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(72) EFFORD, Clive William, GB
(71) EFFORD, Clive William, GB

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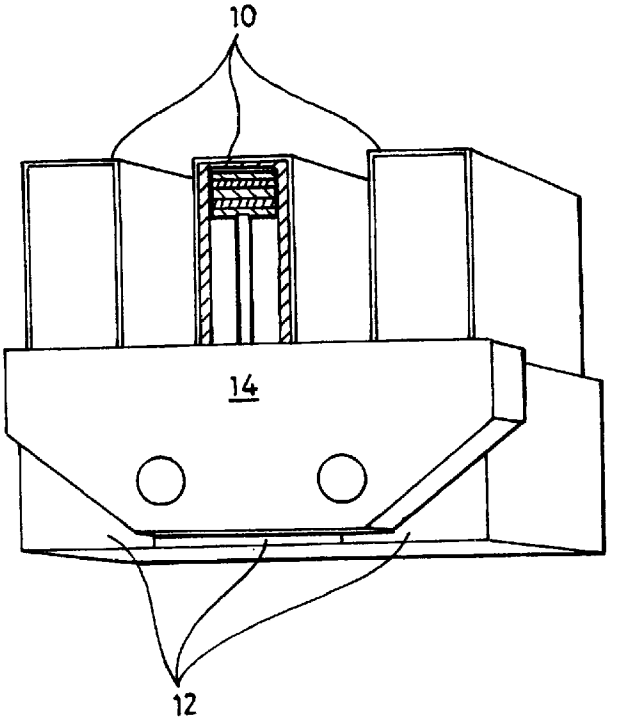
(54) **MOTEUR MODULAIRE**

(54) **MODULAR ENGINE**



(57) La présente invention concerne une unité de production d'énergie, et notamment un moteur à combustion interne, constitué d'une pluralité de modules de production d'énergie, par exemple des modules blocs cylindres (10), qui sont interconnectés par un d'embiellage (14) conçu pour interconnecter sélectivement à un arbre moteur commun les sorties, par exemple les vilebrequins, des modules de production d'énergie comme le ferait un réducteur sélectif.

(57) A power unit, especially an internal combustion engine, comprising a plurality of power modules, e.g. cylinder block modules (10), which are interconnected by a link-up unit (14) adapted, as by means of selective gearing, selectively to interconnect the power module outputs, e.g. crankshafts, to a common output shaft.

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(71)(72) Applicant and Inventor: EFFORD, Clive, William [GB/GB]; 2 White Cottages, Mumby's Drove, Threeholes, Wisbech, Cambs. PE14 9JT (GB).

(74) Agent: STONE, Patrick; 28 Edenside Drive, Attleborough, Norfolk NR17 2EL (GB).

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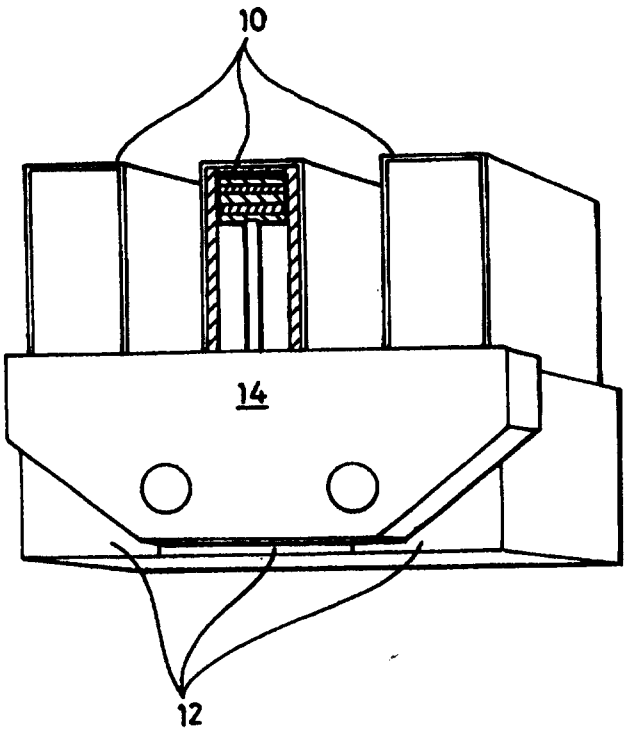
(54) Title: MODULAR ENGINE

(57) Abstract

A power unit, especially an internal combustion engine, comprising a plurality of power modules, e.g. cylinder block modules (10), which are interconnected by a link-up unit (14) adapted, as by means of selective gearing, selectively to interconnect the power module outputs, e.g. crankshafts, to a common output shaft.



Modular Engine

This invention relates to a modular engine.

Various proposals have been made in the prior art for equipping a vehicle, whether land borne or water borne, with two or more engines which can be selectively used.

The present invention has for one object to provide a single power unit, for static or mobile use, having a plurality of interconnectable power modules.

According to one aspect of the invention, there is provided an engine comprising two or more power modules, and means for bolting the modules together in a selected positional relationship, said means including an enclosed link-up device for coupling any one or both power modules to a common output shaft.

Most commonly, each power module will comprise at least one cylinder and a crankshaft, the link-up device coupling any one, both or all crankshafts to a common output shaft, whereby to provide a modular internal combustion engine.

However, the link-up device could alternatively be used to link up two or more gas turbines or electric motors, for example.

According to another aspect of the invention, there is provided a link-up unit, e.g. the aforesaid enclosed link-up device, in the form of a gear casing incorporating gears for selectively interconnecting a plurality of power outputs, e.g. a plurality of crankshafts, with the output shaft. Alternatively, a casing can be provided incorporating hydraulic pumps which are driven by the respective crankshafts and are linked by a control valve. When enclosed gearing is employed, clutches may

be incorporated to enable controlled selection of and number of power units in use. A suitable clutch may be a torque converter, fluid flywheel, centrifugal clutch, hydraulic clutch or spring and pressure plate.

In the case of an internal combustion engine, the cylinder block modules are preferably cast or moulded and are bolted to a crankcase, linked by cooling tubes. A cylinder block module and crankcase may alternatively be cast or moulded as an integral unit. Wet or dry liners may be fitted. While the cylinder block modules may have open tops for fitting of cylinder block heads and associated conventional valves, preferably the cylinder block modules are closed at the top, but bored with apertures for the fitting of valve housings, as later described.

The crankcase is moulded or cast, preferably of open web-type construction, with full main housings drilled for oil passages and returns. Universal drillings are preferably provided for bolting cylinder block modules together. Side plates and sumps are preferably incorporated and, desirably, the crankshaft swing can extend partly into a casing cutaway whilst clearing the parting plate.

The side plate, in particular, can be made in different sizes and shapes to suit the number of cylinder block modules and the relative positionings thereof required for different engines. Thus, any number of engines required for different vehicle models and uses therof can be produced, all based on the same cylinder block module.

As previously mentioned, instead of the cylinder block module being open at the top to receive a conventional cylinder head and conventional camshaft operated valves, most preferably a closed top cylinder block module is employed.

Thus, according to another aspect of the invention, there is provided an internal combustion engine comprising a cylinder block incorporating at least one cylinder,

wherein the cylinder head is dispensed with, and instead at least one machined valve housing is bolted to the cylinder block, the or each valve housing incorporating one or more slide valves which control the intake of fuel or fuel/air mixture through apertures bored in the wall of the cylinder block.

A preferred valve comprises a slide valve housing, valve slide, driving cam for the valve slide and biassing spring or hydraulic damper for the valve slide. Servicing is thus made possible in like manner to that of fuel injectors. The preferred valve system is especially suitable for gas fuelled vehicles.

A cylinder block module can be fitted with two, three or four such valves per cylinder, single or twin cam.

The invention is further described with reference to the accompanying diagrammatic drawings, in which:-

Figure 1 is a perspective view of an engine comprising cylinder block module, crankcase and link-up unit;

Figure 2 is a plan view of the interior of a link-up unit, for an engine having two cylinder block modules;

Figure 3 is a view of the interior of the link-up unit;

Figure 4 shows an engine comprising two cylinder modules;

Figure 4a shows a modification of the engine of Figure 4;

Figure 5 is a side view of the engine of Figure 4;

Figure 6 shows part of an engine having a preferred valve control system; and

Figures 7a to 7d show details of a preferred control valve.

Referring to Figure 1, there are shown three cylinder block modules 10, each comprising one or more cylinders, bolted together via a crankcase unit 12, one for each cylinder module, and a link-up unit 14.

Figures 2 and 3 show the interior of a link-up unit for an engine having two cylinder block modules. Such a link-up unit can readily be modified to suit an engine having three cylinder block modules, as in Figure 1, or four or more cylinder block modules.

The link-up unit of Figures 2 and 3 shows the crankshafts 16 of the two cylinder block modules coupled via clutches 18 and coaxial inner and outer shafts 20 to gear trains 22 which couple to an output drive shaft 24. Reference 26 denotes the back plate of the link-up unit.

The clutches may be automatically controlled by an engine management system so that either one or both cylinder block modules are coupled to the output shaft, depending on the variable power requirements of the engine when in use.

Figure 4 shows an engine having two cylinder block modules 28 bolted together at 30. The cylinder block modules could be integrally formed each with its crankcase. Figure 4a shows the versatility of the arrangement, in that according to requirements the cylinder block modules 28 can be interconnected in any desired positional relationship, in association with appropriate re-arrangement of the link-up unit.

Figure 5 shows the engine of Figure 4 in side view, with the link-up unit 14 on

the right.

Figure 6 shows part of a cylinder block module, and more especially a preferred valve control system therefor. Instead of being open topped to receive a cylinder head and conventional camshaft controlled valves, the top of the module is closed, and fitted with slide valves 32 controlling the injection of fuel into the engine. The arrangement is especially suitable for a gas fuelled engine.

Figures 7a to 7d show detail of one of the slide valves. This comprises a valve housing 34 in which is incorporated a tapered valve slide 36 controlled by a cam follower 38 driven by cam 40 on the camshaft and acting against a spring or hydraulic damper 42. The valve slide 36 opens and closes apertures 44 bored in the top wall of the cylinder block module (see also Figure 6).

More generally, the basic cylindrical block module can be built with two, three or four valves per cylinder, fitted on top with single or twin cams, or side fitted as a crossflow with twin cams. However, conventional valves driven by a conventional camshaft drive could be employed instead. Cam bearings, cam followers and valve slides etc. are all oil fed by oil lines pre-drilled in the valve housings, cylinder block and crankcase with return channels suitable for all engine mounting positions. In the arrangement shown in Figure 7, the valves are provided on a machined face of the cylinder block to which the machined valve housing is bolted; a dowelled oil feed will line up the holes. The valve is hardened and has two tapers which holds the valve tightly closed with the spring or hydraulic pressure holding the plate to the tapers. The valve slide has an adjustable cam follower in front for adjustment and for operating the valve when pushed by the cam to open the port by aligning the hole in the valve plate, housing and cylinder port. On release, the valve slide is pushed back onto the tapers holding it closed. Servicing can be carried out by either unbolting the entire valve unit or removing the valve plate, in situ, by removing the spring cap and

replacing any required parts.

The illustrated link up unit is an enclosed gear train linked together, but could be fitted with a solenoid cut out on each of the intermediate gears, which could operate in the event of damage to any section. Each crankshaft is fitted with a clutch and sliding gear, but the latter is optional, depending on type of clutch used. A torque converter, fluid flywheel, or any other type of clutch can be employed. The gear train can be variable to suit requirements, and the output shaft be fitted in a variety of positions, e.g. high to lower the centre of gravity, and low in marine applications to permit shafts to be fitted in the keel. Moreover, various numbers of output shafts can be used, depending on the number of crankshafts used.

Most importantly, computer control technology, possibly incorporated in an engine management system, will enable multiple crankshafts to run at an identical speed, and to be stopped or brought back into synchronism as and when required.

Some of the many advantages are as follows:

The optional layout of the engine enables designers to lower the centre of gravity, leading to greater stability and increased safety; also with hydraulic power the engine could be fitted in any position in order to improve space or accessibility, as well as eliminating the stress of torque.

The casting may be manufactured of various materials, including some plastics to save weight and costs. As the crankshafts will be housed as single units capable of being bolted together, many savings can be made in production and design as well as in speed and ease of unit or part-unit replacement; also spares stockholding economies.

By making provision for various mounting positions only the side plates and sumps need be made and fitted to allow the units to be adopted in a large number of applications and in different combinations.

The engine is capable of running on any fuel type for which the engine is built, liquid or gas, and by sump or external oil reservoir and pump, and the preferred valve system enables considerable space saving in the overall height of the unit, giving many design advantages. Moreover, as no head is used with this valve system, there is no risk of headgasket problems, and the valves can be changed simply.

Whereas the drawings in general illustrate internal combustion engines acting on a four-stroke cycle, the invention is also applicable to engines operating on a two-stroke cycle. The illustrated engines also incorporate camshafts. However, the invention is also applicable to camless engines incorporating unit valve activators, and to engines wherein the cams are operated by an electronic unit instead of a cam shaft.

Finally, the link up concept is also suitable for use in connecting gas turbine modules or electric power supplies, i.e. electric motors.

Claims

1. A single engine having at least one output shaft, comprising two or more engine sections each comprising a power module, means for bolting the engine sections together in a selected positional relationship, said means including a link-up device for selectively coupling any one or any number of engine sections to the output shaft or shafts so that the single engine can utilise power from any one or any two or more power modules to drive the output shaft or shafts.

2. An engine according to claim 1, wherein each power module comprises at least one cylinder and one crankshaft, the link-up device selectively coupling any one, both or all crankshafts to the common output shaft or shafts, whereby to provide an internal combustion engine.

3. An engine according to claim 2, wherein the link-up device comprises a gear casing incorporating gears for selectively interconnecting a plurality of crankshafts with the common output shaft or shafts.

4. An engine according to claim 3, wherein each cylinder block module is bolted to or integrally formed with the crankcase.

5. An engine according to claim 4, wherein the crankcase is designed and built in size and shape to suit the number of cylinder block modules and the relative positionings of the latter required for different engines.

6. An engine according to any of claims 2 to 5, wherein the cylinder block modules are closed at the top and bored with apertures for the fitting of slide valve housings.

AMENDED SHEET

7. A link-up unit for interconnecting a plurality of power modules, said link-up unit being in the form of a casing incorporating means for selectively interconnecting any one or any plurality of power outputs with at least one common output shaft.

8. A link-up unit according to claim 7, wherein the interconnecting means comprises selectable gear trains.

9. A link-up unit according to claim 7 or claim 8, for selectively interconnecting a plurality of crankshafts appertaining to internal combustion engine modules to the common output shaft or shafts.

10. A link-up unit according to claim 9 when appendant to claim 8, wherein the casing houses, in conjunction with the gearing, at least one clutch to enable controlled selection of the number of power modules in use.

11. An internal combustion engine according to claim 2, comprising a cylinder block incorporating at least one cylinder, wherein the cylinder head is dispensed with, and instead at least one machined valve housing is bolted to the cylinder block, the or each valve housing incorporating one or more slide valves which control the intake of air for direct injection and/or fuel or fuel/air mixture through apertures bored in the wall of the cylinder block.

12. An engine according to claim 11, wherein each valve comprises a slide valve housing, a valve slide, a driving cam for the valve slide and a biassing spring or hydraulic damper for the valve slide.

13. An engine according to claim 11 or claim 12, adapted to be fuelled by gas.

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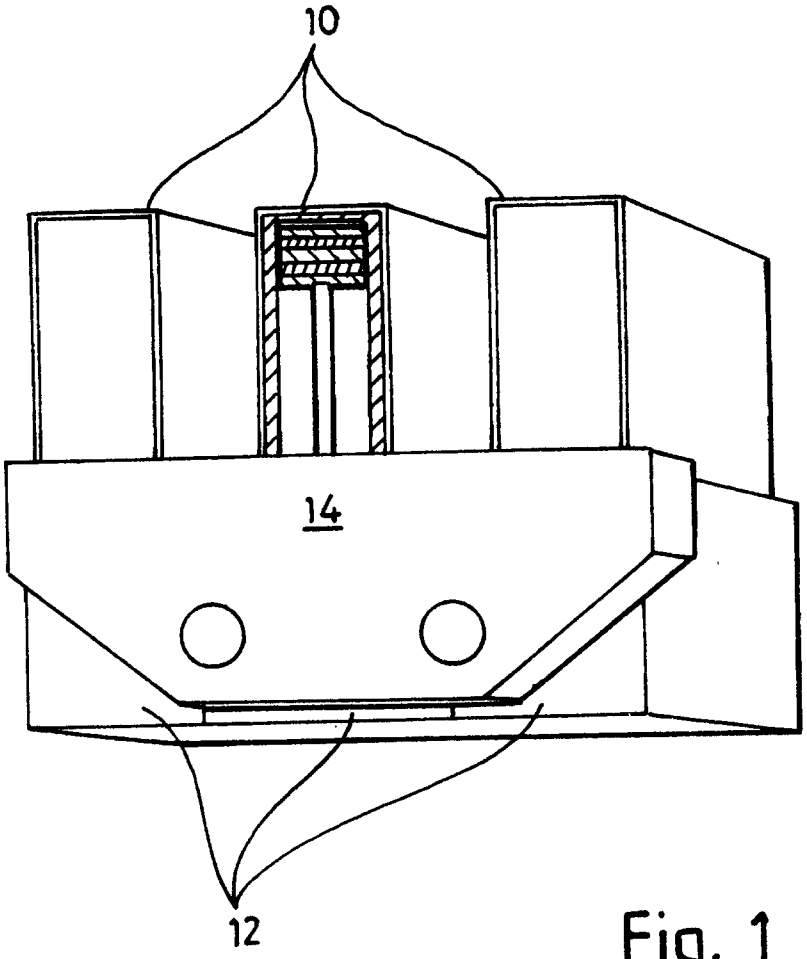


Fig. 1

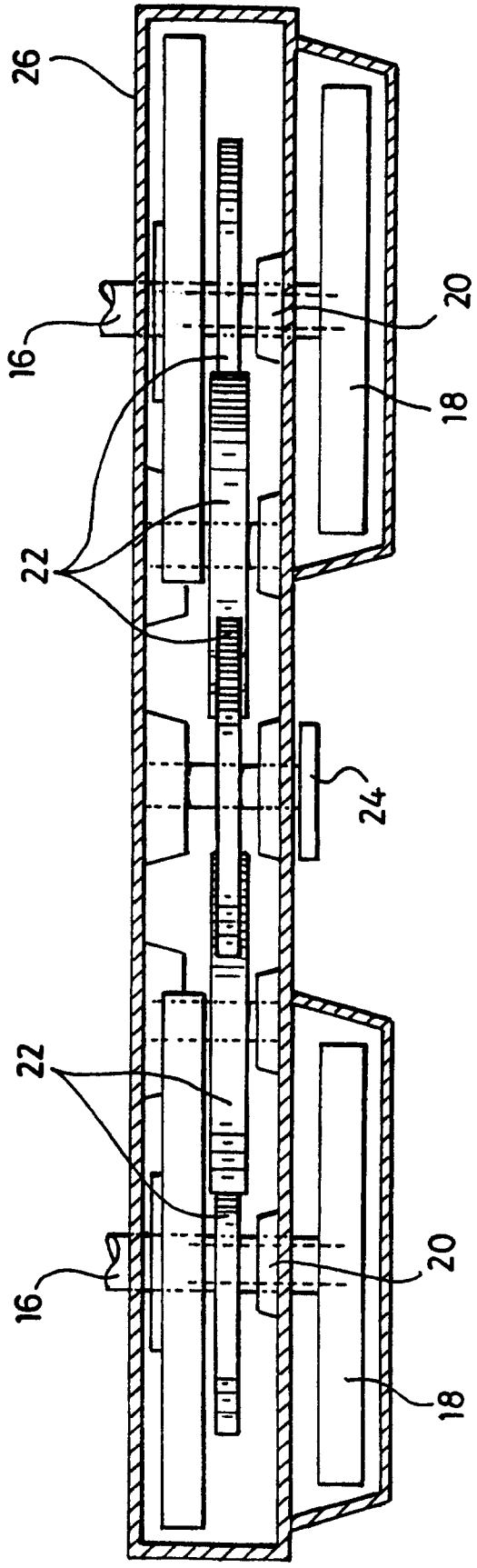


Fig. 2

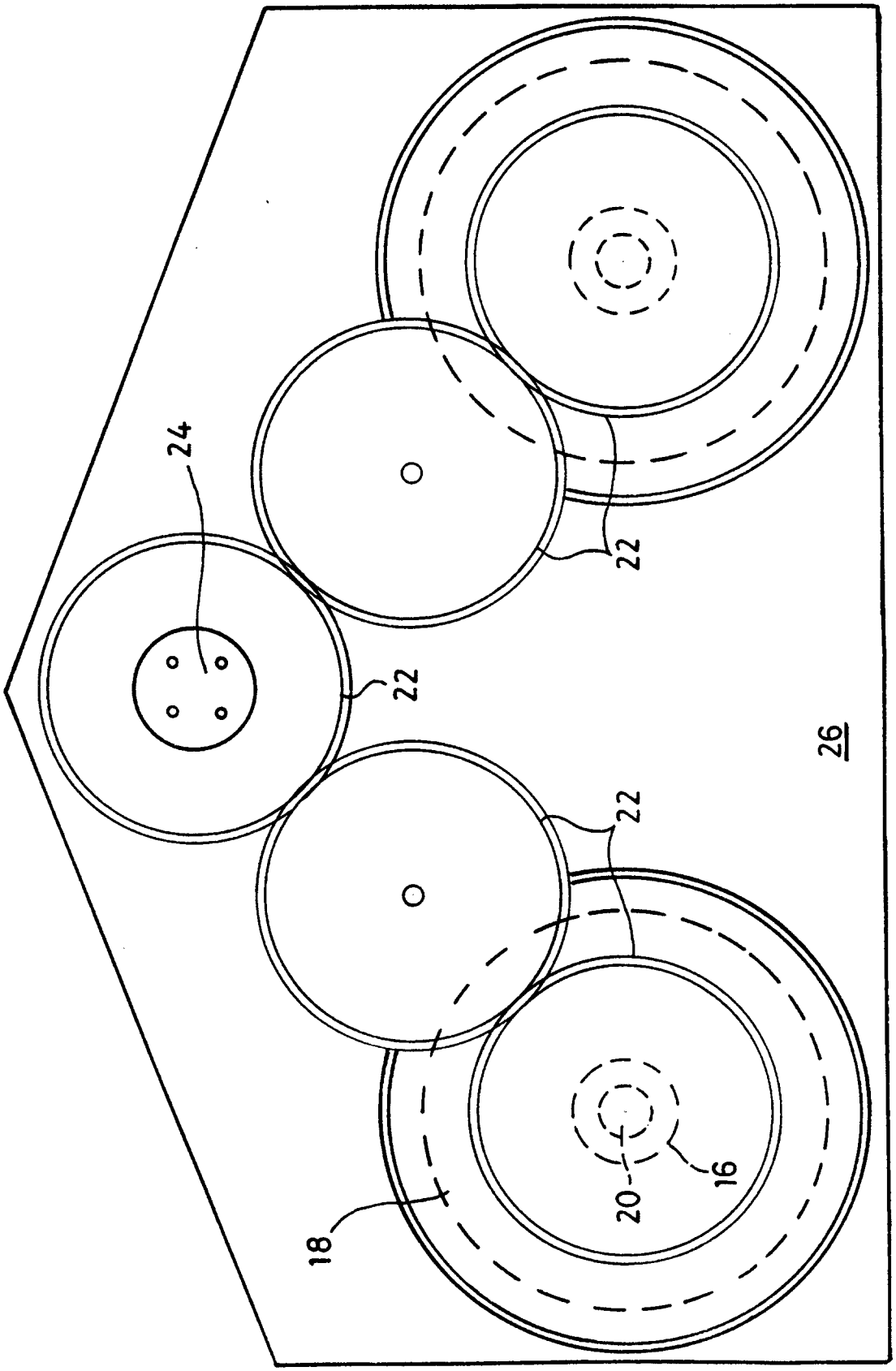


Fig. 3

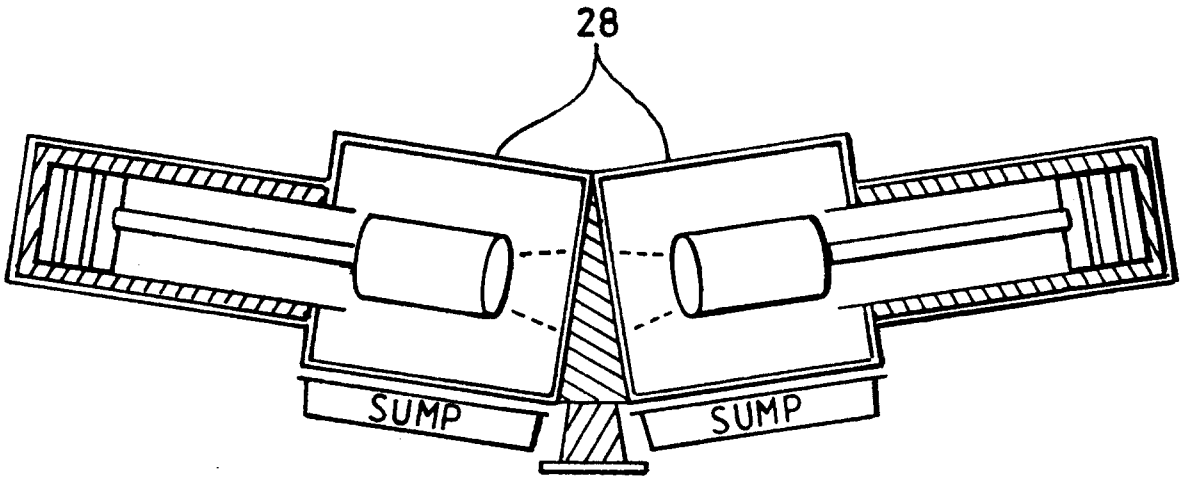


Fig. 4 (a)

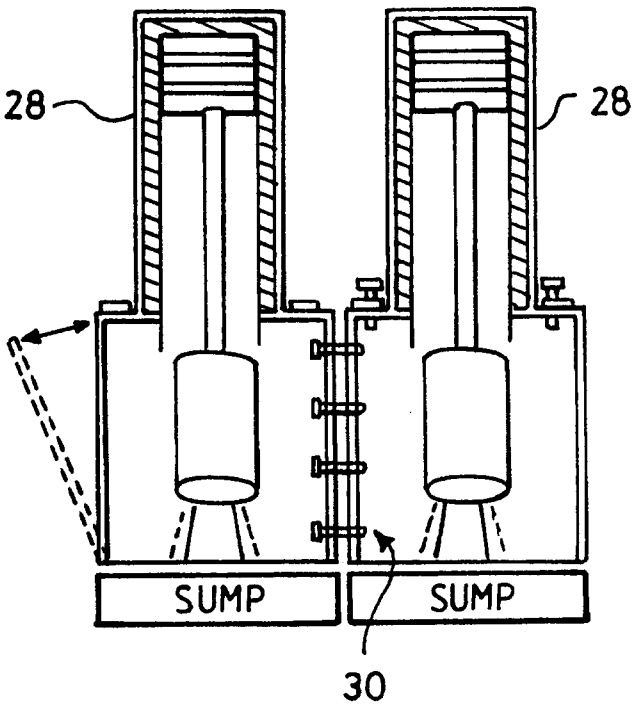


Fig. 4

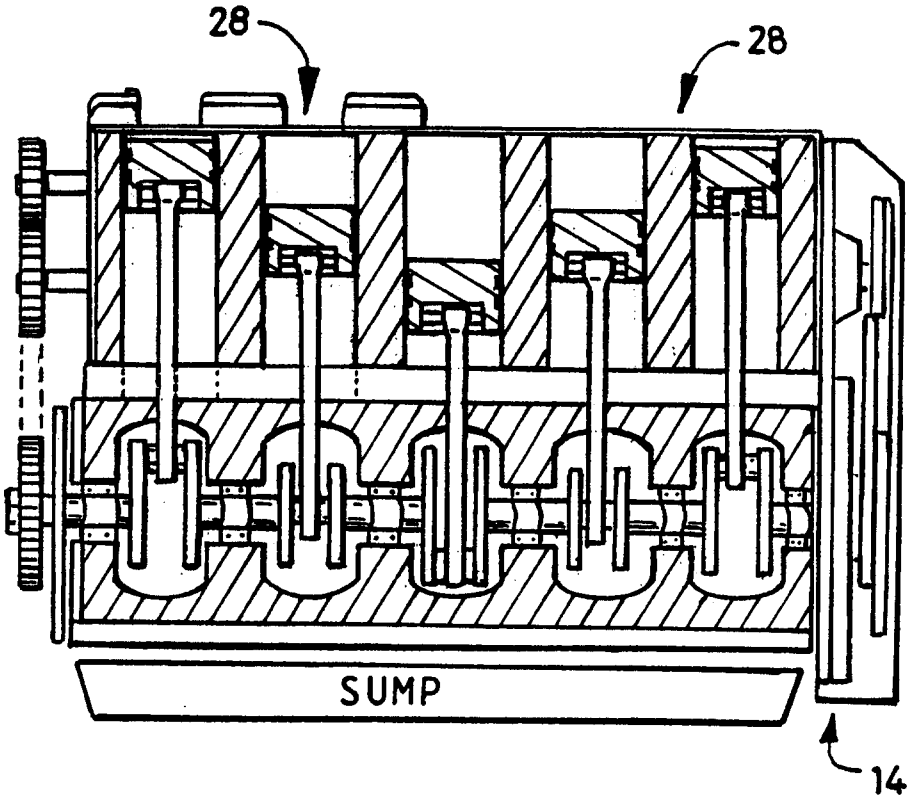


Fig. 5

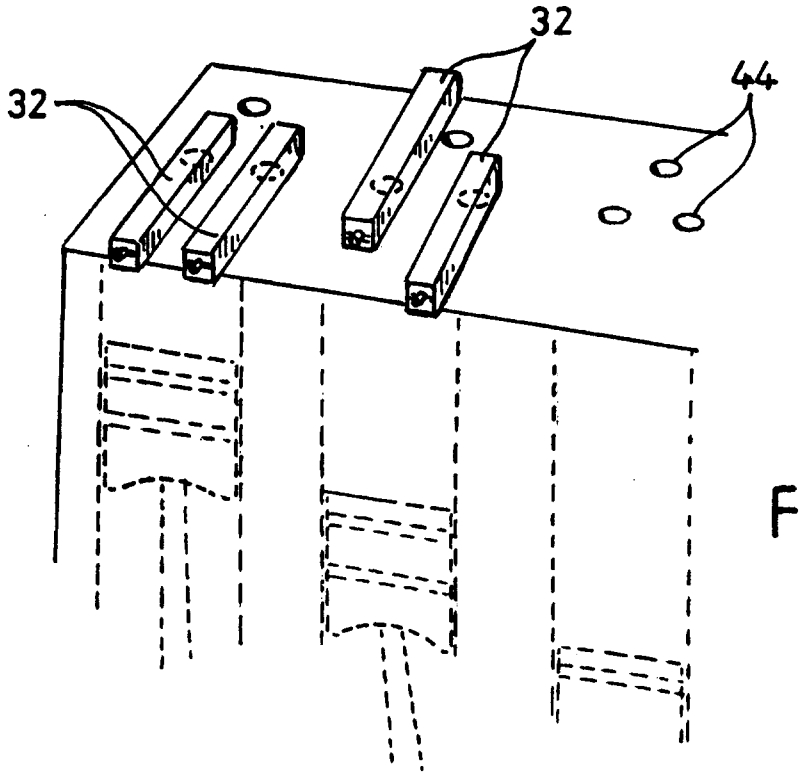


Fig. 6

Fig. 7(a)

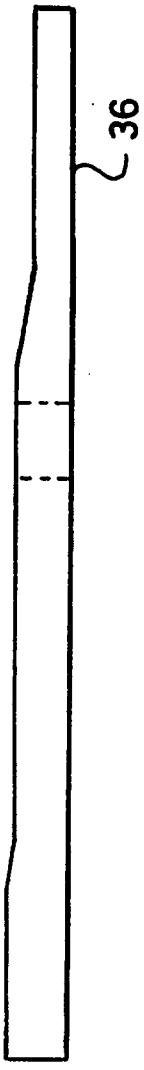


Fig. 7(b)

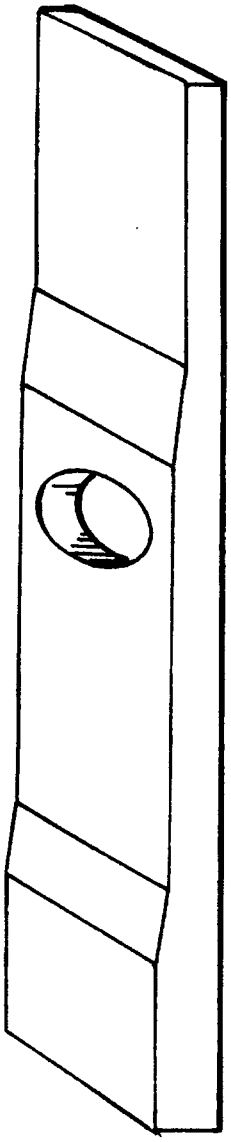


Fig. 7(c)

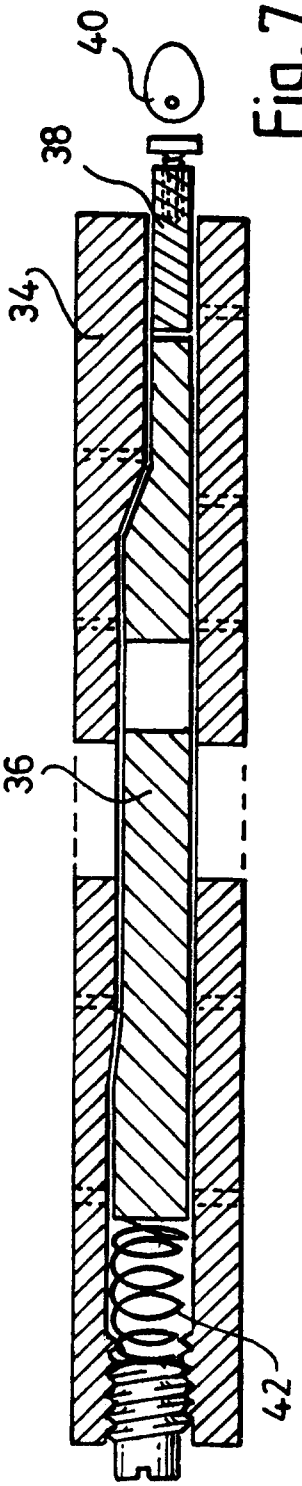
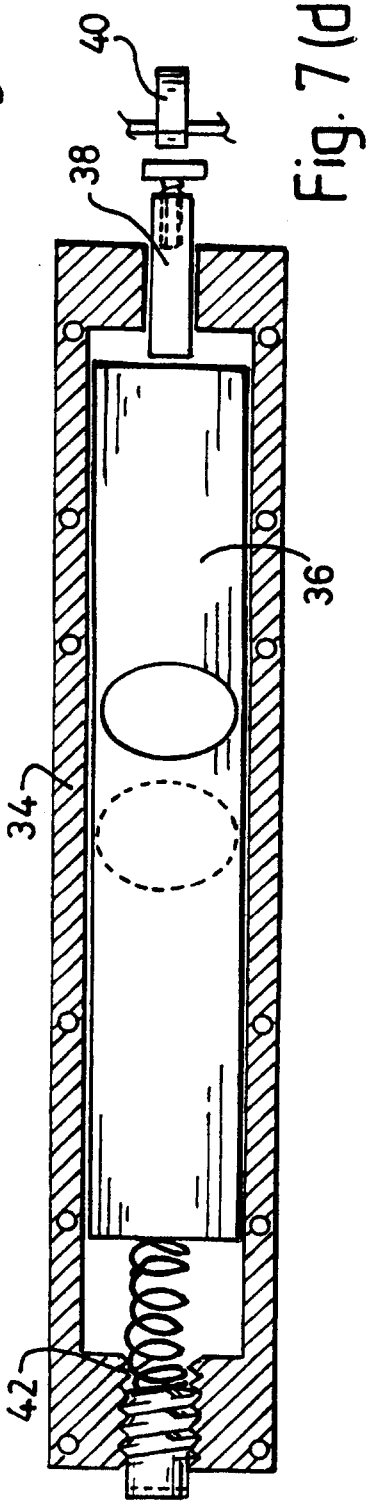
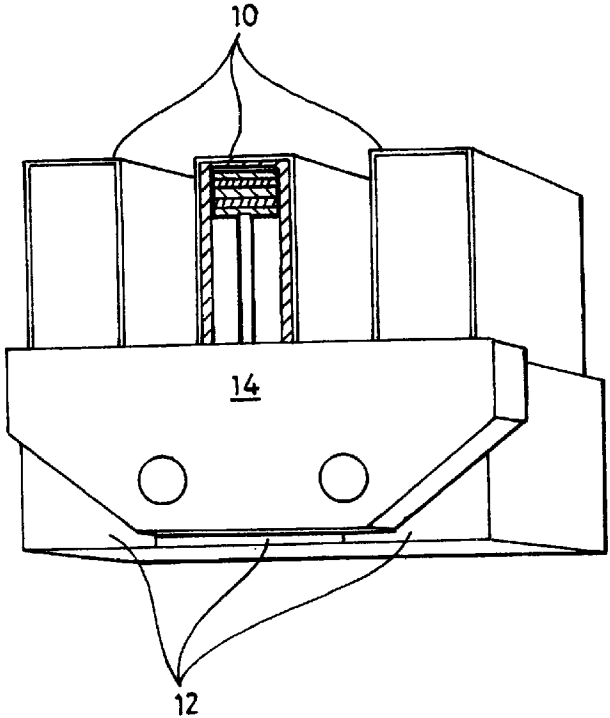


Fig. 7(d)

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