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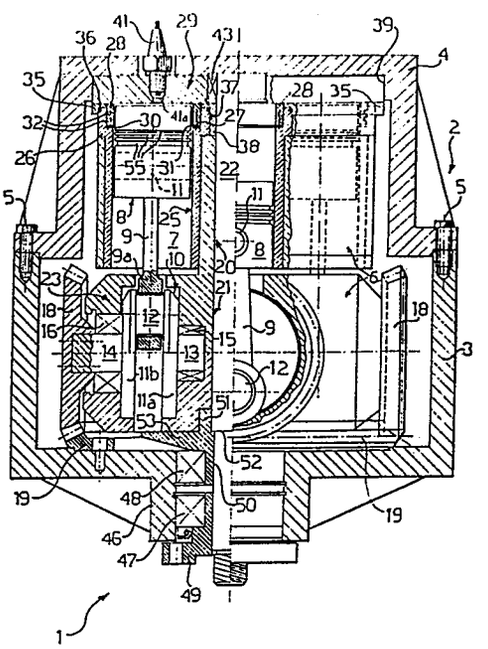
(54) A reciprocating engine with revolving cylinders.

(57) In a reciprocating engine, a drum member is carried rotatably within a case; arranged in the drum at regular intervals are a plurality of cylinder/piston assemblies and corresponding connecting rod/crankshaft throw assemblies. A gear wheel is affixed to the case and is mesh engaged for a rolling mevement by gear wheels keyed to each crankshaft throw, according to the invention, the engine includes a cylinder head rigid with the case and relatively whereto the drum member is rotatable, seal means interposed to the cylinder head and cylinders, and fuel intake and exhaust means affixed to the cylinder head and serving sequentially the cylinders.



EP 0 164 317 A1

A RECIPROCATING ENGINE WITH REVOLVING CYLINDERS

This invention relates to a reciprocating engine with revolving cylinders of the type comprising an engine case, a drum member supported rotatably within the engine case, a plurality of cylinder/piston assemblies and a corresponding plurality of connecting rod/crankshaft throw assemblies, arraged at regular intervals in the said drum member, a gear wheel keyed to each crankshaft throw and meshing with a ring gear in rolling relationship therewith, said ring gear being affixed to the engine case.

Engines of the above type would benefit from a simplification and an improvement of the cylinder fuel intake/exhaust system, which is complicated by that, in operation, the cylinders revolve relatively to a stationary engine case.

UK Patent No. 140,537, for example, discloses an internal combustion engine which operates on a two-stroke cycle wherein the fuel charge to the cylinders is taken through a hollow central shaft branching off at its base toward appropriate intake ports, whilst the burned gases are exhausted directly to the atmosphere.

That engine, in fact, includes a plurality of cylinder/piston assemblies which are structurally independent of one another as regards their fuel intake, exhaust, and ignition arrangements, and are each closed at the top by a separate cylinder head accomodating a spark plug.

Due to its design, such an engine would hardly operate on some thermodynamic cycle other than the two-stroke cycle. Further, while its fuel intake

system may be unitised, that engine defies unitising of the exhaust and ignition systems.

The aim underlying this invention is that of obviating the above limitations by providing a reciprocating engine with revolving cylinders which can operate on any selected thermodynamic cycle, whether endo- or exothermal, and has unitised fuel intake, exhaust, and ignition (if any) systems which are left stationary while the cylinders are revolved.

This problem is solved by a reciprocating engine with revolving cylinders as indicated, and according to the characterising part of Claim 1.

Further features and advantages of the invention will become apparent from the following detailed description of a reciprocating engine with revolving cylinders, given reference to the accompanying illustrative and not limitative drawings, in which:

Figure 1 is a fragmentary, axial section view showing diagramatically the reciprocating engine of this invention;

Figure 2 is a top plan view of the same engine showing diagramatically the arrangement of the intake and exhaust ports, and of the spark plug in the cylinder head;

Figure 3 is a top plan view showing the engine of this invention in ghost lines;

Figure 4 and 5 are cross-sectional views of the engine according to the invention illustrating the operation thereof and

Figure 6 to 8 show diagramatically an improved

embodiment of the engine according to the invention, as respectively depicted generally in Figure 6 with the engine case cut away, in detail and to an enlarged scale in the longitudinal section of Figure 7, and in a bottom plan view of the head in Figure 8.

With reference to the cited drawing figures, and in particular to Figure 1, a reciprocating engine according to the invention is generally designated with the reference numeral 1, and comprises an engine case 2 formed of first and second cups 3 and 4, respectively, which are held together by screws 5; mounted rotatably within the engine case 2 is a drum member 6 having a plurality of cylinder 7/piston 8 assemblies arranged therein and a corresponding plurality of connecting rod 9/crankshaft throw 10 assemblies each attached to a respective piston by means of a gudgeon pin 11.

The crankshaft throws 10 are identical to one another and consist of a pair of crank arms 11a and 11b, respectively, justapposed and interconnected by a crank pin 12 on which the big end 9a of the connecting rod 9 is journalled; the crank arms are respectively rigid with first and second crankshaft journals indicated at 13 and 14, respectively received rotatbly in first and second crankshaft bearings, indicated at 15 and 16.

At the remote end of the crankshaft journal 14 from the crank arm 11b there is keyed therteto a bevel gear 18 meshing in rolling relationship with a bevel ring gear 19 fast with the first cup 3.

The drum member comprises first and second portions

20 and 21, respectively, which are attached to each other and both keyed coaxially to a shaft 22.

The first portion 20 has a plurality of bores parallel to the shaft 22 wherein the cylinder liners are mounted, the second portion 21 being formed with a corresponding plurality of hollow lobes 23 wherein the throws 10 are housed.

Each of the cylinders 7 includes a liner 25 forming, at the remote end thereof to the corresponding throw 10, an annular ridge 26 which definesa seat 27 on the interior of the liner 25. In the seat 27 is housed an annular seal member 28 which is slidable in the axial direction of the liner 25 and which is in constant fretting contact with a cylinder head 29 for the cylinders 7 attached to the second cup 4.

The seal member 28 is spring biased against the head 29 by a spring 30 reacting on a shoulder 31 of the seat 27, and has a pair of grooves for sealing rings 32 for engagement with the seat 27 in gas-tight relationship.

On the outside, i.e. oppositely located with respect to the shoulder 31, the annular ridge 26 is made to bear on the portion 20 of the drum member.

Between the annular ridge 26 and the cylinder head 29 there intervenes, located on the cylinders 7, a plate-like element 35 which is perforated at the cylinder locations to allow for unrestricted sliding movement of the seal members 28. Element 35 is tightly fitted to the corresponding annular ridges 26 by means of seal rings 36. The plate-like element 35 is urged elastically

against the head 29 by a spring 37 encircling the shaft 22 and reacting against a spacer 38 coaxial with said shaft and bearing on the portion 20 of the drum member 6.

With reference to Figures 1 and 2, the head 29 is housed in a seat 39 on the cup 4 and has, suitably spaced apart along an annular path followed by the cylinders 7 revolving rigidly with the drum member, an intake port 40, a hole 41a for a spark plug 41, and an exhaust port 42, which are brought to overlie each cylinder sequentially during the revolving movement of the latter.

Centrally on the head 29, there is accomodated a bearing 43 supporting one end of the shaft 22, the other end thereof is supported on the first cup 3 of the case 2.

More specifically, formed on the first cup 3 is a collar 46 accomodating first and second bearings on its interior, as indicated respectively at 47 and 48, the first bearing supporting the shaft 22 through an intervening flange 49 keyed to the shaft 22 and constituting a power take-off for the engine according to the invention, and the second bearing supporting the same shaft 22 and through a flanged sleeve 50 which is keyed to the shaft 22 and whereto the drum 6 abuts and is locked axially.

More precisely, the sleeve 50 has an annular ridge 51 extending coaxial with the shaft 22 and abutting against a shoulder 52 on the latter and an annular flange 53 extending radially at an intermediate

position on the sleeve 50.

With reference to Figures 3 to 5, the operation of the engine according to the invention will be now described; this is a four-cylinder engine wherein the cylinders are offset in diametrically opposed pairs on the drum member 6 such that whenever two of the pistons 11 are at their TDC, the other two pistons are at their BDC.

The structure just described enables, in the engine according to the invention, the use of a single intake port 40, single exhaust port 42, and single spark plug hole in the head 29 to sequentially serve each of the cylinders 7 as the latter revolve with respect to the head 29.

More precisely, at each upward or downward stroke of the piston 8, the journals 13, 14 are caused to turn in their bearings 15, 16 and so is the gear 18 meshing with the ring gear 19. The gears 18, therefore, will roll around the ring gear 19 and entrain the drum member 6 rotatively; during that rotation relatively to the case 2, and hence, to the head 29, the cylinders 7 are sealed in a gas-tight fashion by the sealing members 28 as biased by the spring 30 against the head 29 in fretting contact therewith.

It should be noted that the axial length of the sealing member 28 is such as not to interfere with piston rings present in piston ring grooves 55 in the piston 8.

Any gas leakage past the seat 27 and sealing member 28 is prevented by the seal rings 32, and any

seepage of compressed gas past the head 29 and sealing member 28 would be prevented by the ring 36 and plate-like element 35 spring biased against the cylinder head 29.

On one of the pistons 8 reaching the intake port 40, a downward stroke begins in the corresponding cylinder 7 to take in a charge of fuel mix; the cited piston and the symmetrically opposed one are, therefore, arranged in the condition shown in Figure 5, i.e. at their BDC.

As rotation continues, the piston arranges itself in the compression stroke due to the mesh engagement of the ring gear 19 with the gear 18 which drives rotatively the throw 10, until it reaches the TDC, as shown in Figure 4, when it underlies the hole 41a wherethrough the spark plug 41 will ignite the compressed mixture.

As the relative rotation between the cylinders 7 and head 29 continues, the same piston moves down toward the BDC owing to the combustion which took place in its cylinder until it reaches the port 42 where it exhausts the now expanded combustion gases, to move back up toward the TDC.

The engine illustrated in the preceding description lends itself advantageously to automatic adjustement of the compression ratio in the cylinders both statically and while in operation.

Particularly in Figures 6 to 8, there is shown diagramatically an internal combustion engine featuring continuous adjustement of the compression ratio accor-

ding to the compression pressure in the cylinders.

That engine is referenced, for like details, with the same numerals previously used. It is generally indicated at 70 and comprises once again an engine case 2 wherein a drum member 6 is carried rotatably with cylinder 7-piston 8 assemblies and respective connecting rod 9 and throw 10 assemblies.

Differently from the previous engine 1, the first and second cups making up the case 2, as respectively indicated at 71 and 72, are guided slidably the one over the other. The cup 72 receives the cup 71 slidably and is provided with a perforated peripheral flange 73 wherein enlarged shank screws 74 are engaged slidably. The screws 74 are affixed to a counter-flange 75 on the cup 71.

Provided between the flange 73 and counter-flange 75is an elastic means comprised of coil springs 76 coaxial with the screws 74 and tending to keep one cup apart from the other.

The compression ratio change in the cylinders is brought about by changing the position of the head 29 relatively to the cylinders 7, as obtainable thanks to the particular configuration of the engine 70 according to the invention and to the mobility of the elements 28 in the seat 27 and of the plate-like element 35, for whose details reference can be made to the preceding description.

In the engine 70, the means for changing the relative position between the head 29 and cylinders 7 comprise a linear actuator, generally indicated at 77,

which is active between the head 29 and, through the shaft 78, the drum member 6.

The actuator 77 comprises a fluid-operated cylinder 80 of annular configuration, coaxially encircling one end 79 of the shaft 78 which protrudes through the cup 72 outward of the engine 70. The cylinder 80 is provided with a piston 84 and is active between the cup 72 and a shoulder formed of a nut 82 threaded onto the end 79 of the shaft 78; between the piston 84 and shoulder 81, there is interposed a thrust bearing 83.

The entire assembly 77 is then protected by a cap 86 attached to the cup 72.

The fluid-operated cylinder 80 is in fluid communication with valving means, more particularly a distributor of fluid under pressure of a conventional design, generally indicated at 87.

From the distributor 87 are extended a drain conduit 88 leading to a reservoir 89 and a delivery conduit 90 for fluid under pressure on which there is provided a pump 91 drawing from the reservoir 89.

The valving means 87 are driven through a control unit 92 connected to a pressure transducer 93.

With reference to Figure 8, the pressure transducer 93 is positioned as follows: indicated at 100 being the path travelled by the centers of the revolving cylinders 7 relatively to the head 29, which path is schematically shown by a dash line, the pressure transducer 93 is affixed to the head with a read hole 94 open to the interior of the engine 70 in an area crossed by the path of the cylinders 7; the hole 94 is proximate the hole

41a but spaced apart from it such that a cylinder moving along the path 100 cannot simultaneously affect both the transducer 93 and spark plug 41.

Advantageously, the transducer 93 is positioned, relatively to the spark plug 41 such that when one cylinder 7 is in tangent contact to enter the hole for the spark plug 41, the cylinder itself is in tangent contact to exit the read hole 94 of the transducer 93.

Thus, the transducer 93 is never affected by the cylinders 7 on the mix drawn into them being ignited by the spark plug 41.

The engine 70 operates as follows: the transducer 93 reads through the hole 94 the compression pressure in the cylinders 7 as the latter move past below it and sends a corresponding signal to the control unit 92. The control unit 92 compares the oncoming signal to a preset reference value, e.g. one which optimizes the thermal output of the engine 70; if that signal is below the reference value, it acts on the valving means 87 to hydraulically communicate the cylinder 80 with the conduit 90 for the fluid under pressure. The fluid under pressure, on reaching the cylinder 80, activate the latter to operate, thus producing a thrust action between the head 29 and shaft 78 with consequent approaching of the head to the drum 6 and increase of the compression ratio in the cylinders.

If the value of the signal detected by the transducer 93 is above the reference value preset in the control unit 92, then the valving means 87 are commanded to move into fluid communication the drain conduit 88

with the cylinder 80 to allow retraction of the piston 84 thereof and, hence, removal of the head 29 from the drum 6 to decrease the compression ratio in the cylinders.

This is specially advantageous before the link between the thermal output of the engine and its compression ratio, as well as between the latter and the volumetric fill of the cylinders.

The volumetric fill of the cylinders is modulated by a throttle valve or the like known means for varying the throat of a carburator placed at the intake port.

By varying the magnitude of that throat one obtains, with conventional engines, a proportional variation in their thermal output. The engine of this invention advantageously allows manipulation of the compression ratio in the cylinders to achieve an optimum thermal output for each volumetric fill value of the same.

Among the many advantages of the reciprocating engine according to the invention it is to be further pointed out that, thanks to the provision of a single spark plug serving several cylinders, the need for a distributor is eliminated. The same spark plug, controlled through standard breaker points, provides in fact, through one complete revolution of the engine, a number of ingitions equal to the number of the cylinders.

The same applies to the engine exhaust and fuel intake in that they serve each cylinder in succesion as if they belonged exclusively to them.

CLAIMS

1. A reciprocating engine with revolving cylinders comprising an engine case (2), a drum member (6) supported rotatably within the engine case (2), a plurality of cylinder (7)/piston (8) assemblies and a corresponding plurality of connecting rod (9)/crankshaft throw (10) assemblies arranged at regular intervals in the said drum member (6), a gear wheel (18) keyed to each crankshaft throw (10) and meshing with a ring gear (19) in rolling relationship therewith, said ring gear 19 being affixed to the engine case, and characterised in that it comprises a cylinder head (29) bearing on the cylinders (7) and rigid with the engine case (2) , seal means (27, 28, 35) between said head (29) and said cylinders (7), and intake and exhaust means (40, 42) affixed to said cylinder head (29) and serving sequentially said cylinders (7).

2. An engine according to Claim 1, characterised in that said seal means comprise, in each of said cylinders (7), a seat (27) confronting said cylinder head (29) wherein an annular sealing member (28) is slidable in constant fretting contact with said cylinder head (29).

3. An engine according to Claim 1, characterised in that said seal means comprise a plate-like element (35) interposed between the cylinder head (29) and said drum member (6), perforated at and in tight sealed relationship with said cylinders (7), said plate-like element (35) being constantly biased into close contact

with said cylinder head (29).

4. An engine according to Claim 1, characterised in that said cylinder head (29) is adjustably positionable relatively to the cylinders (7) to vary the compression ratio of said cylinder (7)/piston (8) assemblies.

5. An engine according to Claim 1, characterised in that it comprises an hydraulic cylinder (80) active between said head (29) and the drum member (6), a delivery and a drain conduits (90, 88) for delivering to and draining from the said cylinder (80) a pressurized fluid, valve means (92) on the said conduits (90, 88), a pressure transducer (93) in the said head (29) for sensing the compression pressure in said cylinder/piston assemblies (7, 8) and a control unit (92) fed with a signal derived from said transducer 93 and driving the said valve means (87) to alternatively connect said hydraulic cylinder (80) to the drain or to the delivery conduits (90, 88).

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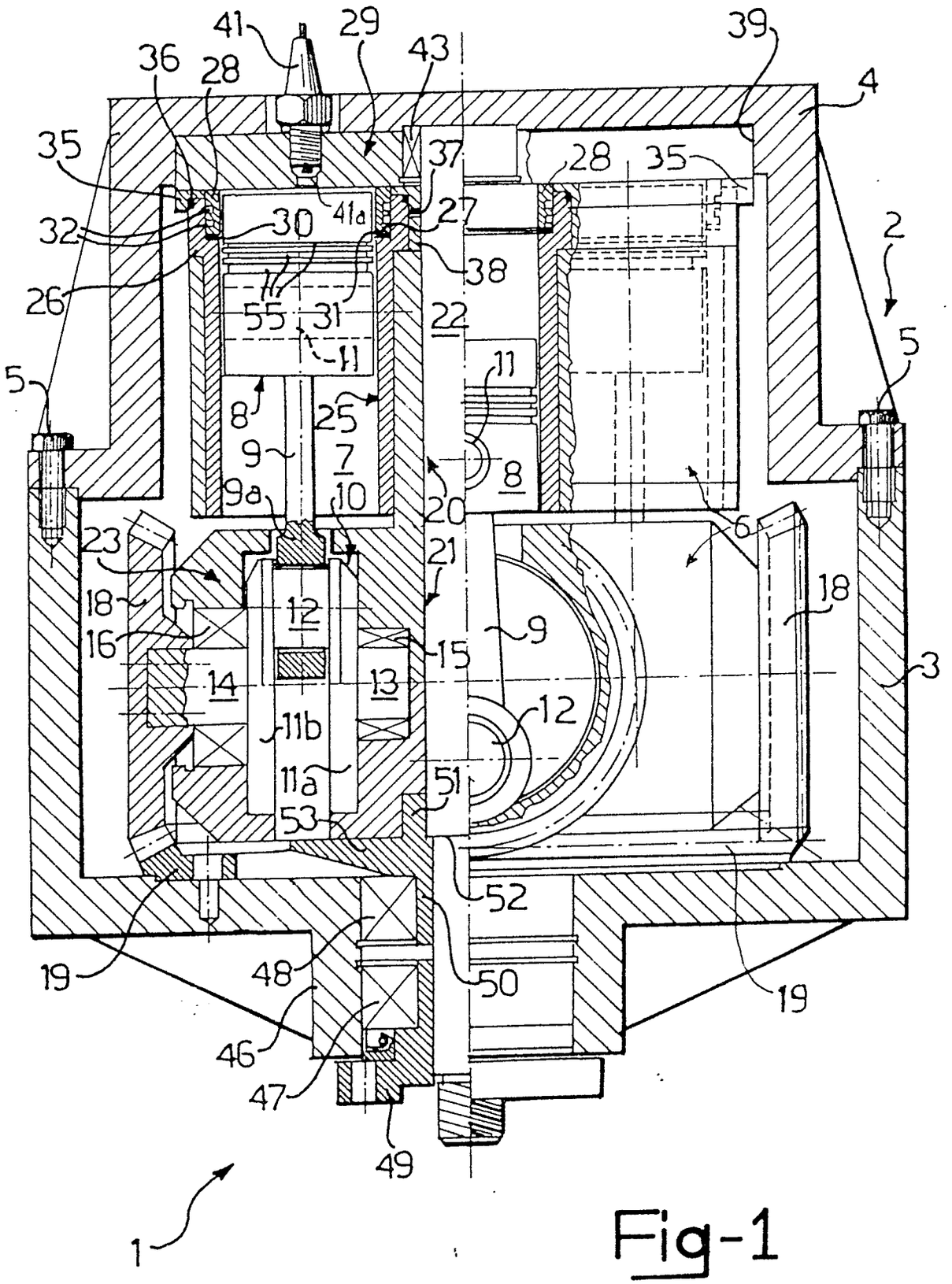

Fig-1

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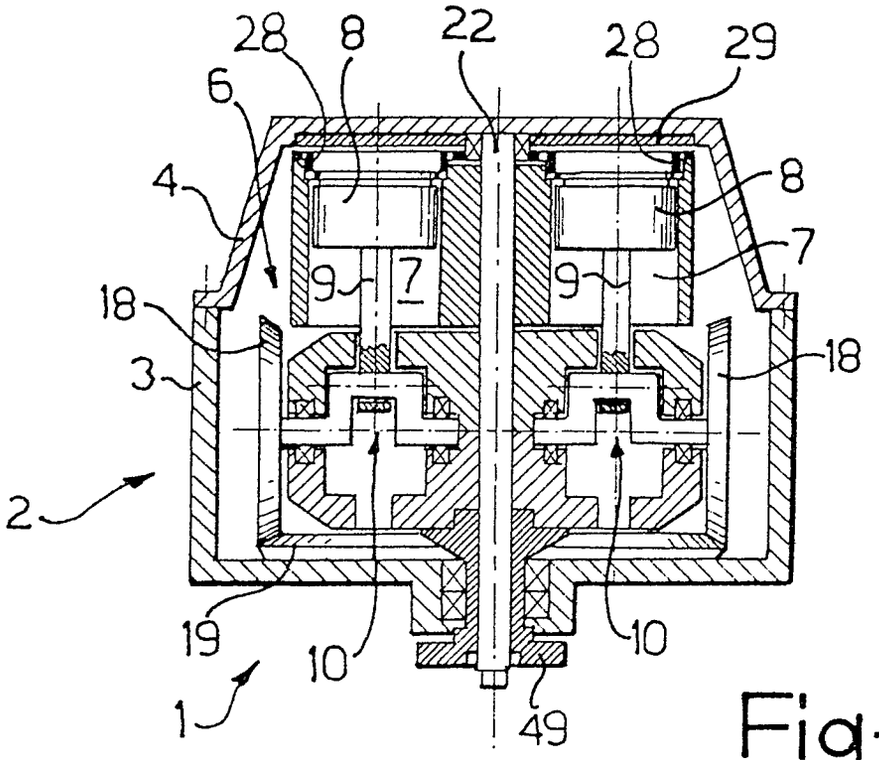

Fig-4

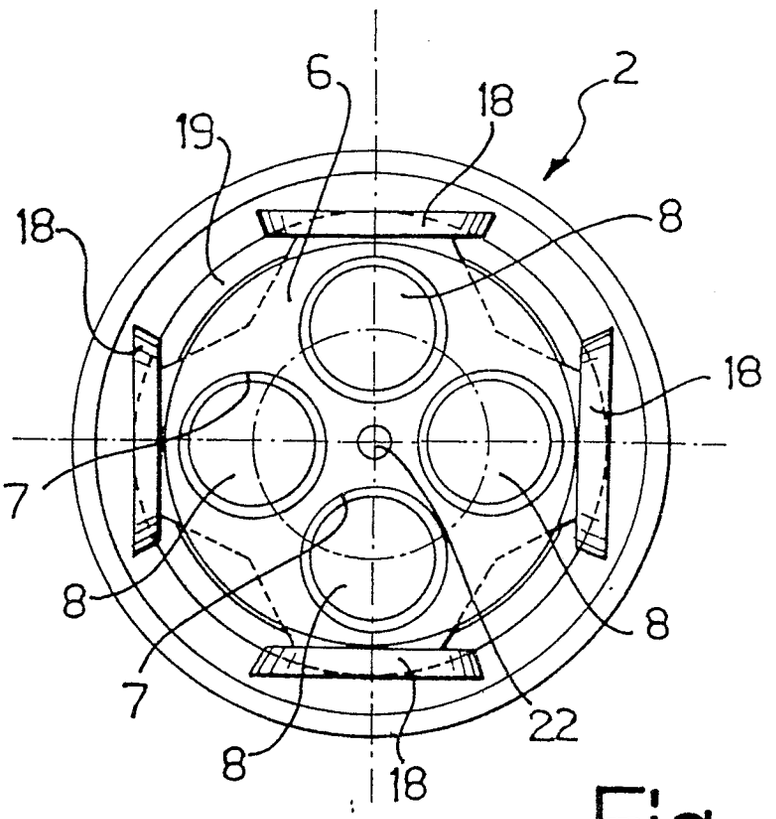

Fig-3

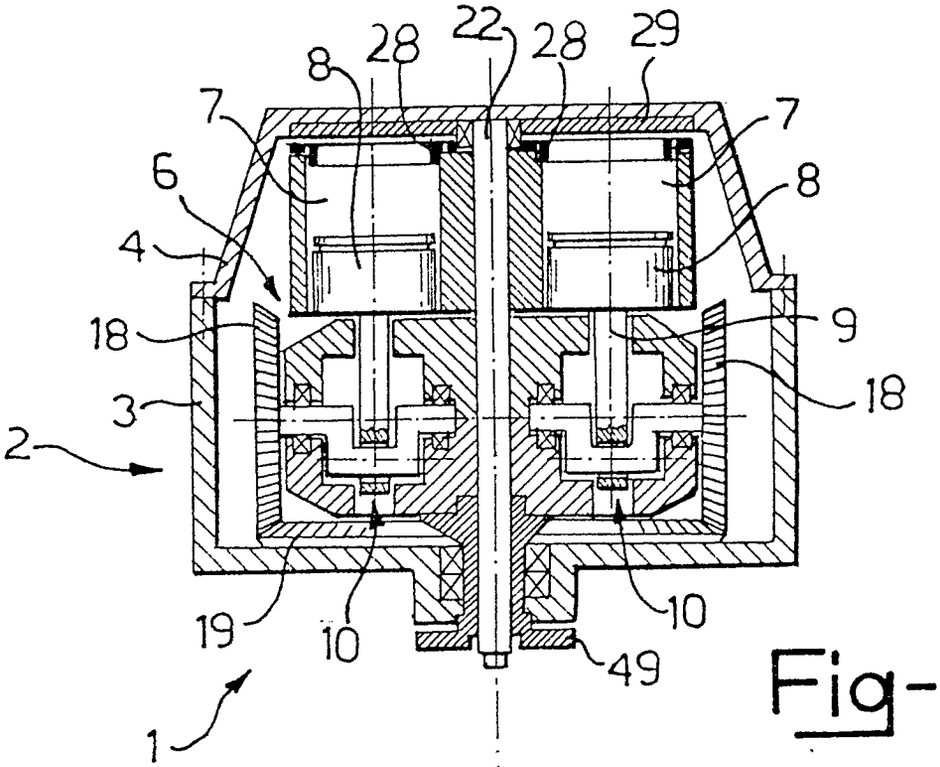

Fig-5

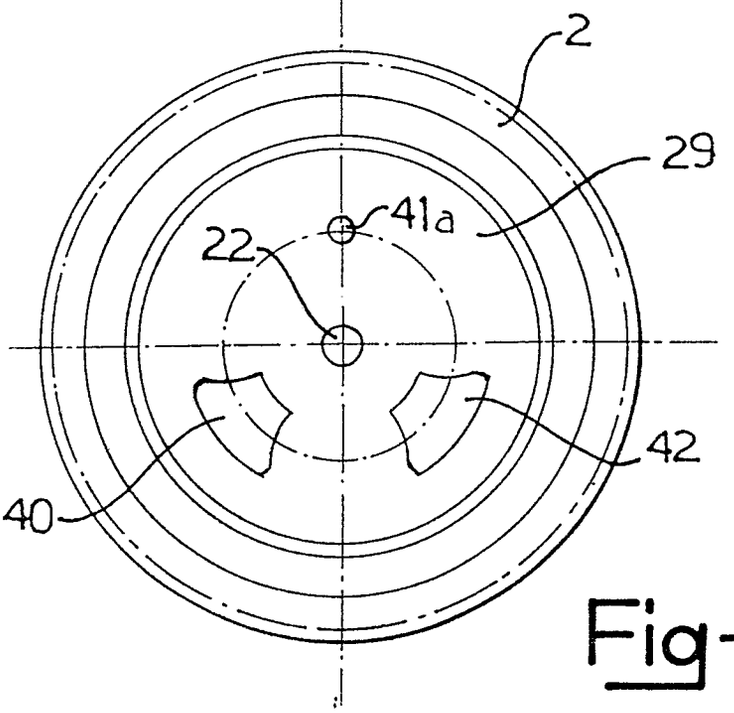

Fig-2

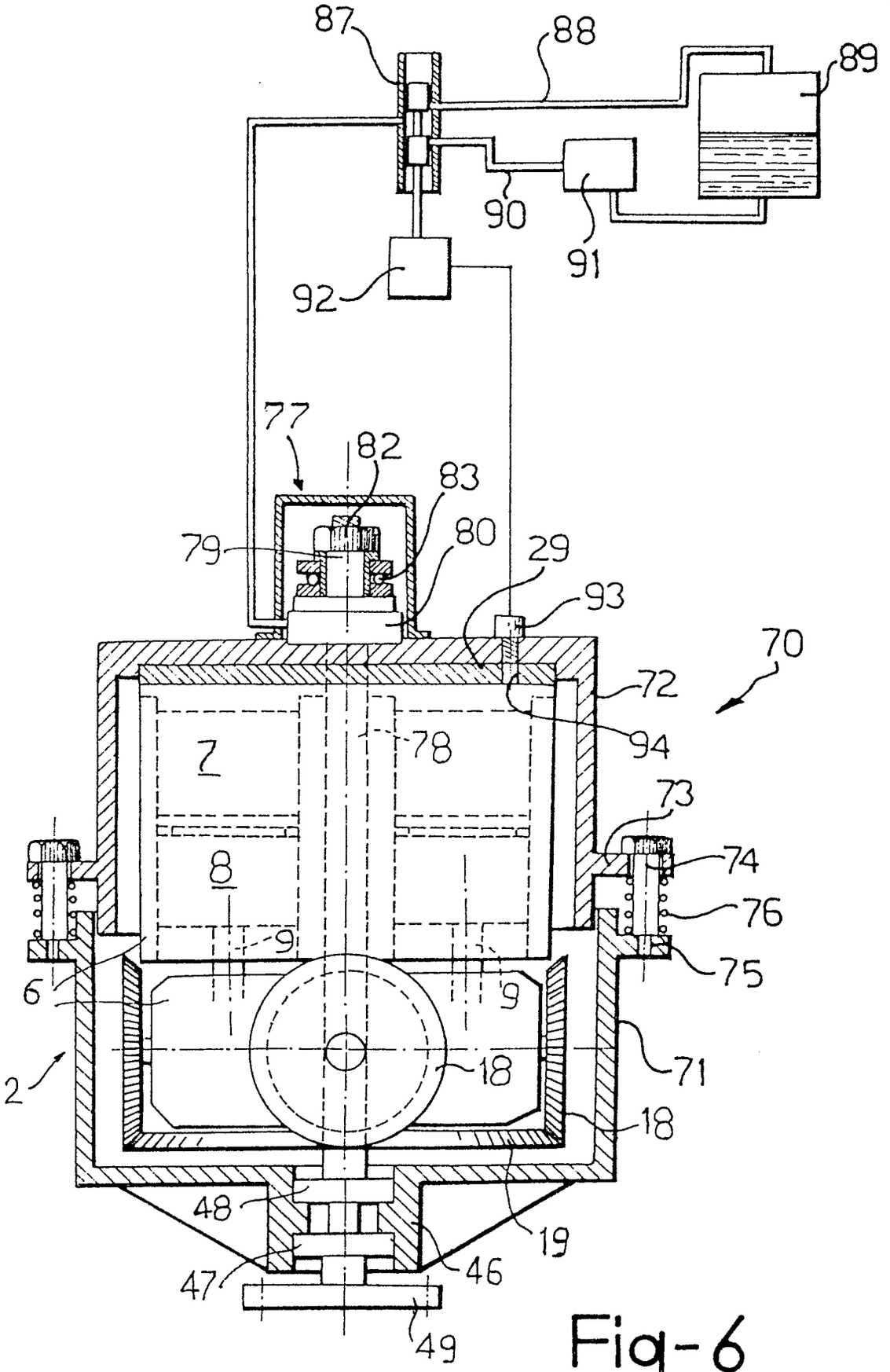
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Fig-6

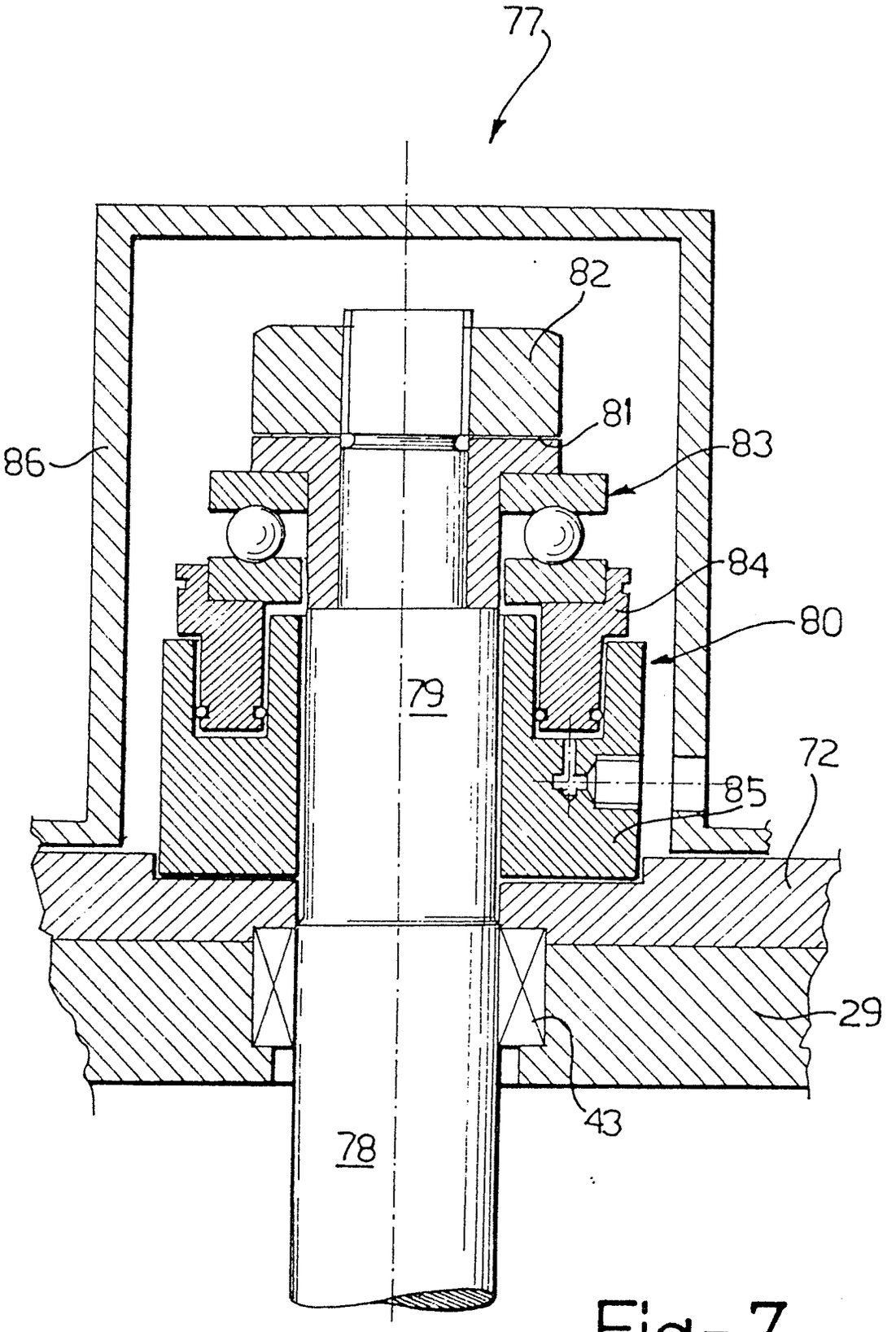

Fig-7

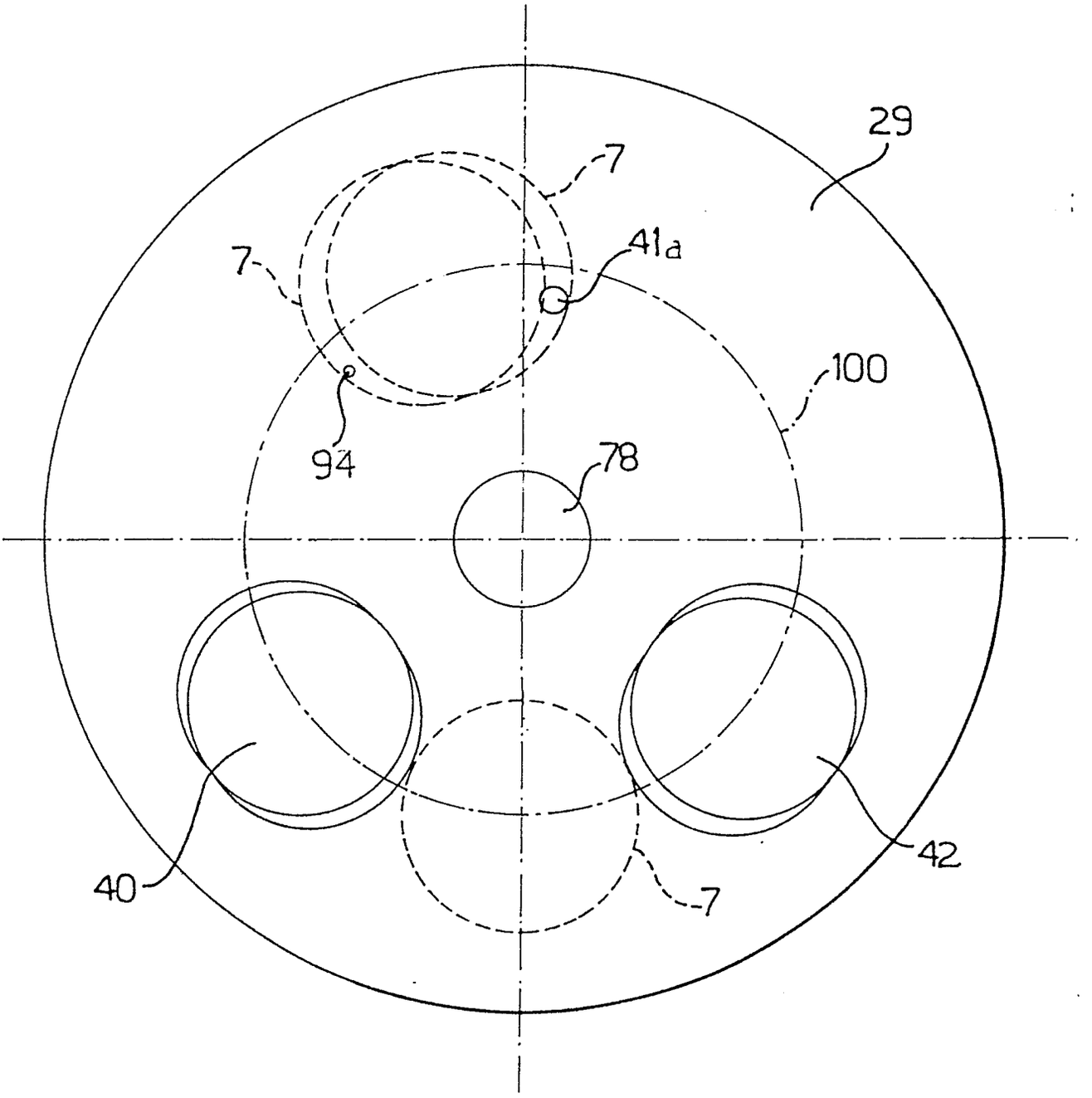

Fig-8

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EUROPEAN SEARCH REPORT

0164317
Application number

EP 85 83 0107

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
X	US-A-1 405 224 (KENMONTH) * Page 1, lines 1-104 *	1,2	F 02 B 75/32 F 01 B 3/00 F 02 B 75/04
A	GB-A-2 116 264 (BUGATTI) * Page 2, lines 6-93 *	1-3	
A	DE-C- 581 380 (WALKER) * Page 2, lines 1-111 *	4,5	

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

F 02 B
F 01 B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	14-08-1985	WASSENAAR G.

CATEGORY OF CITED DOCUMENTS

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