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(54) **An Internal combustion engine.**

(57) A two-stroke internal combustion engine has a duplex piston (48) slidable in co-axial cylinders (18,28). The engine has an inlet (15) for air/fuel mixture, an air inlet (29) and an exhaust outlet (36), and the combustion chamber has air inlet ports (32) and air/fuel transfer ports (34). The piston is arranged to pump a fresh air charge into the combustion chamber slightly in advance of the air/fuel charge to assist in scavenging and avoid unburnt fuel being passed directly to exhaust. The crankcase may or may not be used for charge compression.

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Description

AN INTERNAL COMBUSTION ENGINE

The invention relates to an internal combustion engine of the reciprocating piston type.

Two stroke cycle internal combustion engines have been proposed hitherto comprising first and second cylinders in which respective first and second portions of a piston are reciprocable. Such pistons are known as "duplex pistons". An engine utilising a duplex piston arrangement is known from an article entitled "Top Hat Piston Cleans Up Two Stroke Power" appearing in "The Engineer" dated 6th September 1979. An object of the present invention is to provide an improved internal combustion engine of the duplex piston type.

According to one aspect of the invention there is provided a two stroke internal combustion engine including first and second cylinders in which respective first and second portions of a duplex piston are reciprocable, one only of said cylinders being a combustion cylinder, wherein the piston portions are co-axial and one piston portion lies partially within the other. Preferably the piston has a common crown and co-axial depending skirts. In a preferred embodiment the outer cylinder is the combustion cylinder.

In one embodiment of the invention the engine comprises inner and outer cylinders in which respective first and second portions of the duplex piston are reciprocable whereby movement of the piston in one axial direction will cause said first and second portions of the piston to transfer charges in respective first and second chambers of the engine to a combustion cylinder of the engine.

The charge in one said chamber may be an air/fuel mixture whilst the charge in the other chamber may be air.

Preferably, exhaust from the combustion chamber passes through an exhaust port which is uncovered by the piston in advance of ports leading from said first and second chambers during a power stroke of the engine. Preferably, a port leading from the chamber containing air opens shortly before a further port leading from the chamber containing the fuel and air mixture. In that way, a buffer volume of air is introduced between the outgoing exhaust gases and the incoming fresh charge of fuel and air from said other chamber. Such an arrangement reduces mixing and loss of fresh air/fuel mixture to exhaust thereby offering improved economy and power with less exhaust pollution from unburnt fuel.

According to another aspect of the invention, the first and second cylinders overlap in the axial direction, the overlap of the cylinders being around 90% of the piston stroke.

The inner portion of the piston is preferably spaced from the outer and a cylinder defining section of the engine may extend into the space to form a cylinder for the inner portion of the piston. An outer cylinder defining section of the engine is arranged spaced from the inner cylinder defining section to form a cylinder for the outer portion of the piston. In such a case, the outer portion of the piston preferably extends into a space between the outer and inner cylinder defining sections of the engine.

In a preferred embodiment the inner cylinder is defined by the crankcase and the outer cylinder is defined by the cylinder head.

The inner cylinder section also defines at least part of a first chamber for receiving a charge which is transferred to the combustion cylinder during use. The space between the inner and outer cylinder defining sections may define a second chamber for receiving a charge which is transferred to the combustion cylinder during use.

The first chamber may include part of the crank case of the engine into which may be drawn a charge comprising the aforesaid air/fuel mixture; a charge of air may be drawn into the second chamber during use.

The inner cylinder defining section may include an opening therein which communicates with one or more transfer passages in the engine for transferring the charge from the first chamber to the combustion cylinder.

In a preferred embodiment, the upward movement of the piston will create suction in both chambers the suction in the chambers being different, preferably the suction in the second chamber and also its compression ratio will be higher than the first chamber.

Non-return valve means may be provided in an inlet for air/fuel mixture and preferably in a further inlet for air. Such valve means may be of the reed-valve type.

The use of overlapping cylinders and the use of pistons arranged one within the other enables the engine to be made shorter in the direction of the cylinder axis. This is advantageous over the engines shown in the aforesaid "Engineer" article.

The engine may include a plurality of pistons arranged in respective cylinders.

According to a further aspect of the invention there is provided an internal combustion engine comprising first and second cylinders in which respective first and second portions of a duplex piston are reciprocable, the engine including a combustion chamber having therein respective ports through which exhaust gas passes and through which first and second incoming charges, at least one of which comprises a mixture of air and fuel, can enter the combustion chamber as a result of movement of the piston in said cylinders.

During movement of the piston axially away from the top dead centre position, the exhaust is preferably opened before the other ports. The next port to open is preferably the port through which the charge of air is delivered. The port through which air is delivered is preferably uncovered slightly before the port through which the charge of air/fuel mixture is delivered.

In another embodiment of the invention the air/fuel charge and the air charge are drawn sequentially into one of the chambers so that on transfer to the combustion cylinder, the air charge is released first followed by the air/fuel mixture. In this way the buffer of air helps to scavenge the combustion cylinder of exhaust gases and prevents unburnt fuel from passing to exhaust. A single transfer passage or set of passages connects the charge chamber to the combustion cylinder and a plurality of transfer ports may be provided; no air ports are necessary in this embodiment.

Preferably the space between the first and second piston portions is connected to the source of air/fuel mixture and the transfer passage is connected to a source of air.

In this arrangement the exhaust port opens slightly before the transfer ports as before.

The invention also encompasses a duplex piston for a two stroke internal combustion engine in which the piston has reciprocable first and second portions, the portions being co-axial and lying partially one within the other. Preferably the piston has a common crown and co-axial depending skirts.

Two embodiments of an internal combustion engine in accordance with the invention will now be described by way of example only with reference to the accompanying drawings in which:-

Fig.1 is a vertical cross-section through an internal combustion engine on the line A-A in Fig.3,

Fig.2 is a vertical cross-section through the engine of Fig.1 on the line B-B in Fig.3,

Fig.3 is a horizontal cross-section of the internal combustion engine of Fig.1 on the line C-C in Fig.1.

Fig.4 is a vertical cross section through a second embodiment of the invention and corresponding to Fig 2, and

Fig.5 is a vertical cross section through the engine of Fig.4 and corresponding to Fig.1.

With reference to Figs 1-3, the engine comprises a crankcase 10 rotatably supporting a crankshaft 12 in bearings 13. The crankshaft is sealed against the crankcase by means of oil seals 14.

The crankcase has an inlet 15 provided with a reed-valve 16. The inlet 15 is connected to a carburettor (not shown). The crankcase 10 is formed with an upstanding tubular section 17 having an inner bore defining a first cylinder 18. The crankcase is formed with a passage 19 which extends through the tubular section 17 to form an orifice 20 therein. The lower portion of tubular section 17 as viewed in the drawings is formed with a tapered lead-in 22. The upper outer edge of the tubular section 17 is formed with a chamfer 23.

The crankcase is formed with a cylindrical register surface 24 which spigotally locates a cylinder head 25. A seal between the cylinder head and crank case may be achieved by using a gasket between a base surface 26 on the crankcase and an adjacent surface 27 on the cylinder head 25. The cylinder head defines a second cylinder 28 which is co-axial with cylinder 18. It will be noted that the cylinder 28 and the cylinder 18 overlap axially by approximately 90% of piston stroke (the piston being described below). The cylinder head is formed with an inlet passage 29 for air. The inlet passage 29 is provided with a reed-valve 30 and communicates through passages 31 with two air inlet ports 32. The cylinder head is formed with passages 33 which at their upper end communicate with two transfer ports 34 for a mixture of fuel and air transferred from the crankcase. The passage 19 and passages 33 together form transfer passages indicated generally at 35. The cylinder head is formed with an exhaust outlet 36 leading from an exhaust port 37 in the cylinder 28. The usual spark plug 38 is provided and the cylinder head is formed with galleries 39 for cooling water. The cylinder head defines a combustion chamber 51. The crankshaft 12 has the big end of a connecting rod 40 mounted on its throw 42 through needle roller bearings 43. The little end of the connecting rod is rotatably connected to a gudgeon pin 44 through needle roller bearings 45. The gudgeon pin is mounted in bosses 46 formed on a first piston portion 47 of a duplex piston 48. The first portion 47 of the piston 48 fits slidably in the first cylinder 18 and is formed with a window 41 (Fig.2) which enables the interior of the crankcase 10 and the transfer passage 35 to communicate during reciprocation of the piston. The piston 48 also includes a second portion 49 which fits slidably within the second cylinder 28. It will be noted that the first portion 47 of the piston lies coaxially within the second portion 49 so as to define an annular chamber 50 therebetween which has a substantially toroidal upper end 52 as viewed in Figs.1 and 2.

The tubular section 17 of the crankcase extends into the annular space 50. The wall of second piston portion 49 is cut away as indicated at 54 so that the passages 31 can communicate with the annular space 50.

The second portion 49 of the piston 48 carries two piston rings 55, 56, the upper piston ring being of L-shaped cross-section as shown.

In use, and with the piston 48 at the bottom dead-centre position shown and with the crankshaft rotating clockwise as viewed in Fig.1, upward movement of the piston 48 causes a charge comprising a mixture of fuel and air to be drawn past reed-valve 16 into the crank case 10 which together with the interior of first piston portion 47 defines a charge receiving first chamber 10a; and also causes air to be drawn past reed-valve 30 into the annular and second chamber 50 via passages 31. The expansion ratio of the second chamber 50 is preferably greater than that of the first chamber 10A. As the piston moves past top dead centre and descends, the crown of the piston will initially uncover exhaust port 37 followed by inlet port 32. The descending piston causes the air in annular chamber 50 to pass to the inlets 32 via passages 31 and into the combustion chamber 51. Continued downward movement of the piston then uncovers transfer ports 34 through which air and fuel mixture passes from the transfer passages 35. The combustion chamber 51 is, therefore, occupied by air from inlets 32 and an air/fuel mixture from inlets 34. The piston then passes the bottom dead centre position and begins to move upwardly eventually covering ports 32, 34 and exhaust port 37. The charge in the combustion chamber is compressed as the piston moves towards its top dead centre position and slightly in advance of top dead centre the spark plug 38 produces spark to ignite the mixture. The piston passes top dead centre and is forced downwardly by the expanding gases. As the piston begins to uncover exhaust port 37, exhaust gases pass into the exhaust outlet 36. Incoming air again passes through inlets 32 due to the descending piston so as to begin scavenging the combustion chamber followed by introduction of the air/fuel mixture through transfer ports 34 to provide a fresh charge in the combustion chamber 51. The incoming air forms a buffer between the air/fuel mixture entering through transfer ports 34 and helps to provide a cleaner environment within the combustion chamber for subsequent combustion.

The amounts of air and air/fuel mixture entering the engine through the inlet passages 15 and 29 are controlled by the respective reed-valves 16 and 30.

By arranging the cylinders 18, 28 so that they overlap, the engine can be made shorter and more compact than the engine which is described in the aforementioned article in "The Engineer".

In an alternative arrangement the carburettor could feed air/fuel mixture to ports 29 whereas air alone would be drawn in through inlet 15; the ports 37,32,34 would be re-arranged to ensure the buffer of air between exhaust and unburnt mixture, and transfer ports 34 would be arranged to open slightly after inlet ports 32 during descent of the piston.

A second preferred embodiment is shown in Figs 4 and 5 which correspond to Figs 2 and 1 of the first embodiment. In the second embodiment the crankcase is not used for charge compression and the crankshaft and connecting rod assembly may therefore be lubricated under pressure according to normal four-stroke practice using dry or wet sump methods.

The second embodiment has an inlet tract 61 for the passage of air/fuel mixture from a carburettor (not shown), through a reed valve 62 to an inlet port 63. An exhaust port 64 opens into an exhaust tract 65 as before. Transfer passages 66 connect the toroidal second chamber 67 with transfer ports 68 opening into the cylinder bore. Also opening into passages 66 are air inlets 69 normally closed by reed valves 70. In operation, as the piston approaches top dead centre, the air/fuel mixture will be drawn into the second chamber 67. At the same time reed valves 70 will open to allow air to be drawn into the transfer passages 66. Mixture drawn in the previous cycle will be compressed and ignited forcing the piston downward to compress the mixture in the second chamber 67 and thereby compress the air in the transfer passages 66, the reed valves being automatically closed. As the piston continues toward bottom dead centre the exhaust port 64 will be uncovered followed by the transfer ports 68. The air in transfer passages 66 is pumped into the combustion chamber followed by the air/fuel mixture, the sequential release ensuring that the air acts as a buffer between outgoing exhaust and incoming mixture. The piston then returns to top dead centre, compressing the fresh charge and drawing air/fuel mixture into second chamber 67 and air into transfer passages 66 as before.

Oil may be sprayed on the walls of the inner piston bore to give lubrication and cooling; oil control rings 71 may be fitted to the skirt of the inner piston portion 72 to wipe off any excess.

Furthermore, if the skirt length of outer piston portion 73 is designed to allow exhaust gas recirculation, the rings 71 will help keep exhaust gases and combustion productions out of the crankcase and sump. Any exhaust gases which pass the rings 74 of the working piston 73 will recirculate with the next fresh charge and therefore not contaminate oil in the crankcase/ sump.

Whilst the engine described is suitable for a air/petrol mixture, it could of course be adapted to run on diesel fuel, propane gas or any other suitable fuel with appropriate changes to the detail design. For example a diesel version would require a strengthened construction, no spark plug, arrangements for direct or indirect injection and perhaps revised porting; the basic design would however remain unchanged.

Although a single-cylinder engine has been described, the invention could be applied to a multi-cylinder engine of in line, horizontal-opposed or other type. Other variations will be apparent to engineers skilled in the art and the foregoing examples are to be considered non-limiting within the scope of the Claims appended hereto.

Claims

1. A two-stroke internal combustion engine including a first and second cylinder (18,28) in which respective first and second portions (47,49) of a duplex piston (48) are reciprocable one only of said cylinders being a combustion cylinder characterised in that the piston portions (47,49) are co-axial and one piston portion lies partially within the other.

2. An engine according to Claim 1 characterised in that the piston has a common crown and co-axial depending skirts reciprocable in corresponding co-axial cylinders.

3. An engine according to Claim 2 characterised in that the outer cylinder (28) is the combustion cylinder.

4. An engine according to any preceding Claim characterised in that movement of said piston (48) in one direction causes said first and second piston portions (47,49) to transfer charges from respective first and second chambers to the combustion cylinder.

5. An engine according to Claim 4 characterised in that means are provided to connect said first chamber to a source of air/fuel mixture and to connect said second chamber to a source of air.

6. An engine according to Claim 5 characterised in that non-return valves (16,30) are provided in respective inlet tracts (15,29) for air/fuel mixture and air.

7. An engine according to any of Claims 4 to 6 characterised in that said first chamber includes

the crankcase 10 and said second chamber includes the annular space (50,52) between said piston portions (47,49).

8. An engine according to Claim 7 characterised in that a transfer passage 35 is provided from said crankcase (10) to a transfer port (34) of the combustion cylinder, and an air passage (31) is provided from said annular space (50,52) to an air port (32) of the combustion cylinder, said combustion cylinder also having an exhaust port (37), the air port (32) being between the exhaust port (37) and transfer port (34).

9. An engine according to Claim 8 characterised in that the exhaust port (37) is uncovered in advance of said air port (32) and transfer port (34).

10. An engine according to Claim 9 characterised in that said air port (32) is uncovered in advance of said transfer port (34).

11. An engine according to any of Claims 8 to 10 characterised in that more than one air port (32) and more than one transfer port (34) are provided.

12. An engine according to any preceding Claim characterised in that the combustion cylinder is defined by the cylinder head (25) and the other cylinder is defined by the crankcase (10).

13. An engine according to any of Claims 4 to 12 characterised in that the respective expansion ratios of the first and second chambers are different.

14. An engine according to any of Claims 1 to 3 characterised in that movement of said piston in one direction causes one of said piston portions (73) to transfer charge from a charge chamber to the combustion cylinder.

15. An engine according to Claim 14 characterised in that said charge chamber includes the annular space 67 between said piston portions and a transfer passage (66) from said annular space to said combustion cylinder.

16. An engine according to Claim 15 characterised in that means are provided to connect said annular space (67) to a source of air/fuel mixture and to connect said transfer passage (66) to a source of air.

17. An engine according to Claim 16 characterised in that non-return valves (70) are provided in inlet tracts (61,69) for air and air/fuel mixture.

18. A piston for an engine according to any preceding Claim.

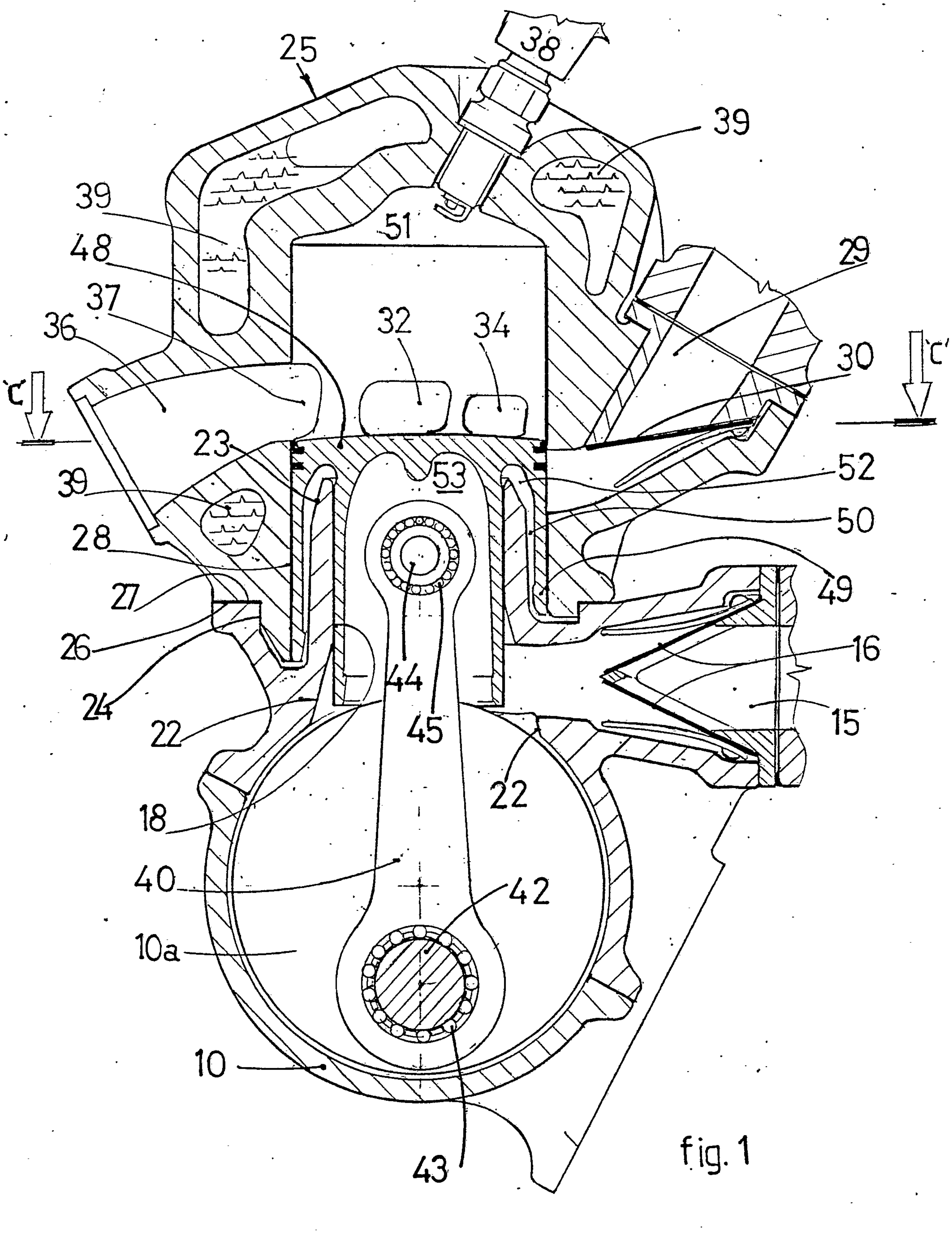

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fig. 1

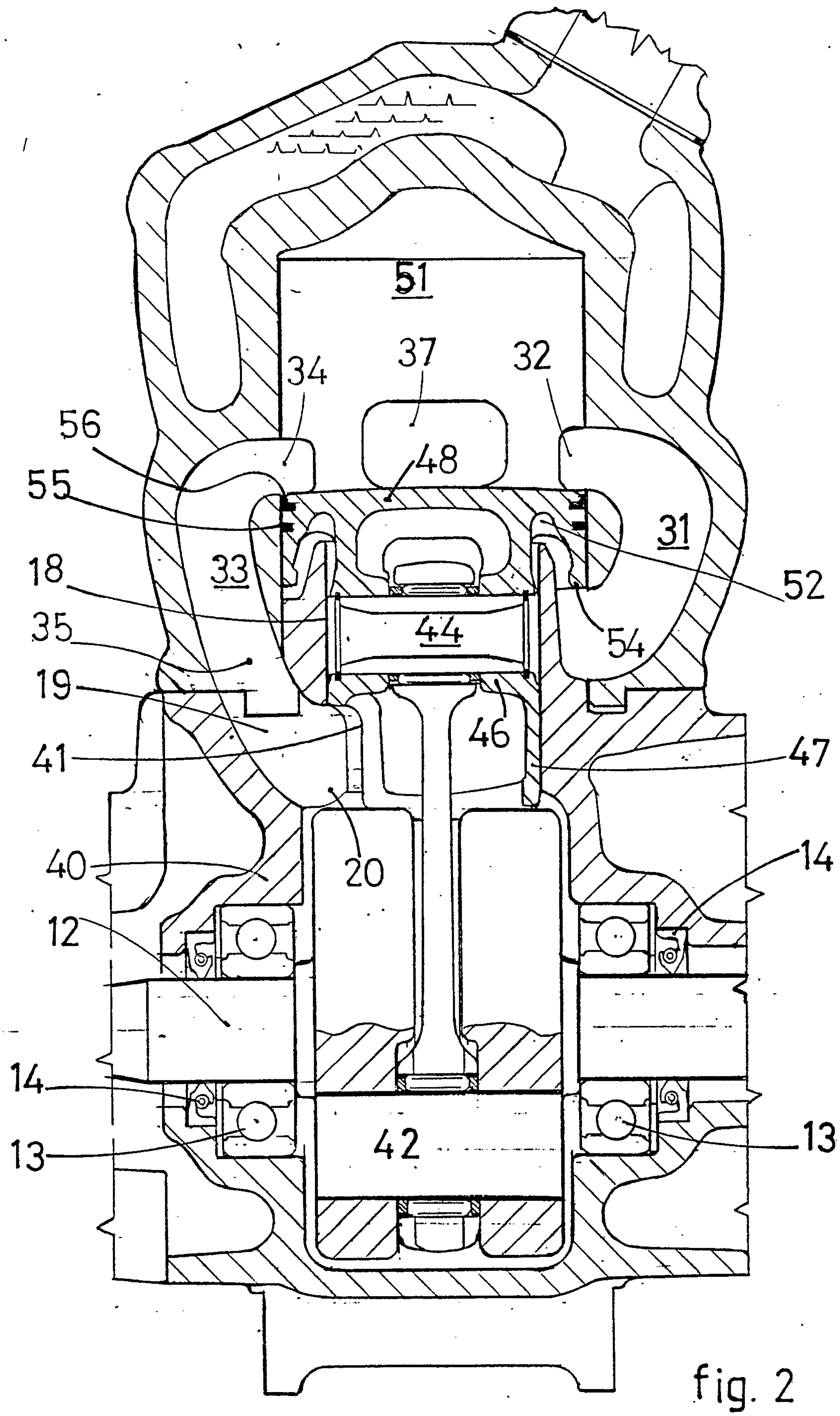
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fig. 2

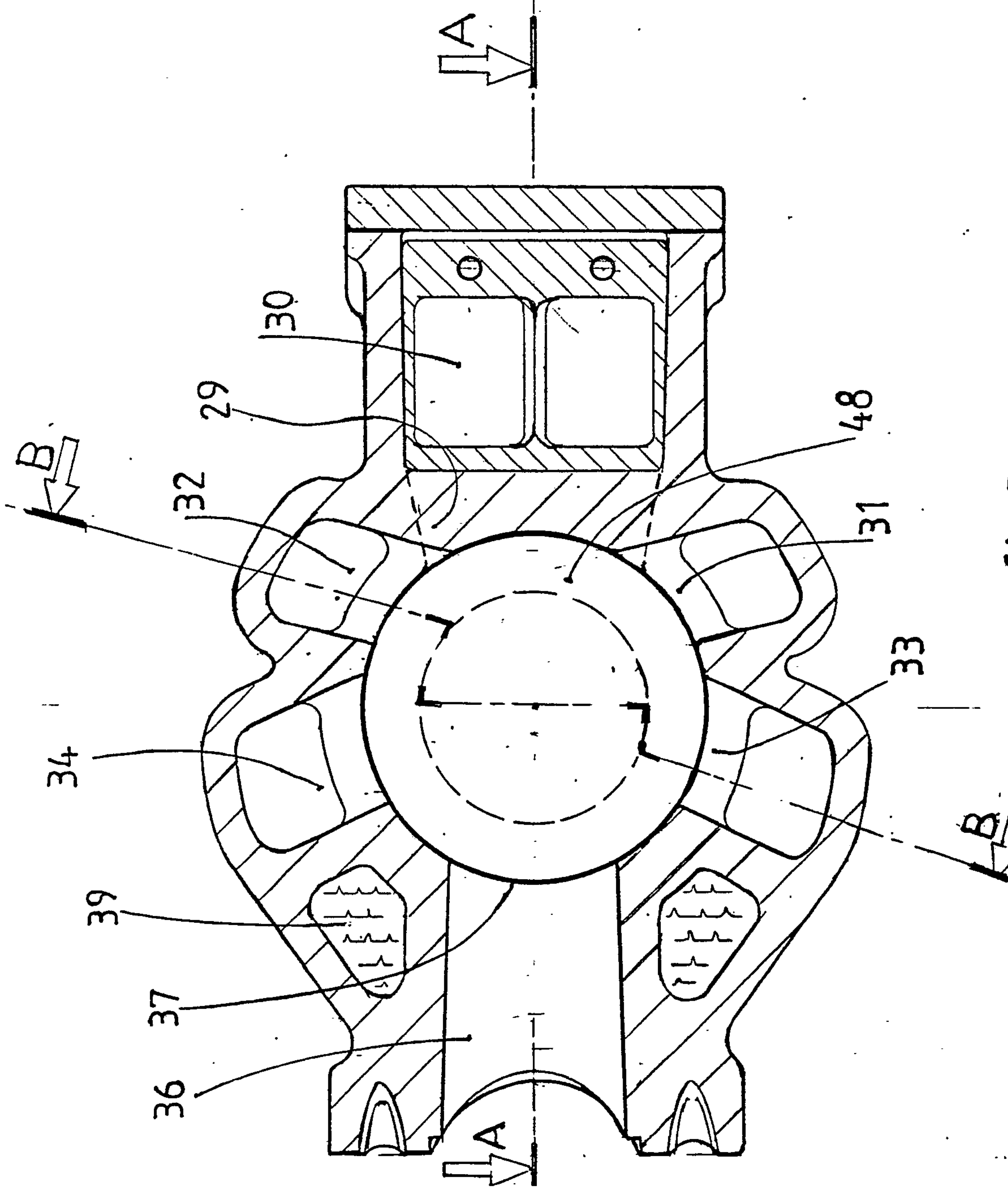

fig. 3

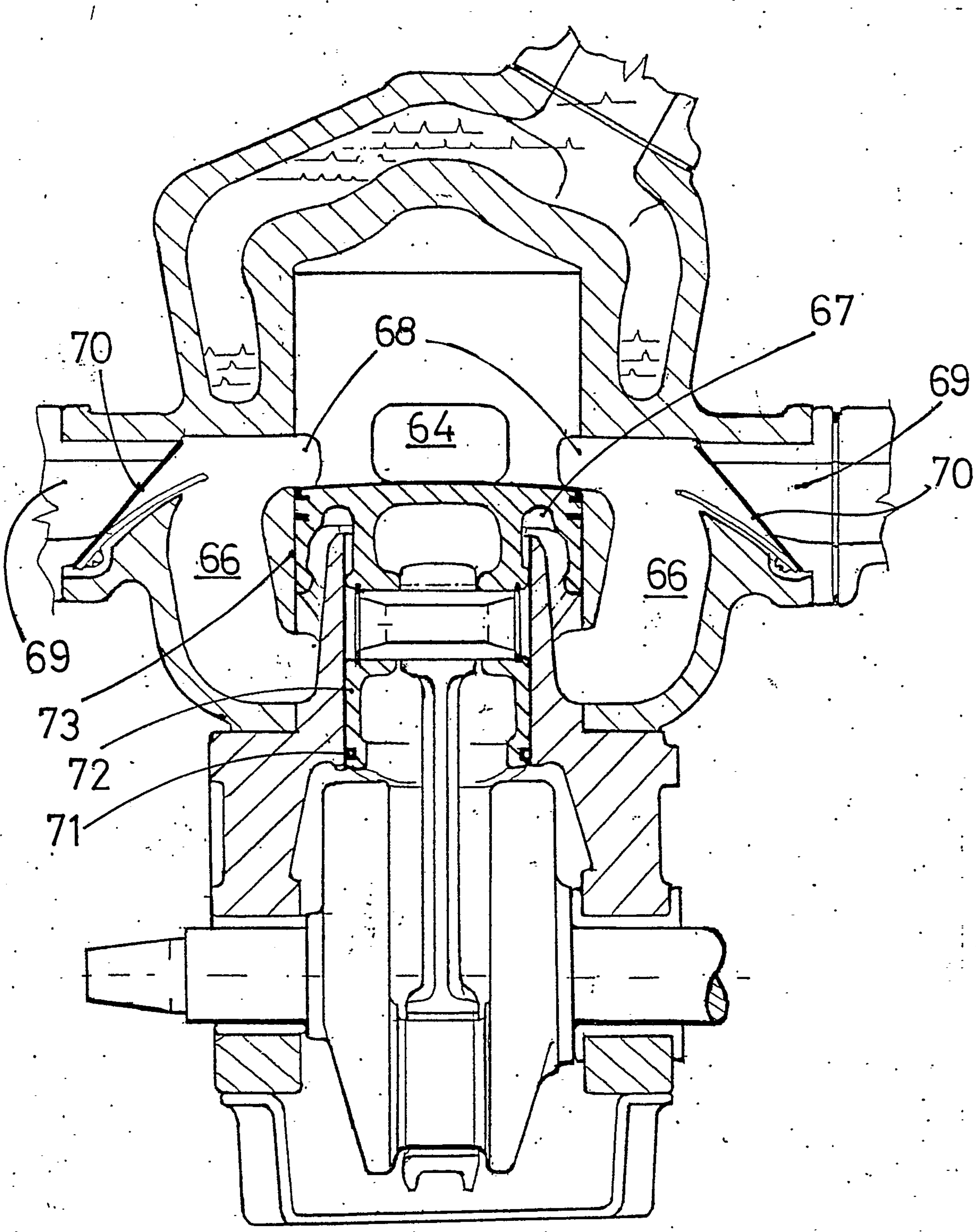

fig. 4.

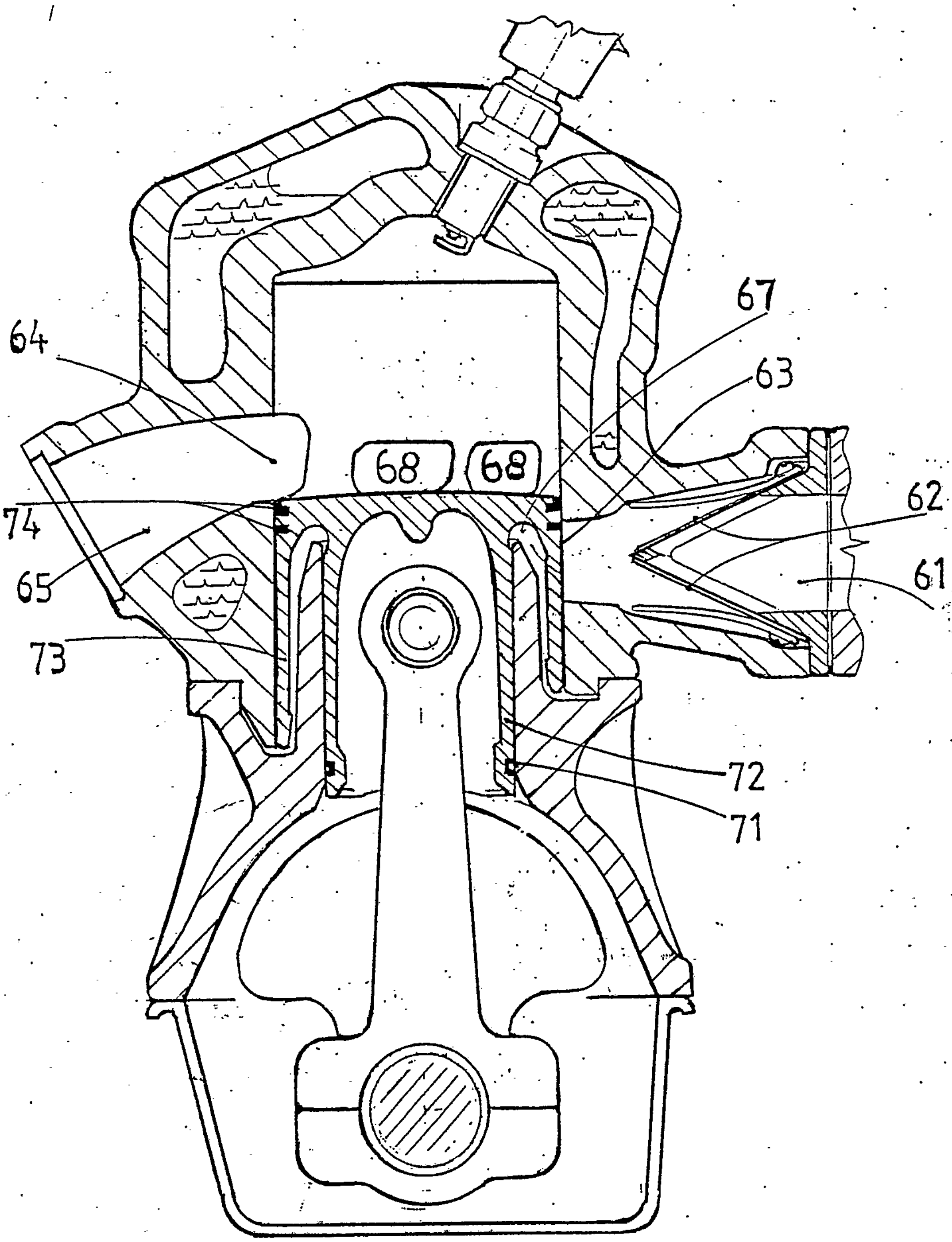

fig. 5