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(54) **Internal combustion engines**

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Description

The present invention relates to internal combustion engines and is particularly concerned with the positioning and bearing arrangements for the crankshaft of such engines. The invention relates to that type of engine which comprises two cylinder blocks, each defining one or more cylinders, each cylinder in each cylinder block being opposed to a cylinder in the other cylinder block, the two cylinder blocks being connected together with the interposition of two or more crankcase structures and defining between them a space in which a crankshaft is rotatably supported by at least two main bearings which are at least partially supported by the crankcase structures, a piston mounted to reciprocate in each cylinder, each piston being connected to a crank of the crankshaft (see for example FR-A-1 423 850). Whilst the invention is principally concerned with four stroke engines of spark ignited type, particularly engines for racing cars, it is applicable also to those of two stroke and/or diesel type.

Reciprocating piston engines include one or more pistons which are mounted to reciprocate in respective cylinders and are typically connected by respective connecting rods to a crankshaft accommodated within a crankcase defined beneath the cylinder block. This construction is inherently relative large and heavy. Furthermore, the engine exerts a considerable torque on its mountings during acceleration and has a considerable rotational inertia which can lead to catastrophic failure in the event of the engine seizing during high speed operation.

Engines of the generic type referred to above with the cylinders in the so-called flat configuration are known. The necessary connecting rods and relatively large cranks on the crankshaft are bulky and heavy and this is highly undesirable in racing car engines in which it is always desired to produce more power from an engine of given size and weight, i.e. a more compact engine with an improved power to weight to ratio.

It is an object of the present invention to provide a reciprocating piston engine which is smaller and lighter than known engines and thus has a higher power output per unit weight and per unit volume and a further object to provide such an engine which is perfectly balanced at all times and has no net rotational inertia.

According to the present invention, an internal combustion engine of the type referred to above is characterised in that each opposed pair of pistons is rigidly connected by two walls which afford respective apertures and which define between them a space, that each opposed pair of pistons is connected to two cranks of the crankshaft by two sliders which are accommodated in a respective one of the said apertures and are mounted to slide with respect to the associated wall only in the direction transverse of its reciprocal movement and which define an opening in which a respective one of the cranks is rotatably received, a main crankshaft bearing being supported in the said space between the two walls.

Thus in the engine in accordance with the invention the conventional connecting rods are eliminated and replaced by slider mechanisms of the per se known Scotch Yoke type (see US-A-3 220 390) and pairs of spaced walls connecting opposed pistons which thus reciprocate in unison. The sliders reciprocate laterally in the apertures in the connecting walls and convert the reciprocal motion of the pistons into rotary motion of the crankshaft and this permits the heavy and space-consuming cranks on conventional crankshafts to be replaced by smaller and lighter cranks. The space between the connecting walls accommodates not only a portion of the crankshaft but also a crankshaft main bearing which results in the crankcase being much smaller than is usual. The walls connecting opposed pairs of pistons also inherently occupy less space than traditional connecting rods.

The main crankshaft bearing within the space defined by two connecting walls may be supported solely by the crankcase structures or there may be an additional supporting member whose provision will enable the cylinder heads to be less rigid and thus less heavy. In one embodiment of the latter possibility in which a significant proportion of the crankshaft load is transferred directly to the cylinder heads, thus enabling them to be thinner and lighter, each piston is of annular shape with an axial hole passing through it, the two cylinder blocks are connected together by one or more fastening members, each of which passes through a respective opposed pair of pistons, and each fastening member at least partially supports a main crankshaft bearing in the space between the two associated connecting walls. In this embodiment the fasteners at least partially support or constitute a main crankshaft bearing. This construction results in the engine being more compact and thus lighter and also less subject to vibration. In practice, the fasteners will be connected to the cylinder head which closes the cylinders at the end remote from the crankshaft and the cylinder head may either form an integral part of the cylinder block or be a separate component rigidly connected to it.

It is preferred that each cylinder block defines an even number of cylinders arranged in two parallel rows and that the cylinders of each opposed row are associated with a respective crankshaft and that the two crankshafts are connected together to rotate in synchronism, either in the same sense or, more preferably, in opposite senses. In this embodiment the engine thus has n cylinders, where n is divisible by 4, and the engine may therefore be considered to be constituted by one or more modules, each of which has four cylinders. Two separate crankshafts are provided which counter-rotate and this results in perfect primary balance, perfect secondary balance, no rocking couples and no net rotational inertia.

In the event that the cylinders are arranged in a single row, the cylinder blocks are preferably connected together with the interposition of only two crankcase structures, each main crankshaft bearing being supported either solely by the crankcase structures or partly by the

associated fastener member and partly by two crankcase structures. In the preferred embodiment in which the cylinders are arranged in two parallel rows it is preferred, in the case in which the crankcase bearings are supported only by the crankcase structures, that the two lateral crankcase structures and one central crankcase structure and each of the said main crankshaft bearings is supported by a respective portion of a lateral crankcase structure and the central crankcase structure. In the case in which the crankcase bearings are supported partly by the crankcase structures and partly by the associated fastener member, it is preferred that there are two lateral crankcase structures and one central crankcase structure and that each fastening member comprises two separate portions and further that each main crankshaft bearing is supported by two fastening member portions and a respective portion of a lateral crankcase structure and the central crankcase structure, all the said portions being connected together at the crankshaft bearing.

The inlet and outlet valves of the engine may be of conventional type provided in a cylinder head which forms a removable part of the cylinder block but it is preferred that each cylinder contains a cylindrical cylinder liner, the end of which remote from the associated crankshaft is substantially closed by an end wall in which one or more ports are formed, that the free edge of the side wall of the cylinder liner carries gear teeth which engage directly or indirectly with gear teeth on the crankshaft and that one or more inlet apertures and exhaust apertures are formed in that portion of the associated cylinder block which is adjacent to the end wall of the cylinder liner whereby rotation of the crankshaft results in rotation of the cylinder liner about the axis of the associated cylinder and the ports in the cylinder liner move cyclically into and out of registry with the inlet apertures and exhaust apertures in the cylinder block. Thus in this embodiment the engine valves are of rotary type and the movable valve member of all the valves in each cylinder is constituted by a single respective cylinder liner which is rotated continuously about its axis by a geared drive coupled to the crankshaft. This construction results in a considerable simplification and reduction in the number of components as compared to conventional valve actuating mechanisms and the fact that the cylinder liner rotates continuously means that dynamic lubrication of the piston rings is maintained at all times. This construction has advantages which do not require the presence of the features of claim 1 and may therefore be provided in any engine of known type. It is preferred that each cylinder liner carries a hollow bush which is integral with its end wall and extends towards the associated crankshaft and around the associated fastener member, optionally with the interposition of a cylindrical bearing. This bush can thus guide the piston and receive the piston side loads and it can therefore be ensured that the piston does not come into direct contact with the internal surface of the cylinder liner whereby wear and friction are reduced.

In the preferred embodiment the or each crankshaft is provided with an internal oil supply passage extending along its length which communicates with the main crankshaft bearing surfaces via radial passages in the crankshaft.

Further features and details of the invention will be apparent from the following description of one specific embodiment which is given by way of example with reference to the accompanying drawings, in which:-

Figure 1 is a longitudinal sectional view through a four cylinder engine in accordance with the invention; and

Figure 2 is a transverse sectional view of the engine of Figure 1 on a line which passes through the scotch yoke of two cylinders and the main crankshaft bearing of two further cylinders; and

Figure 3 is a view similar to Figure 1 of a modified engine from which the fasteners and associated components have been omitted.

The engine illustrated in the drawings is effectively an engine module having four cylinders and two crankshafts, and may thus be thought of as a H4 engine. An engine having 8, 12 or even more cylinders may be provided by connecting the appropriate number of such modules end to end and to two common crankshafts. The module includes two opposed cylinder blocks 2, each of which defines two cylinders 4 side by side. Each cylinder 4 receives an annular piston 6, as will be described below, which is connected to the piston 6 received in the opposing cylinder 4 formed in the other cylinder block 2 by two parallel spaced walls 8. The four pistons are thus connected together in two pairs whose axes lie in a common plane. Formed in the centre of each wall 8 is an aperture 10 through which a respective one of the crankshafts 12 passes. Slidably retained within each aperture 10 is a slider constituted by two slippers or half shells 14 which together define a circular aperture in which a crank 16 of the crankshaft is received. In this case the two slippers are connected together by bolts, but these bolts could be omitted and each slipper could be constituted by more than two components. This arrangement constitutes a "Scotch Yoke", which is known per se, and thus as the pistons reciprocate vertically, as seen in Figures 1 and 2, the slippers 14 reciprocate horizontally, as seen in Figure 2, and the crankshaft 12 is rotated. As will be appreciated, there are thus two separate crankshafts, each of which has two cranks which are associated with two pistons. The two crankshafts are connected to respective geared flywheels 17 so that they rotate in opposite senses but in phase. Due to the use of the Scotch Yoke mechanisms which are wholly contained within the cylinder bore diameter the stroke of the pistons is necessarily relatively short and is typically substantially less than their diameter.

The two cylinder blocks 2 are connected together with the interposition of two lateral crankcase structures

18 and a central crankcase structure 20 by means of elongate fasteners. There is one central fastener for each pair of opposed cylinders and it passes through the central hole in the associated pistons 6 and the space between the two walls and corresponding holes in the cylinder blocks and is secured in position by nuts 22. In practice, there may be additional circumferential fasteners around each cylinder but these form no part of the present invention and are not illustrated. Each fastener comprises two rods 24 whose outer end is threaded to receive a nut 22 and whose inner end is part-circular and engages a respective half bearing shell 26. The associated lateral crankcase structure 18 and the central crankcase structure 20 also engage and support a respective one of the half bearing shells 26. The two bearing shells 26 are secured together to define a "flying" main crankshaft bearing which receives and supports the associated crankshaft 12. A crankshaft bearing is thus provided within each connected opposed pair of pistons. The lateral crankcase structures 18 also carry further crankcase bearings 31 at the two ends of the crankshaft 12.

Rotatably received within each cylinder 4 is a cylindrical cylinder liner 32 whose end remote from the associated crankshaft is substantially closed. Formed in the closed end is a coaxial hole around which is a tubular bush 34 which projects through the piston and extends around the associated fastener rod 24. Between this tube and the edge of the aperture in the piston is a cylindrical bearing 33 which transfers piston side thrust to the fastener rod. The free edge of the wall of the cylinder liner carries gear teeth 36 which mesh with a jockey gear 38 which in turn meshes with teeth 40 on the crankshaft. Thus as the crankshaft rotates about its axis the cylinder liner rotates also about its axis. The cylinder liner 32 acts as a rotary inlet and exhaust valve member in which a diametrically opposed pair of ports 42 are formed. Retained between the cylinder liner 32 and the associated cylinder block 2 is a stationary plate 46 in which pairs of inlet apertures 43 and exhaust apertures (not shown) are formed which are in registry with corresponding inlet apertures 48 and exhaust apertures (not shown) in the cylinder block which communicate with the engine inlet and exhaust system respectively. The plate 46 is slightly recessed (not shown) over an area radiating from the inlet apertures which permits high pressure gas to penetrate behind the end of the cylinder liner in a controlled manner and thus to act as a partial force balance and reduce the rotary valve seal loads. Extending through the plate 46 are two spark plugs 47 per cylinder which communicate with the ports 42 at the appropriate times to ignite the fuel air mixture in the ports, which thus serve as combustion chambers, shortly before top dead centre. The cylinder liners perform only half a revolution per cycle of the engine. In use, the ports 42 in the cylinder liner come successively into registry with the inlet apertures 43,48 and the exhaust apertures and thus serve alternately as inlet ports and exhaust ports. Both the inlet and exhaust apertures in the cylinder block are shielded by tubes (not shown) which are spaced from the cylinder block and reduce heat transfer between the inlet air, the exhaust gases and the engine structure.

Each crankshaft 12 has an internal oil supply passage 54 extending along its length which communicates with the main crankshaft bearing surfaces through radial bores 56. In use, pressurised oil is supplied through the passages 54, 56 to lubricate the crankshaft bearings.

In use, perfect "simple harmonic motion" is imparted to the pistons by the cranks through the Scotch Yoke mechanisms and there are thus no secondary out-of-balance forces. The axes of all the pistons of each module lie are coplanar and there are thus no rocking couples. Due to the use of two counterrotating crankshafts, each of which fully counterbalances the inertia of the reciprocating pistons, each engine module is in complete primary balance. The engine also has no net rotational inertia. Due to the Scotch Yokes the acceleration of the piston at top dead centre is reduced compared to an engine employing connecting rods. The rotating cylinder liners are driven in a simple and reliable manner and the central bush attached to the cylinder liner may be used to locate the piston which need thus not touch the cylinder wall. Since the cylinder liner rotates continuously the piston rings are never at rest with respect to it and dynamic lubrication of the piston rings is thus maintained at all times. Supporting the crankshaft bearings by fasteners which pass through the pistons together with the elimination of the conventional connecting rods means that the engine is particularly simple, compact and light.

In the modified construction illustrated in Figure 3 the fasteners 24, bushes 34 and bearings 33 are omitted and the crankshaft bearings are supported only by the crankcase structures. In most other respects the engine is substantially the same as that described above except that the cylinder heads are a little stiffer and thus heavier than previously. This is, however, found to be acceptable and technically satisfactory in many engines, though in, for instance, a high power, turbocharged diesel engine the necessary increase in weight is likely to be unacceptable and the fasteners 24 may thus be necessary.

During the induction stroke of each piston, the subatmospheric pressure within the cylinder coupled with the frictional force exerted on the associated cylinder liner by the piston rings result in a tendency of the cylinder liner to move towards the crankshaft. If this were to happen, even to a very small extent, an unacceptably high leakage of oil into the cylinder could occur. It may therefore be desirable in both the engines described above to provide some means for axially locating the cylinder liners. This may be achieved in many ways but in the engine shown in Figure 3 with no fasteners 24, it is achieved by connecting each cylinder liner 32 to the associated cylinder head 2 by means of a connector 60 which is situated on the rotational axis of the cylinder liner and which is arranged to permit rotational movement but no axial movement of the cylinder liner.

Claims

1. An internal combustion engine comprising two cylinder blocks (2), each defining one or more cylinders (4), each cylinder in each cylinder block being opposed to a cylinder in the other cylinder block, the two cylinder blocks being connected together with the interposition of two or more crankcase structures (18,20) and defining between them a space in which a crankshaft (12) is rotatably supported by at least two main bearings (26,31) which are at least partially supported by the crankcase structures, a piston (6) mounted to reciprocate in each cylinder, each piston being connected to a crank (16) of the crankshaft, characterised in that each opposed pair of pistons (6) is rigidly connected by two walls (8) which afford respective apertures and which define between them a space, that each opposed pair of pistons is connected to two cranks (16) of the crankshaft (12) by two sliders (14) which are accommodated in a respective one of the said apertures and are mounted to slide with respect to the associated wall (8) only in the direction transverse of its reciprocal movement and which define an opening in which a respective one of the cranks (16) is rotatably received, a main crankshaft bearing (26) being supported in the said space between the two walls (8).

2. An engine as claimed in Claim 1, characterised in that each piston (6) is of annular shape with an axial hole passing through it, that the two cylinder blocks (2) are connected together by one or more fastening members (24), each of which passes through a respective opposed pair of pistons and that each fastening member (24) at least partially supports a main crankshaft bearing (26) in the space between the two walls (8).

3. An engine as claimed in Claim 1 or 2 characterised in that each cylinder block (2) defines an even number of cylinders (4) arranged in two parallel rows, that the cylinders of each pair of opposed rows are associated with a respective crankshaft (12) and that the two crankshafts (12) are connected together to rotate in synchronism.

4. An engine as claimed in Claim 3 characterised in that the two cylinder blocks (2) are connected together with the interposition of two lateral crankcase structures (18) and one central crankcase structure (20), that each fastening member comprises two separate portions (24) and that each of the said main crankshaft bearings is supported by two fastening member portions (24) and a respective portion of a lateral crankcase structure (18) and the central crankcase structure (20), all the said portions being connected together at the crankshaft bearing.

5. An engine as claimed in Claim 3 characterised in that the two cylinder blocks (2) are connected together with the interposition of two lateral crankcase structures (18) and one central crankcase structure (20), and that each of the said main crankshaft bearings is supported by a respective portion of a lateral crankcase structure (18) and the central crankcase structure (20).

6. An engine as claimed in any one of the preceding claims characterised in that each cylinder contains a cylindrical cylinder liner (32), the end of which remote from the associated crankshaft is substantially closed by an end wall in which one or more ports (42) are formed, that the free edge of the side wall of the cylinder liner (32) carries gear teeth (36) which engage directly or indirectly with gear teeth (40) on the crankshaft (12) and that one or more inlet apertures (48) and exhaust apertures are formed in that portion of the associated cylinder block which is adjacent to the end wall of the cylinder liner (32) whereby rotation of the crankshaft (12) results in rotation of the cylinder liner (32) about the axis of the associated cylinder and the ports (42) in the cylinder liner (32) move cyclically into and out of registry with the inlet apertures (48) and exhaust apertures in the cylinder block (2).

7. An engine as claimed in Claims 4 and 6 characterised in that each cylinder liner (32) carries a hollow bush which is integral with its end wall and extends towards the associated crankshaft (12) and around the associated fastener member (24).

8. An engine as claimed in Claims 5 and 6 characterised in that the end wall of the cylinder liner (32) is connected to the associated cylinder head (2) on its axis of rotation by a connection (60) which permits rotation but not axial movement of the cylinder liner (32).

Patentansprüche

1. Verbrennungsmotor mit zwei Zylinderblöcken (2), von denen jeder ein oder mehrere Zylinder (4) aufweist, wobei jeder Zylinder in jedem Zylinderblock einem Zylinder in dem anderen Zylinderblock gegenüberliegt, die beiden Zylinderblöcke miteinander durch die Einfügung von zwei oder mehr Motorgehäusestrukturen (18, 20) verbunden sind, die zwischen diesen einen Raum bilden, in dem eine Kurbelwelle (12) drehbar in mindestens zwei Hauptlagern (26, 31) gelagert ist, die zumindest teilweise durch die Motorgehäusestruktur abgestützt sind, wobei ein Kolben (6) in jedem Zylinder zur Hin- und Herbewegung vorgesehen ist und jeder Kolben mit einer Kurbel (16) der Kurbelwelle verbunden ist,

dadurch gekennzeichnet, daß jedes sich gegenüberliegende Paar von Kolben (6) starr mit zwei Wänden (8) verbunden ist, die jeweils Öffnungen bieten und die zwischen sich einen Raum bilden, und daß jedes gegenüberliegende Paar von Kolben mit zwei Kurbeln (16) der Kurbelwelle (12) durch zwei Schieber (14) verbunden ist, die jeweils in einer der Öffnungen angeordnet und montiert sind, um mit Bezug auf die zugeordnete Wand (8) nur quer zu deren Hin- und Herbewegung zu gleiten und die eine Öffnung bilden, in der jeweils eine der Kurbeln (16) drehbar aufgenommen ist, wobei ein Hauptkurbelwellenlager (26) in dem Raum zwischen den beiden Wänden (8) abgestützt ist.

2. Verbrennungsmotor nach Anspruch 1, **dadurch gekennzeichnet,** daß jeder Kolben (6) eine ringförmige Form besitzt und mit einem durchgehenden, axialen Loch versehen ist, daß die beiden Zylinderblöcke (2) mit einem oder mehreren Befestigungselementen (24) miteinander verbunden sind, von denen jedes durch ein jeweils sich gegenüberliegendes Paar von Kolben verläuft, und daß jedes Befestigungselement (24) zumindest teilweise ein Hauptkurbelwellenlager (2) in dem Abstand zwischen den beiden Wänden (8) abstützt.

3. Verbrennungsmotor nach Anspruch 1 oder 2, **dadurch gekennzeichnet,** daß jeder Zylinderblock (2) eine gerade Anzahl an Zylindern (4) besitzt, die in zwei parallelen Reihen angeordnet sind, wobei die Zylinder von jedem Paar von der gegenüberliegenden Reihe jeweils einer Kurbelwelle (12) zugeordnet sind, und daß zwei Kurbelwellen (12) synchron rotierend miteinander verbunden sind.

4. Verbrennungsmotor nach Anspruch 3, **dadurch gekennzeichnet,** daß die zwei Zylinderblöcke (2) durch die Einfügung von zwei seitlichen Motorgehäusestrukturen (18) und einer zentralen Motorgehäusestruktur (20) miteinander verbunden sind, wobei jedes Befestigungselement zwei separate Abschnitte (24) aufweist, und daß jedes der Hauptkurbelwellenlager durch zwei Abschnitte der Befestigungselemente (24) und einen jeweiligen Abschnitt der seitlichen Motorgehäusestruktur (18) und der zentralen Motorgehäusestruktur (20) abgestützt ist, und alle Abschnitte an dem Kurbelwellenlager miteinander verbunden sind.

5. Verbrennungsmotor nach Anspruch 3, **dadurch gekennzeichnet,** daß die zwei Zylinderblöcke (2) durch die Einfügung von zwei seitlichen Motorgehäusestrukturen (18) und einer zentralen Motorgehäusestruktur (20) miteinander verbunden sind, und daß jedes der Hauptkurbelwellenlager durch einen jeweiligen Abschnitt der seitlichen Motorgehäusestruktur (18) und der zentralen Motorgehäusestruktur (20) abgestützt ist.

6. Verbrennungsmotor nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet,** daß jeder Zylinder eine zylinderförmige Laufbuchse (32) aufweist, deren von der zugeordneten Kurbelwelle entferntes Ende im wesentlichen durch eine Stirnwand verschlossen ist, in welcher ein oder mehrere Ansaugschlitze (42) gebildet sind, daß das freie Ende der Seitenwand der zylinderförmigen Laufbuchse (32) eine Getriebeverzahnung (36) aufweist, die direkt oder indirekt mit der Getriebeverzahnung (40) der Kurbelwelle (12) in Eingriff steht, und daß eine oder mehrere Einlaßöffnungen (48) und Auslaßöffnungen in dem Abschnitt des zugeordneten Zylinderblocks ausgebildet sind, der dem Wandende der zylinderförmigen Laufbuchse (32) benachbart ist, derart daß eine Rotation der Kurbelwelle (12) zu einer Rotation der zylinderförmigen Laufbuchse (32) um die Achse des zugeordneten Zylinders führt und die Ansaugschlitze (42) in der zylinderförmigen Laufbuchse (32) sich zyklisch ein und aus einem Deckungsbereich mit den Einlaßöffnungen (48) und den Auslaßöffnungen des Zylinderblocks (2) bewegen.

7. Verbrennungsmotor nach den Ansprüchen 4 und 6, **dadurch gekennzeichnet,** daß jede zylinderförmige Laufbuchse (32) von einer hohlen Buchse gebildet ist, die einstückig mit der Stirnwand geformt ist und sich in Richtung auf die zugeordnete Kurbelwelle (12) und um die zugeordneten Befestigungselemente (24) erstreckt.

8. Verbrennungsmotor nach den Ansprüchen 5 und 6, **dadurch gekennzeichnet,** daß die Stirnwand der zylinderförmigen Laufbuchse (32) mit dem zugeordneten Zylinderkopf (2) an der Rotationsachse durch eine Verbindung (60) verbunden ist, die eine Rotation, aber keine axiale Bewegung der zylinderförmigen Laufbuchse (32) erlaubt.

Revendications

1. Moteur à combustion interne comportant deux blocs-cylindres (2), définissant chacun un ou plusieurs cylindres (4), chaque cylindre de chaque bloc-cylindres étant opposé à un cylindre de l'autre bloc-cylindres, les deux blocs-cylindres étant reliés l'un à l'autre avec interposition de deux ou plus de deux structures (18, 20) de carter de vilebrequin et définissant entre elles un espace dans lequel un vilebrequin (12) est supporté de manière rotative par au moins deux paliers principaux (26, 31) qui sont au moins partiellement supportés par les structures de carter de vilebrequin, un piston (6) monté pour

se déplacer en va-et-vient dans chaque cylindre, chaque piston étant relié à une manivelle (16) du vilebrequin, caractérisé en ce que chaque paire opposée de pistons (6) est reliée de manière rigide par deux parois (8) qui présentent des ouvertures respectives et qui définissent entre elles un espace, en ce que chaque paire opposée de pistons est reliée à deux manivelles (16) du vilebrequin (12) par deux coulisseaux (14) qui sont reçus dans l'une, respective, desdites ouvertures et sont montés pour coulisser par rapport à la paroi associée (8) uniquement dans la direction transversale à son mouvement en va-et-vient et qui définissent une ouverture dans laquelle l'une, respective, des manivelles (16) est reçue de manière rotative, un palier principal de vilebrequin (26) étant supporté dans ledit espace existant entre les deux parois (8).

2. Moteur selon la revendication 1, caractérisé en ce que chaque piston (6) a une forme annulaire ayant un trou la traversant, en ce que les deux blocs-cylindres (2) sont reliés l'un à l'autre par un ou plusieurs éléments de fixation (24), dont chacun passe à travers une paire respective opposée de pistons et en ce que chaque élément de fixation (24) supporte au moins partiellement un palier principal de vilebrequin (26) dans l'espace existant entre les deux parois (8).

3. Moteur selon la revendication 1 ou 2, caractérisé en ce que chaque bloc-cylindres définit un nombre pair de cylindres (4) agencés en deux rangées parallèles, en ce que les cylindres de chaque paire de rangées opposées sont associés à un vilebrequin respectif (12) et en ce que les deux vilebrequins (12) sont reliés l'un à l'autre pour tourner en synchronisme.

4. Moteur selon la revendication 3, caractérisé en ce que les deux blocs-cylindres (2) sont reliés l'un à l'autre avec interposition de deux structures latérales de carter de vilebrequin (18) et d'une structure centrale de carter de vilebrequin (20), en ce que chaque élément de fixation comporte deux parties séparées (24) et en ce que chacun desdits paliers principaux de vilebrequin est supporté par deux parties (24) d'élément de fixation et une partie respective d'une structure latérale de vilebrequin (18) et de la structure centrale de vilebrequin (20), toutes lesdites parties étant reliées l'une à l'autre au niveau du palier de vilebrequin.

5. Moteur selon la revendication 3, caractérisé en ce que les deux blocs-cylindres (2) sont reliés l'un à l'autre avec interposition de deux structures latérales de carter de vilebrequin (18) et d'une structure centrale de carter de vilebrequin (20), et en ce que chacun desdits paliers principaux de vilebrequin est supporté par une partie respective d'une structure latérale de carter de vilebrequin (18) et de la structure centrale de carter de vilebrequin (20).

6. Moteur selon l'une quelconque des revendications précédentes, caractérisé en ce que chaque cylindre comporte une chemise cylindrique de cylindre (32), dont l'extrémité éloignée par rapport au vilebrequin associé est pratiquement fermée par une paroi d'extrémité dans laquelle un ou plusieurs orifices (42) sont formés, en ce que le bord libre de la paroi latérale de la chemise de cylindre (32) porte des dents d'engrenage (36) qui viennent en prise directement ou indirectement avec des dents d'engrenage (40) situées sur le vilebrequin (12) et en ce qu'une ou plusieurs ouvertures d'admission (48) et ouvertures d'échappement sont formées dans la partie du bloc-cylindres associé qui est adjacente à la paroi d'extrémité de la chemise de cylindre (32) de sorte que la mise en rotation du vilebrequin (12) entraîne une mise en rotation de la chemise de cylindre (32) autour de l'axe du cylindre associé et les orifices (42) existant dans la chemise de cylindre (32) se déplacent de manière cyclique en vis-à-vis et hors du vis-à-vis avec les ouvertures d'admission (48) et les ouvertures d'échappement du bloc-cylindres (2).

7. Moteur selon les revendications 4 et 6, caractérisé en ce que chaque chemise de cylindre (32) supporte une douille creuse qui forme un tout avec sa paroi d'extrémité et s'étend en direction du vilebrequin associé (12) et autour de l'élément de fixation associé (24).

8. Moteur selon les revendications 5 et 6, caractérisé en ce que la paroi d'extrémité de la chemise de cylindre (32) est reliée à la tête de cylindre associée (2) sur son axe de rotation par un raccord (60) qui permet la rotation mais ne permet pas de déplacement axial de la chemise de cylindre (32).

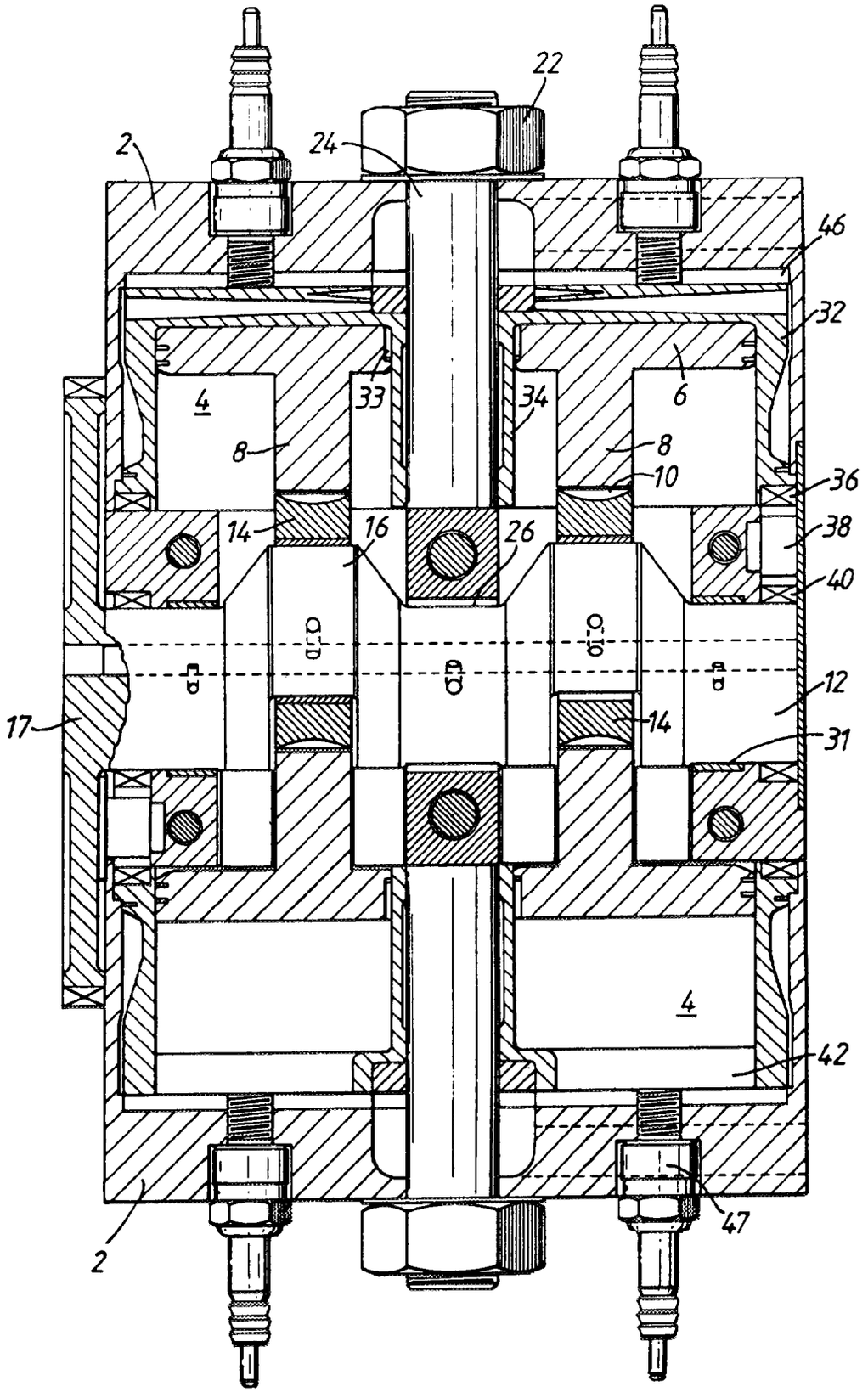


Fig.1.

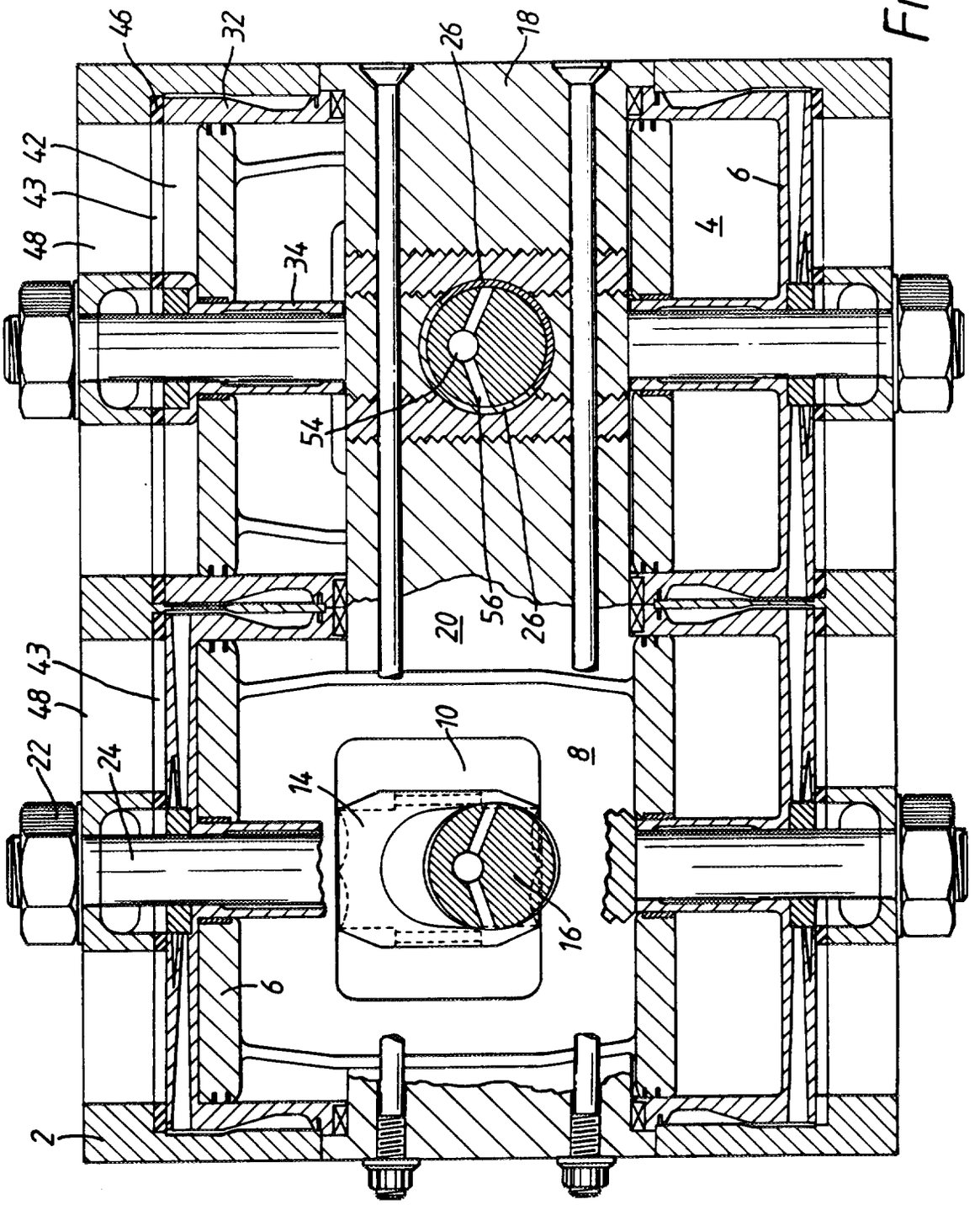


Fig. 2.

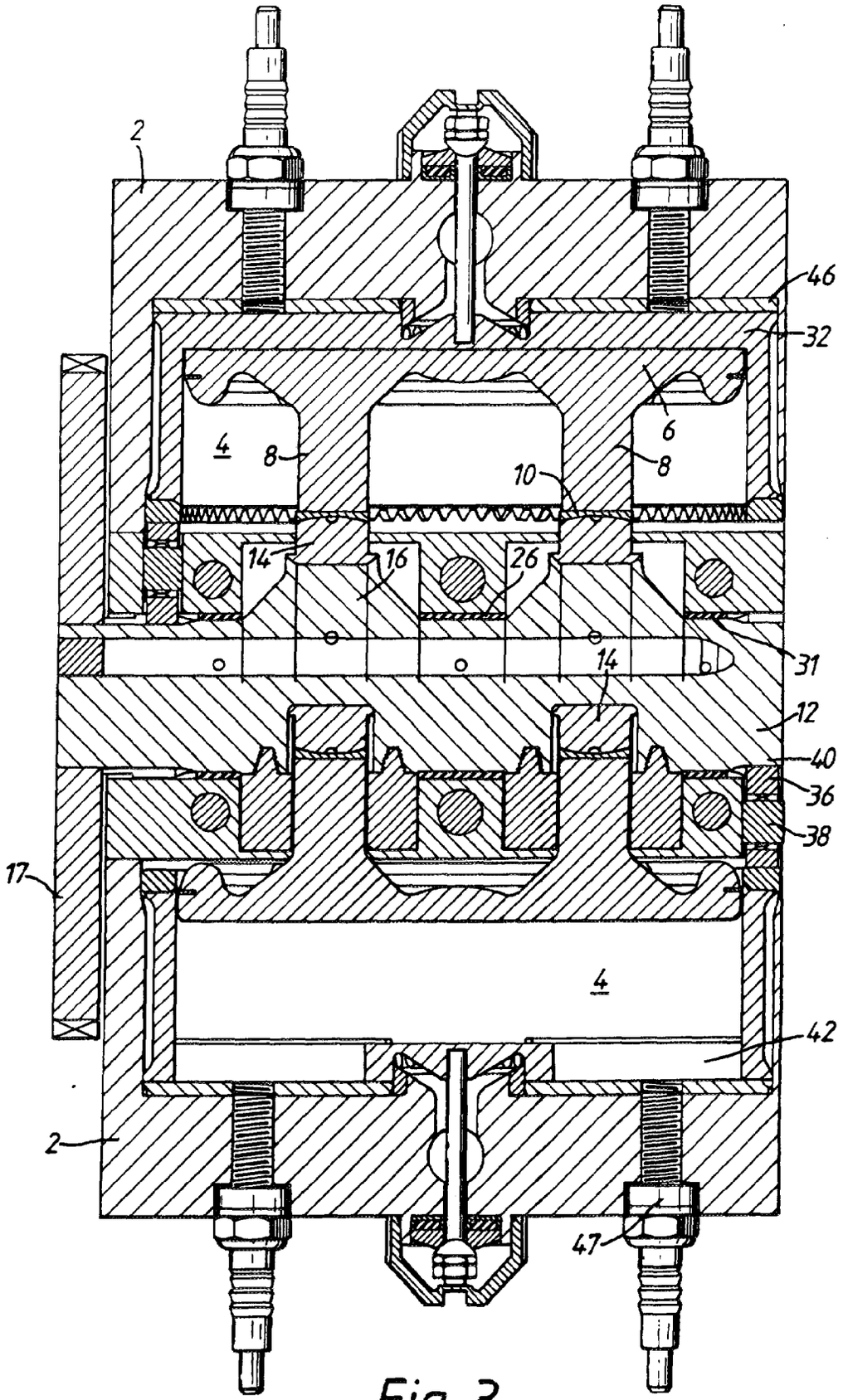


Fig. 3.