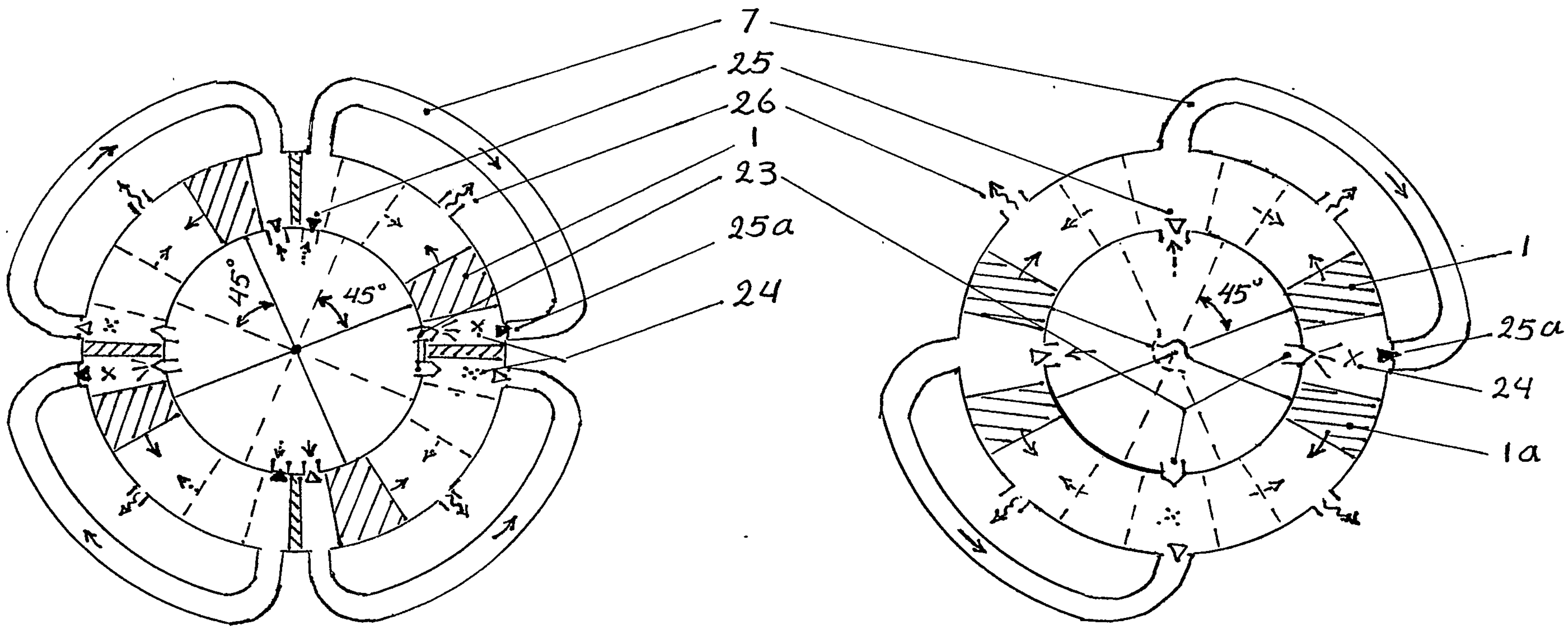

Figure 6

Figure 7

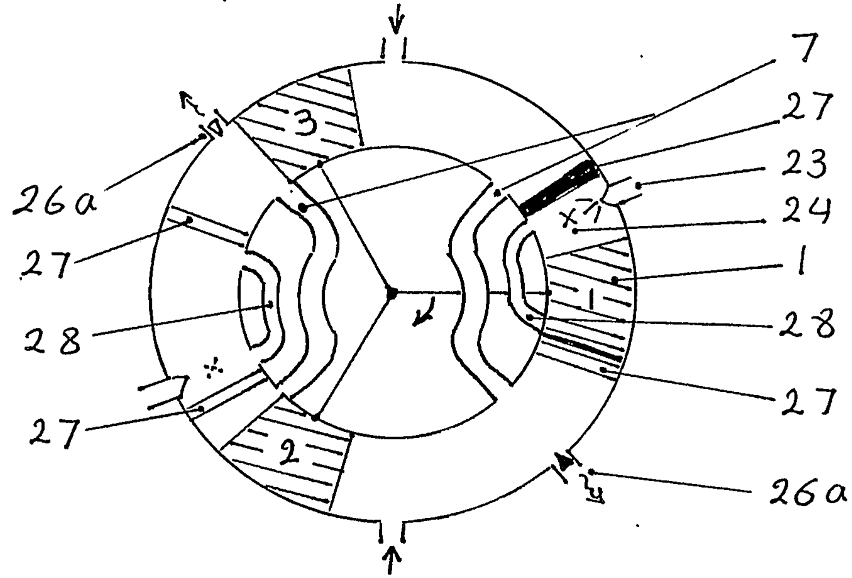

Figure 8

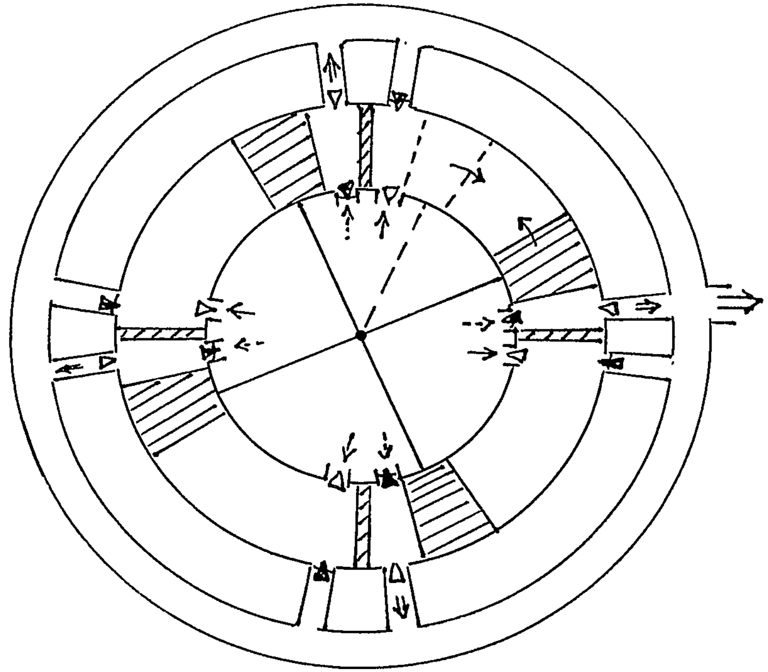

Figure 9

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Rotary Piston Internal Combustion Engine and Compressor

1. DESCRIPTION

A. Introduction

Piston type internal combustion engines (I.C.E.) are rather complicated machines with a power stroke for every three power consuming strokes of piston in 4 cycle machines. This results in one power stroke per two revolutions of the crankshaft. Besides, there are many accessories such as cranks, crankshaft, valves, tappets, valve rods, camshaft, etc. Making it as one once said theoretically unworkable!

Two cycle piston engines on the other hand, although have one power stroke per revolution, require mixing lubricating oil with fuel for lubricating piston, using the backside of piston for respiration and scavenging purposes. Burning the oil makes the engine unsuitable with regards to air pollution. Besides the scavenging is achieved by fuel mixed with air, with consequent escape of unburned fuel with exhaust gases. This also causes loss of efficiency.

The advantage of piston type I.C.E.'s is its positive displacement characteristics enabling it to compress the air to whatever ratio required with the same piston which is also producing power. Also because of almost zero leakage, the full power of explosion is transmitted to the piston. Besides this the amount and timing of the fuel injection (in case of injection type engines) is under full control, so that maximum efficiency can be achieved.

Gas turbines on the other hand, have almost an open cycle with little control of exact fuel injection. Besides, since of necessity of their mechanical configuration, they have large air gaps between moving and stationary blades, both in compressor and power turbine, the pressure loss is considerable. Also they have cumbersome compressors because they are not positive displacement type. All this makes them unsuitable for smaller powers and reduced speeds. Their efficiencies are also quite low as compared with piston type engines.

Of course there is another type of rotary engine I.C.E. that is Heckle engine, in which a triangular rotor is rotating in a circular casing and apparently they have sealing problems which is expected when one tries to fit a square peg into a round hole.

B. The Basic Idea

The arrangement proposed in this application has the best characteristics of both types of I.C.E.'s without having most of their disadvantages.

The basic idea as shown in Figure (1) consists of the followings.

A curved piston (1) is rotating or swinging in a toroidal or ring type cylinder (2) which is more or less like a tire tube. The movement of the piston is transmitted to the power shaft (4) through a piston disc (3) on which piston (5) is fixed.

Sealing between piston and cylinder is achieved through normal type piston rings (16), thus a complete positive, displacement action is achieved while having a radial movement.

By this arrangement both sides of the piston can be utilised for compression and/or power strokes, without the necessity of mixing lubricating oil and fuel. The lubrication is achieved by the use of oil tube (5) in the disc which leads the lub oil either through centrifugal action or pressure from an oil pump to an oil groove (17) in the middle of piston. Other distributing grooves can also be utilised.

Sealing between the piston disc (3) and engine body half walls (8) is achieved by a combination of O-Rings (11) and labyrinth (12). The action of labyrinth is to reduce the pressure of residual leakage and lead it to outside through tube (13).

Side thrust of the piston disc is controlled through flat ring type ball or roller bearings (not shown) and a ball (15) at the end of power shaft.

The engine operates more or less on the principles of a 2 cycle engine, thus having one power stroke in every one to and fro movement in the case of swinging engine or in every one revolution of output shaft in the case of fully rotating machine to be explained later on.

C. <u>The Alternative Types</u>

There are different types possible emanating from the basic type explained in section B. above. These are as followings.

C.1 Swinging or Oscillating type (VIBRO):

In this alternative piston is swinging in a rotary left and right oscillating motion and this swinging action, if required can be translated into a rotating movement through a single crack and crankshaft arrangement at the end of power shaft (4) and output shaft (20), shown in a sketch from in figure (2).

C.2 Rotary or Turbine Type (TURBO):

In this type, figure (3), the pistons and piston disc is continuously rotating in one direction this eliminating the need for crank and crankshaft. In this arrangement cylinder valves (27) act as cylinder head, while allowing the pistons to pass through when required. Cylinder valves are activated through a cam disc (29) fixed to power shaft and activated by it and this in synchronizon with piston disc and pistons. It is a fail safe arrangement preventing the pistons hitting a closed valve.

To reduce the travel of cylinder valve, either the pistons should be reduced in diameter or the pistons should be shaped as shown in figure (4).

C.3 Counter Acting Pistons, Double Disc Type:

This is an alternative to swinging type, see figures (5 & 7). Two piston discs 3 & 3a carry two counter acting pistons 1 & 1a and the compression is achieved between opposing faces of the counteracting pistons as they travel towards each other and fuel is injected at the end of stroke by fuel injector (23). The resulting explosion pushes the pistons apart producing power. In this arrangement no cylinder heads are required and all the cylinder volume except that displaced by pistons themselves, is utilised to produce more power, or a smaller engine will produce the same power.

Transfer of power output from secondary piston disc to the power shaft which is attached tot he primary piston disc is achieved trough a gearing system, preferably a planetary type, which will also act as an interlock and synchronising device for the movement of the two piston discs.

C. 4. Turbocharged Type

Supply of fresh air for scavenging and compression stroke can be provided either by the backside of the piston as described or through a turbocharger operated by the exhaust gases enabling the backside of the piston to be used for power cycle, thus enabling the power output of the engine doubled with the same number and size of the cylinders and pistons.

C. 5. Multliple units or stages

By connecting unit engines, without crank and crankshaft, in tandem, multistage engines can be made with power output multiplied by the number of stages. For swinging type engines only the last stage need to have crank and crankshaft. Of course power shaft in each stage and the end crankshaft and output shaft will need to be designed for the increased torque and power output. Furthermore by shifting each stage in suitable angles a smoother power and torque output will be obtained due to the distribution of power stroke around 360°.

D. Basic Operating Cycles

D. 1. Single Disc, Single Action:

The general arrangement of this type is shown in figure (6) in sketch form for a four cylinder engine. Full lines represent top dead centre (T.D.C.) position and dotted lines bottom dead centres (B.D.C.) as compared in normal piston type I.C.E.'s.

In this type one side of the piston (1) is used for power stroke and the other side for respiration and scavenging. The air inlet is through a non-return valve (25) through which the fresh air is sucked in a clockwise movement of the piston while it is compressing the fresh air from previous cycle.

At firing cycle which is initiated by injecting fuel through fuel injector (23) at T.D.C., the force of explosion pushes back the piston in an anti clockwise direction providing the power. At the same time air inlet valve (25) closes and the fresh air starts to be compressed in B.D.C. section. This goes on until the exhaust port (26) is opened by the piston and the pressure in T.D.C. section is reduced. When the compressed fresh air pressure overcomes the pressure of residual exhaust gases the secondary air inlet non return valve (25a) is opened and the compressed fresh air enters the T.D.C. section through by pass manifold (7) starting scavenging cycle and filling the cylinder with fresh air making it ready for the next cycle.

As it is seen at every half swing two cylinders are in firing position so that air compression is always achieved by the power stroke of the diagonal piston. A small flywheel may be necessary to help the compression at the end of stroke.

In two stage engine with 90° shift this flywheel will not be necessary.

In figure (6) and other figures fresh air is shown by straight line arrow and the exhaust gas by wavy line arrow. Furthermore a spark plug (24) is also placed near fuel injector to help ignite the fuel if the compressed air temperature is not enough for this.

As it is seen there is no exhaust valve used and the exhaust port is opened by the piston and this port can be designed in shape and size to reduce the exhaust noise and for example by drilling multiple parts around the cylinder the port size can be increased considerably making the scavenging in shortest possible time and thoroughly.

Air inlet non return valves are always handling fresh cool air and secondary air inlet valve (25a) remains closed during the firing cycle so there will be no problem of valve burning and leakage. In figures open valves are shown blank and closed valves in black.

D. 2. Double Disc, Counteracting

The general arrangement is shown in sketch form in figure (7) for a four piston type.

Here counteracting pistons are fixed on two discs and there is no cylinder head in the system. Fuel is injected in the compressed air trapped between the two faces of the counteracting pistons.

The other sides of the pistons are used for respiration and compression of the fresh air to be used for scavenging and supply of fresh air for compression cycle. Here again by pass manifold (7) is used for this purpose.

D. 3. Full Rotary or Turbine Type

On this arrangement which is shown in figure (8) also figure (3), swinging movement is replaced by a continuous rotating movement in one direction. This is achieved, as explained earlier, by cylinder valve (27) acting as cylinder heads, but allowing the pistons to pass at the required times.

Here a unic by pass system is utilised to be pass the compressed air in front of piston to its backside through tube (28) for firing cycle, so that firing always occurs behind piston this enables the continuous rotation in one direction. There is a non-return valve (26a) in the exhaust port to prevent the suction of exhaust gases in respiration cycle, but actual opening of the exhaust port is by the piston itself.

In this arrangement there is always plenty of fresh air for scavenging and supply of fresh air for compression cycle and there is also one firing cycle around the cylinder for providing power for compression.

In the figures the open position of cylinder valve is shown blank and the closed position in black.

E. Air or Gas Compressor

By eliminating exhaust port and rearranging the suction and discharge non return valves the swinging type engine can be utilised as an air or gas compressor (fig. 9). In every to and fro movement of the piston the air is sucked in the compressed at both sides of the piston and compressed air led to outside through discharge parts. Double acting type can also be used as compressor.

This compressor can be coupled to a swinging type engine directly. When using rotary prime movers crank and crankshaft arrangement will be required. For higher output pressures and for volumes, multi stage units can be utilised.

IV. FIGURES AND REFERENCE NUMBERS

A. FIGURES

Fig. 1) Basic Type Arrangement
2) Crank and Crankshaft Arrangement
3) Turbine Type Engine
4) Piston Blade
5) Double Acting Arrangement
6) Single Disc, Single Acting Type Engine
7) Double Disc, Counter Acting Type Engine
8) Turbine Type Fully Rotating Type Engine
9) Air or Gas Compressor

B. REFERENCE NUMBERS

1) Piston
1a) Counteracting Piston
2) Cylinder
3) Piston Disc (Primary)
3a) Piston Disc (secondary)
4) Power Shaft
5) Oil Tube
6) Cylinder Sealing Rings
7) Air By Pass Manifold
8) Engine Body
9) Cooling Water
10) Lubricating Oil
11) Piston Disc Sealing Rings
12) Labyrinth
13) Pressure Leak Tube
14) Bearings
15) End Travel Stop Ball
16) Piston Rings
17) Piston Oil Groove
18) Crank
19) Crankshaft
20) Output shaft
21) Flywheel
22) Piston Blade
23) Fuel Injector
24) Spark Plug
25) Air Non-return Valve
25a) Secondary Non-Return Valve
26) Exhaust Port
26a) Exhaust Non-Return Valve
27) Cylinder Valve
28) By Pass Tube
29) Cam Disc

II. CLAIMS

1. A curved piston rotating or swinging in a toroidal ring shaped cylinder (fig. 1) provides the basis for piston type rotary internal combustion engine (RPICE). This arrangement enables a positive displacement action with rotary motion. The motion of the piston is transmitted to the power shaft through a piston disc on which the pistons are fixed. This arrangement also permits the use of both faces of the piston for compression and for combustion purposes, thus doubling the utility of each piston.

2. A RPICE s claimed in claim (1) in which the lubrication of piston is achieved through a tube (5) in the piston disc leading to a groove (17) or grooves around the piston thus eliminating the need for mixing fuel with lubrication oil.

3. A RPICE as claimed in claims (1 & 2) in which the sealing between piston disc and cylinder half bodies are achieved through O-Rings (11) and labyrinth (12) arrangement as explained in part I, the leakage (if any) led through a tube to outside or oil sump.

4. A RPICE as claimed in claims (1 to 3) in which the sealing of the piston is achieved through normal piston rings utilised for compression and oil scraping.

5. A RPICE as claimed in claims (1 to 4) which is arranged as single disc, single acting swinging type (VIBRO), figure (6) for a four cylinder/piston engine, where one face of the piston is used for compression and combustion and the other face for respiration and scavenging. The explosion is achieved through fuel injection and spark ingtion (for low compression ratios). Transfer of fresh air from one side of piston to the other side is through a by pass tube and the use of non-return valve.

6. A RPICE as claimed in claim (1 to 4) which is arranged as double disc, double acting type (fig 7) for four cylinder/piston type, where two sets of pistons fixed on two piston discs are acting in opposition around the same cylinder ring, thus eliminating the need for cylinder heads and as a result utilising the cylinder space to the full. Only one power shaft is utilised, the transfer of power from the seconday piston disc to the power shaft being achieved through the arrangement of a gearing or leverage system which also acts as an interlock and synchronising means.

7. A RPICE as claimed in claim (1 to 4) which is rotating instead of swinging, (TURBO), figures (3 and 8), where with the utilisation of cylinder valves (27) and a unic air by pass tube, the pistons and piston disc is rotating in one direction thus eliminating the need for crank and crankshaft the end of engine.

8. A RPICE as claimed in claim (7), in which transfer of compressed air from the leading face of the piston to the backside of piston is achieved through a by pass tube (28) realised by the piston itself. This arrangement allows the rotation of the pistons and piston disc in one direction with the combustion always taking place at the backside of the piston.

9. A RPICE as claimed in claims (7 & 8) where a cylinder valve (27) is used to act as cylinder heads, while allowing the pistons to pass at required times.

10. A RPICE as claimed in claims (7 to 9) where the arrangement of the pistons around the piston disc is such that there is always one explosion in the system producing power for compression in 360° around the cylinder ring.

11. A RPICE as claimed in claims (7 to 10) where the operation of cylinder valves are achieved fail safe, by the use of cam disc (29) fixed to the power shaft, operating the cylinder valves at the required times.

12. A RPICE as claimed in claims (1 to 11) where the operating signals (mechanical or electrical) of the operation of fuel injections and spark plugs are given by the piston disc (5).

13. A RPICE swinging type as claimed in claims (1 to 7) where the swinging action is transformed into rotating action by means of single crank and crankshaft arrangement (Fig 2).

14. A RPICE units as claimed in previous claims which are connected in tandem, resulting in a multistage engine thus increasing the output power by any factor required. By shifting the stages in required degrees around 360°, a smooth output is achieved eliminating the need (if any) for the flywheel.

15. A rotating piston, positive displacement arrangement as claimed in claims (1 to 4), where by rearranging the non-return valves and eliminating exhaust port, fuel injectors and spark plugs, it is used as an air or gas compresson, swinging type. This compressor can be driven directly from a RPICE or by any prime move using crank and crankshaft arrangement at the end of compressor, single or multistage.

16. A rotary piston internal combustion engine or rotary piston positive displacement compressor substantially as desciebed herein with reference to Figures 1-9 of the accompanying drawings.

Patents Act 1977
Examiner's report to the Comptroller under Section 17 (The Search Report)

Application number 9127568.5

Relevant Technical fields

(i) UK Cl (Edition K) F1F:FD

(ii) Int CL (Edition 5) F01C 9/00, 1/063

Search Examiner

B W DENTON

Databases (see over)

(i) UK Patent Office

(ii)

Date of Search

8 MAY 1992

Documents considered relevant following a search in respect of claims 1-16

Category (see over)	Identity of document and relevant passages		Relevant to claim(s)
X	GB 1333971	(ROCHA) whole document	1 & 4 at least
X	GB 1205584	(EHRLICH) whole document and especially line 85, page 1 to line 26 page 2	1,13 & 15 at least
X	GB 0759110	(FRANCIS) whole document, especially lines 44-81, page 2	1,4,10, 14 at least
X	GB 0499553	(MC INTYRE) whole document, especially Figure 21	1,6 & 14 at least
X	GB 0334674	(CHEVALLIER) whole document, especially lines 15-19, page 3	1,3 & 10 at least
X	WO 86/01255 A1	(MARFELL) whole document	1 & 6 at least
X	US 4035111	(CRONEN) whole document	1,3,4 at least
X	US 3937187	(BERGEN) whole document, especially lines 56-65 column 3 and lines 21-26, column 4	1,2,11, 12 at least

Category	Identity of document and relevant passages	Relevant to claim(s)

Categories of documents

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Patents Act 1977
Examiner's report to the Comptroller under Section 17 (The Search Report)

Application number

9127568.5

Relevant Technical fields

(i) UK Cl (Edition) Contd. from page 1

(ii) Int CL (Edition)

Search Examiner

B W DENTON

Databases (see over)

(i) UK Patent Office

(ii)

Date of Search

8 MAY 1992

Documents considered relevant following a search in respect of claims

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
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