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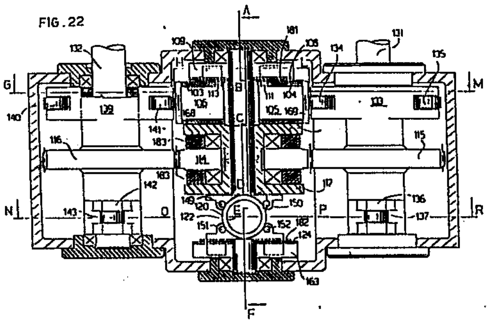
(54) **Rotary engine.**

(57) The proposed rotary engine comprises a rotating block fitted with cylinders (103, 104, 119, 120) fixed in opposed pairs on the respective supports (102, 117) which are integral with each other and with a gear (114) that engages with other gears (115, 116), identical to each other and to the gear shaft (131, 132), that is rotationally driven in the opposite direction to the engine block, but at the same speed, there being provided on each driving shaft (131, 132) links that cooperate intermittently with a respective piston. The links on the driving shafts can consist in particular of arms (133, 136, 139, 142) at the ends of which are rollers (134, 135; 137, 138; 140, 141; 143, 144) that cooperate intermittently and alternately with the respective pistons (106, 105, 121, 122). The engine block may comprise, for example, two cylinder pairs (103, 104; 119, 120) having their axes perpendicular to each other.

The engine according to the invention is preferably an internal combustion engine with spark ignition, the cylinder heads in this case being equipped with sparking plugs (177).

FIG. 22



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Description

ROTARY ENGINE

The present invention refers to rotary engines.

Many engines of this type are known, with spark or compression ignition.

There are many problems associated with known engines, regarding both their constructional design, which makes them costly, and their running costs.

One of the many serious problems to be solved concerns efficiency in terms of work absorbed by the friction that develops between the moving parts.

Particularly important, moreover, is the problem of cooling, which must be optimized for any working condition of the engine. Water cooling is more efficient than air cooling but its cost weighs considerably on the total engine cost owing to the cooling unit with related ducts, tank, radiator, pump, fan, pressure switches, thermostats etc. Furthermore, in fixed engines the inside of the pistons is cooled by transferring heat to the respective cylinder walls.

Another problem is engine noise due to the valves.

The volumetric efficiency factor is also important. According to an ideal cycle, opening and closing of the ducts for intake of the fuel/air mixture and expulsion of exhaust gases must take place at the piston's dead centre, whereas in known engines opening and closing of the valves occurs well before the pistons reach dead centre. Naturally this prevents optimum exploitation of the piston stroke.

Lastly, the problem of the seal between cylinders and pistons has been solved, although not in an ideal manner, in fixed engines but not in rotary engines, making use of rotary engines virtually prohibitive.

The aim of the present invention is to create an engine that will solve or considerably attenuate the above problems.

This aim is achieved by envisaging a rotary engine block in which the cylinders are fixed in opposed pairs on their respective supports, said cylinders being integral with each other through a gear that engages with other identical gears, each one integral with a respective driving shaft, which is made to rotate in the opposite direction to the engine block but at the same speed, each driving shaft being provided with links that cooperate with the respective piston.

In a preferred embodiment there are two cylinder pairs, the axes of the two pairs being perpendicular to each other.

The links on the driving shafts consist of arms at the ends of which are rollers that cooperate intermittently and alternately with the respective pistons.

The rotary engine block and the driving shafts are preferably supported by ball bearings integral with a fixed frame.

The engine according to this invention may be a spark ignition, internal combustion engine; in this case each cylinder head will have a sparking plug to ignite the fuel mixture.

An opening set along the side surface of the cylinders immediately below the head is preferably provided to allow passage of the intaken fuel/air mixture. The thickness of the cylinder walls is preferably sufficient to allow the passage of longitudinal holes used for air cooling of the cylinder walls.

The pistons are preferably hollow and provided with a cover having holes connecting the inner cavity with the outside, for efficient air cooling of the pistons. In order to make the cooperating movement between the pistons and the relative links smoother, a sloping plane can be provided in the area of contact betwween each link and the respective piston. In order to draw in the mixture, a notch can also be provided in the top of each piston, said notch being in positioned to coincide with the cylinder opening.

The pistion cover is preferably engaged by springs set in diametrally opposed longitudinal holes on the cylinder periphery. Said springs serve to drive the piston towards internal dead centre during the induction stroke. In particular, four springs can be provided.

These springs are preferably such as to act only at the beginning of the induction stroke, the remaining piston stroke being brought about by centrifugal force alone.

Ducts are preferably provided for intake of the mixture and outlet of burnt gases, passing in a fixed support alongside the cylinders and equipped with mouthpieces communicating with the cylinder openings.

The duct mouthpiece is preferably shaped like a portion of an annulus and its length is determined on the basis of the piston stroke during the induction and exhaust phases so that each cylinder opening is made to coincide with the mouthpiece of the respective duct when the fuel/air mixture induction and exhaust gas expulsion phases are under way.

The seal between the cylinder openings and the duct mouthpieces can be ensured by a lapped and lubricated surface provided on the fixed support housing said ducts. The lapped and lubricated surface of the fixed support is created by fitting a lapped and lubricated plate on the support.

When the induction stroke is completed, the piston of each cylinder is at its external dead centre and the cylinder opening is closed by the solid part of the fixed support.

It is possible to design engines with more than two pairs of cylinders in line or with one or more cylinder assemblies set at 120°.

The components of the engine according to the invention, by virtue of their simple shape, lend themselves to manufacture from refractory material in order to carry out adiabatic cycles.

The engine according to the invention can be provided with compression ignition (Diesel cycle). A similar engine can also be envisaged with internal combustion (Sterling engine).

The operating cycle can be either or four-stroke or two-stroke.

In a further embodiment the cylinders are double-acting; in this case two pistons move in opposite directions in a single cylinder that replaces the opposed cylinder pair.

Exemplary embodiments of the present invention are illustrated in the accompanying drawings, in which:

Fig. 1 shows a front view, partially sectioned along line 1-1 of figure 2, of an engine;

Fig. 2 shows a section along line 2-2 of figure 1;

Fig. 3 shows a section along line 3-3 of fig.2;

Fig. 4 shows a section along line 4-4 of fig. 2;

Fig. 5 shows a view partially sectioned along the line 5-5 of fig. 2

Figs. 6 to 13 show schematically the cycle phases of a first piston;

Figs. 14 to 21 also show schematically the cycle phases of a second piston that is the one opposed to the first;

Fig. 22 shows a partially sectioned front view of a second exemplary engine;

Fig. 23 shows a section along the line A-B-C-D-E-F in figure 22;

Figure 24 shows a section along the line G-H-L-M in figure 22;

Fig. 25 shows a section along the line N-O-P-R in figure 22;

Figs. 26, 27, 28 and 29 show schematically the cycle phases of the two upper pistons;

Figs. 30, 31, 32, 33 show schematically the cycle phases of the two lower pistons that take place simultaneously with the respective phases shown in figs. 26, 27, 28 and 29:

Fig. 34 shows a plan view of a cylinder/piston assembly;

Fig. 35 shows a section alon the line A-B-C in figure 34:

Figs. 36a, 36b, 36c and 36d are schematic side views of a cylinder/piston assembly in various operating position, in relation to the respective link.

Figure 1 shows the rotary engine comprising a driving shaft 1 integral with the central gear 6 that engages the two lateral gears 7 and 8, both identical and having the same number of teeth as gear 6. The driving shaft is integral with the two opposed cylinders 2 and 3 wherein pistons 4 and 5 slide.

Each of the lateral gears 7 and 8 is integral with its respective shaft 9 and 10 which is rotationally driven at the same speed as the rotary block but in the opposite direction. Said shafts rotationally drive the respective arms 40, 42, 44 and 46 respectively with idle rollers 41, 43, 45 and 47. Rollers 41 and 45 intermittently and alternately engage with piston 4 while the rollers 43 and 47 engage intermittently and alternately with piston 5, so that pistons 4 and 5 can impart motion to the arms as well as being positioned by them during their cycle. It can be noted in fig. 1 that the cylinders 2 and 3 are preferably in one piece with driving shaft 1.

Each cylinder 4 and 5 has a head 55 and 56 with a sparking plug 24.

Openings 22 and 50, on cylinders 4 and 5 respectively, allow fuel/air mixture to be drawn in and exhaust gases to be expelled. The fuel/air mixture, as shown in figures 4 and 5, comes from ducts 30 and 32 for cylinders 2 and 3 respectively, and flows through mouthpieces 17 and 20 to reach openings 22 and 50. The burnt gases pass through mouthpieces 18 and 19 to reach ducts 31 and 33. The ducts are in fixed supports 34 and 35 alongside cylinders 2 and 3. To ensure that the cylinders slide with the least possible friction, lapped and lubricated plates 13 and 14 are provided, creating an optimum sliding surface.

Pistons 4 and 5 are hollow and their respective cavities 15 are closed at the outer end by covers 11 and 12, said covers having holes 11a (Figures 1 and 2) that allow the cooling air to pass.

Cylinders 2 and 3 are efficiently cooled by the air circulating in longitudinal holes 27 provided in the side wall of each cylinder.

To assist induction, pistons 4 and 5 are provided with notches 23 and 51 coinciding with openings 22 and 50.

In figure 5 a section can be seen, showing cylinder 2 with piston 4 having reached internal dead center. The cover 11 cooperates with roller 41 and the spr8ings 26, preferably set in longitudinal holes 27 also used for cooling, act on the cover. The springs 26 are held in place by means of pistons 28 integral with the cover 11, said pistons sliding in said holes 27. The stroke of the pistons 28 is defined by the tabs 36 that limit the upstroke by abutting against the piston head.

The cycle phases for both cylinders are shown in figures 6 to 21.

Figure 6 shows the position of cylinder 2 during the fuel induction stroke. The driving shaft 1 rotates clockwise and by means of toothed gearing causes gears 7 and 8 to rotate counter-clockwise so that the piston 4, driven by the springs 26, comes out of the cylinder accompanied by the roller 45, at the same time opening 22 passes through the sector occupied by the mouthpiece 22 of the intake duct 30 (fig. 3) and the cylinder chamber fills with the fuel/air mixture.

Figure 7 shows the position of the cylinder 2 and the respective piston 4 at the end of the induction stroke.

Figure 8 shows the fuel compression phase. The cover 11 of the piston is engaged by idle roller 41 which , being integral with arm 40, drives the piston towards the inside of the combustion chamber until it reaches internal dead centre. In figure 9 maximum compression has been reached. Sparking plug 22 ignites the fuel/air mixture which expands as it burns, driving the piston 4 outward (fig. 10), said piston cooperating with roller 41 and arm 40 to obtain working power. The end of the expansion stroke is illustrated in fig. 11.

The roller 45, by engaging the piston cover and rotating counter-clockwise, obliges the piston to return inside the chamber, expelling the exhaust gases through opening 22 running along the mouth-piece of exhaust duct 31 (fig. 3).

At the end of the exhaust stroke the cylinder and respective piston are in the positon shown in figure 13 and the cycle begins again.

Figures 14 to 21 show the cycle performed by cylinder 3 with the respective piston 5 while the cylcle of cylinder 2 with the relative piston 4 is being carried out. It can be noted that when cylinder 2 is drawing in fuel (fig. 6), cylinder 3 is in the expansion phase (fig. 14); when the sparking plug ignites the fuel/air mixture in cylinder 2 (Fig. 9), cylinder 3 is at the end of the exhaust phase (Fig. 17), vice versa when cylinder is at the end of the exhaust phase (Fig. 13) the sparking plug ignites the mixture in cylinder 3 (Fig. 21). With this arrangement an engine has been created that performs a complete four-stroke cycle in a single revolution of the driving shaft. Moreover, the engine has no intake or exhaust valves and therefore it has a better seal and is more silent than known engines.

The connecting rod assemblies and cooling unit have been eliminated to the great advantage of the engine weight and cost.

The present engine can use various types of fuel and it can be fitted with mechanically or electronically operated, spray or injection carburettors. It can also be provided with any kind of ignition system.

Figures 22 and 36 show a rotary engine block comprising a support 102, on which are fixed two opposed, coaxial cylinders 103 and 104, integral with a central gear 114 in turn integral with a support 117 to which are fixed two opposed, coaxial cylinders 119 and 120. The axis of cylinders 103 and 104 is perpendicular to the axis of cylinders 119 and 120. Each cylinder 103, 104, 119, 120 houses a piston designated 106, 105, 121, 122 respectively. The engine block is supported in its central part by four sturdy ball bearings made fast to a frame by means of four radial housings 183. The central gear 114 is engaged with two lateral gears 115 and 116 identical to each other and to gear 114, each of which is integral with a driving shaft 131 and 132 respectively, that is rotationally driven at the same speed as the engine block but in the opposite direction. The driving shaft 131 rotationally drives arms 133 and 136 the ends of which are equipped with idle rollers 134, 135, 137 and 138 respectively. Driving shaft 132 rotationally drives arms 139 and 142 the ends of which are equipped with idle rollers 140, 141, 143, 144 respectively. Rollers 134, 135 and 140, 141 intermittently and alternately engage pistons 105 and 106, while rollers 137, 138 and 143, 144 intermittently and alternately engage pistons 121 and 122, pistons 105, 106, 121 and 122 being able to impart movement to the arms or be actuated by them during the cycle.

Each cylinder is equipped with a sparking plug 177 (Fig. 25).

Openings 113, 11 (Fig. 22) and 161, 162 (Fig. 25) on cylinders 103, 104, 119 and 120 respectively allow intake of the fuel/air mixture and expulsion of the exhaust gases.

The fuel/air mixture comes from a duct 110 (Fig. 24) for cylinders 103 and 104 and from a duct 128 (Fig. 25) for cylinders 119 and 120 and flows through a mouthpiece 164 to reach opening 111 in cylinder 104 and opening 113 in cylinder 105 and through a mouthpiece 166 to reach opening 161 in cylinder 119 and opening 162 in cylinder 120.

The exhaust gases pass through the mouthpieces 165 (Fig. 24) and 167 (Fig. 25) to reach exhaust ducts 112 and 127 respectively. Mouthpieces 164, 166, 165 and 167 are shaped like a portion of an annulus.

Ducts 110 and 112 (Fig. 24) for intake of the fuel/air mixture and expulsion of the exhaust gases for cylinders 103 and 104 are provided in a fixed support 109 alongside said cylinders 103 and 104.

Ducts 128 and 127 (Fig. 25) for intake of the fuel/air mixture and expulsion of the exhaust gases for cylinders 119 and 120 are provided in afixed support 163 alongside said cylinders 119 and 120.

To ensure that the engine block slides on the fixed supports with the least possible friction, provision is made for: a lapped and ground plate 108 (Fig. 22) bearing mouthpieces 164 and 163 (Fig. 24) on fixed support 109 and a lapped and ground plate 124 (Fig. 22) bearing mouthpieces 166 and 167 (Fig. 25) on fixed support 163. At the ends of the engine block provision is made for a lapped and ground, perforated plate 181 (Fig. 22) at opening 111 if cylinder 104 and opening 113 of cylinder 103 and a lapped and ground perforated plate 182 (Fig. 22) at opening 161 (Fig. 25) of cylinder 119 and opening 162 (Fig. 25) of cylinder 120.

Said plates 108, 124, 181 and 182 create an optimum sliding surface and ensure the seal between the cylinder openings and the duct mouthpieces during the induction and exhaust phases.

Pistons 105, 106, 121 and 122 are hollow and the outer end of their cavities is closed by covers 169, 168, 170 and 171 respectively, said covers having holes 123 (Figs. 34 and 35) that allow the cooling air to pass. Each cover 169, 168, 170 and 171 has, at the ends of the central part engaged with rollers 134, 135, 140, 141, 137, 138, 143 and 144, sloping surfaces 173 and 173' (Figs. 34, 35 and 36) to assist initial roller contact.

To draw in the fuel/air mixture each piston 105, 106, 121 and 122 is driven towards external dead centre by four springs (indicated by 149, 150, 151 and 152 in figure 34 and in figs. 23 and 35), set in diametrally opposed, peripheral, longitudinal holes in each cylinder 104, 103, 119 and 120, said springs acting on the cover 169, 168, 170 and 171, the outward stroke of the piston being limited by a ledge 178 (Fig. 35). The spring preferably acts only at the beginning of the stroke and disengages before ledge 178 is reached, the piston continuing its stroke by centrifugal force. The axial position of the ledge 178 is preferably adjustable.

As can be seen in figures 26 to 33, the engine block rotates clockwise, while the drive shafts are made to rotate counter-clockwise by means of toothed gearing 115, 114, 116.

Figures 26, 27, 28 and 29 show the operating cycle phases for pistons 105 and 106 which slide in cylinders 104 and 103, corresponding to an engine block rotation of about 135°. In figure 26 pistons 105 and 106 are reaching external dead centre; cylinder 104 is in the induction phase (piston 105 is driven by the springs), while the cylinder 103 is in the expansione phase (piston 106, engaged with roller

135, drives arm 133). In figure 27 the pistons are at external dead centre; in cylinder 104 the induction phase has been completed, while in cylinder 103 the expansion phase has been completed. In figure 28 pistons 105 and 106 are reaching internal dead centre; cylinder 103 is in the compression phase (piston 106, engaged with roller 141, is driven by arm 139), while cylinder 104 is in the exhaust phase (piston 105, engaged with roller 134, is driven by arm 133). In figure 29 (corresponding to figure 22) pistons 106 and 105 are at internal dead centre. In cylinder 103 the compression phase has been completed; in the next stage the compressed mixture, ignited by sparking plug 177, will expand driving piston 106 outwards, said piston cooperating with roller 141 and arm 131 to obtain working power. In cylinder 104 the exhaust phase has been competed; in the next phase the springs will push the piston to external dead centre bringing about fuel induction.

In the remainder of the engine block rotation the operating phases described above will be exchanged between cylinders 119 and 120.

Figures 30, 31, 32 and 33 show the operating cycle phases for pistons 121 and 122 of cylinders 119 and 120, corresponding to an engine block rotation of about 135°. In figure 30 pistons 121 and 122 are reaching the internal dead centre; cylinder 119 is in the exhaust phase (piston 121, engaged with roller 144, is driven by arm 142) while cylinder 120 is in the compression phase (piston 122, engaged with roller 137, is driven by arm 136). In figure 31, pistons 121 and 122 have reached the internal dead centre; in cylinder 119 the exhaust phase has been completed, while in cylinder 122 the compression phase has been completed. In figure 11 pistons 121 and 122 are reaching external dead centre. Cylinder 119 is in the induction phase (piston 121 is driven by the springs), while cylinder 120 is in the expansion phase (piston 122, engaged with roller 137, drives arm 136). In figure 33 (corresponding to figure 25) pistons 121 and 122 of cylinders 119 and 120 are at external dead centre. In cylinder 119 the induction phase has been completed. In the subsequent phase piston 121 will begin to cooperate with roller 138 to compress the air/fuel mixture. In cylinder 120 the expansion phase has been completed; in the subsequent phase piston 122 will begin to cooperate with roller 143 to expell the exhaust gases.

Claims

1. An engine comprising a rotating block provided with cylinders (2, 103, 104, 119, 120) wherein pistons (4, 5; 106, 105, 121, 122), slide the cylinders (2,3; 103, 103, 119, 120) being opposed in pairs, integral with each other and with a gear (6, 114) that engages with other gears (7, 8; 115, 116), identical and each separately integral with a driving shaft (9, 10; 131, 132), that is rotationally driven in the opposite direction to the rotating block but at the same speed, provision being made on each driving shaft (9, 10; 131, 132) for links that cooperate intermittently with the respective piston.

2. An engine as in claim 1, characterized in that it comprises two cylinder pairs (103, 104; 119, 120) the axes of the two pairs being perpendicular to each other.

3. An engine as in claim 1 or 2, characterized in that the links on the shafts (9, 10 ; 131, 132) consist of arms (40, 42, 44, 46; 133, 136, 139, 142) at the ends of which are rollers (41, 43; 45, 47; 134, 135; 137, 138; 140, 141; 143, 144) that cooperate intermittently and alternately with the respective pistons (4, 5, 106, 105, 121, 122).

4. An engine as in any one of the preceding claims, characterized in that the rotating block and the shafts (9, 10; 131, 132) are supported by ball bearings integral with a fixed frame.

5. An engine as in any one of the preceding claims, characterized in that each cylinder (2, 3; 103, 104, 119, 120) has a head equipped with a sparking plug (24; 177) for ignition, the engine being an internal combustion engine with spark ignition.

6. An engine as in any of the preceding claims, characterized in that each cylinder (2, 5; 103, 104, 119, 120) is provided with an opening (22, 50; 113, 111, 161, 162) for intake of the fuel/air mixture and outlet of the burnt gas.

7. An engine as in claim 6, characterized in that the opening (22, 50; 113, 111, 161, 162) communicates with intake ducts (30, 32; 110, 128) provided with mouthpieces (17, 20; 164, 166) and with exhaust ducts (31, 33; 112, 127) also provided with mouthpieces.

8. An engine as in claim 6 or 7, characterized in that the side surface of the cylinders (2, 5; 103, 104, 119, 120) has an opening (22, 50; 113, 111, 161, 162) set immediately below the head.

9. An engine as in any of the preceding claims, characterized in that the pistons (4, 5; 106, 105, 121, 122) are hollow and each is provided with a cover (11, 12; 169, 168, 170, 171) integral with the respective piston, said cover having holes (11a; 123) connecting the cavity of each piston with the outside.

10. An engine as in claim 9, characterized in that the cover (11, 12; 169, 168, 170, 171) of the pistons (4, 5; 105, 106, 121, 122) is engaged by springs (26; 149, 150, 151, 152) fitted in longitudinally diametrally opposed holes provided on the cylinder periphery.

11. An engine as in claim 10, characterized in that the springs are such as to act only at the beginning of the opening stroke of the pistons.

12. An engine as in any of the preceding claims, characterized in that the piston surfaces have sloping planes (73, 73′) at the contact area between link and piston, so as to make this contact smooth.

13. An engine as in any of the preceding claims, characterized in that ducts (30, 32, 31, 33; 110, 128, 112, 127) are provided for intake of air/fuel mixture and outlet of exhaust gases, passing in a fixed support (34, 35; 109, 163)

alongside the cylinders.

14. An engine as in claim 13, characterized in that the support (34, 35; 109, 163) for the ducts (30, 32, 31, 33; 110, 128, 112, 127) is fitted with a lapped and lubricated plate (13, 14; 108, 124) bearing mouthpieces (13, 14; 166, 165, 167).

15. An engine as in claim 14, characterized in that the cylinder ends are fitted with a lapped and lubricated plate (181, 182) integral with said cylinders, having holes coinciding with the cylinder openings (113, 111, 161, 162).

16. An engine as in claims 7 and 14, characterized in that the mouthpieces of the ducts (30, 32, 31, 33; 110, 128, 112, 127) and the mouthpieces (164, 166, 165, 167) provided in the plates (108, 124) are shaped like a portion of an annulus.

17. An engine as in any of the preceding claims, characterized in that the cylinder walls (2, 3; 103, 104, 119, 120) are provided with cooling holes that can also serve as a seat for the springs (26; 149, 150, 151, 152).

18. engine as in any of the previous claims, characterized in that the pistons have a notch (23, 51) on their side surface coinciding with the position of the cylinder opening.

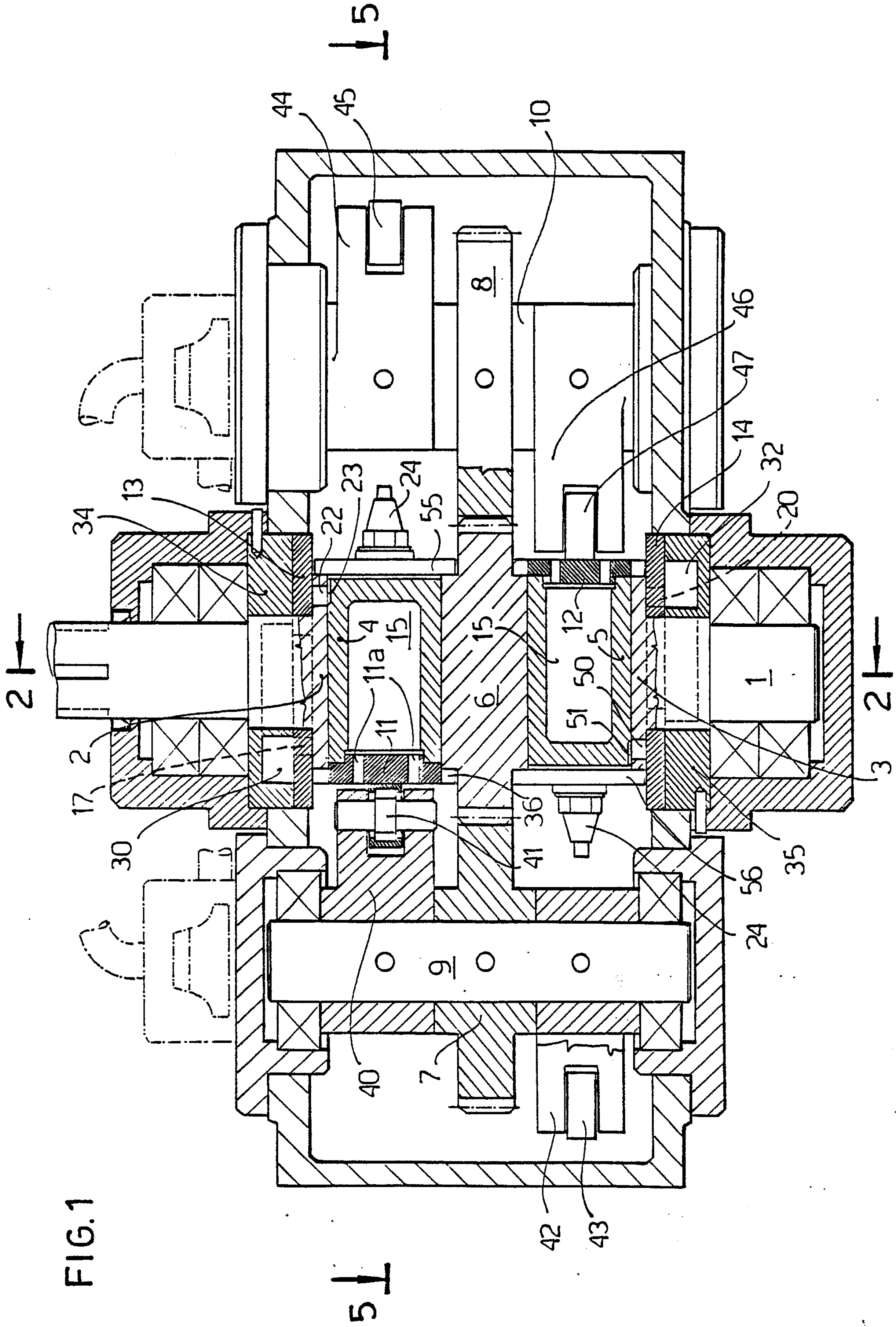
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FIG.1

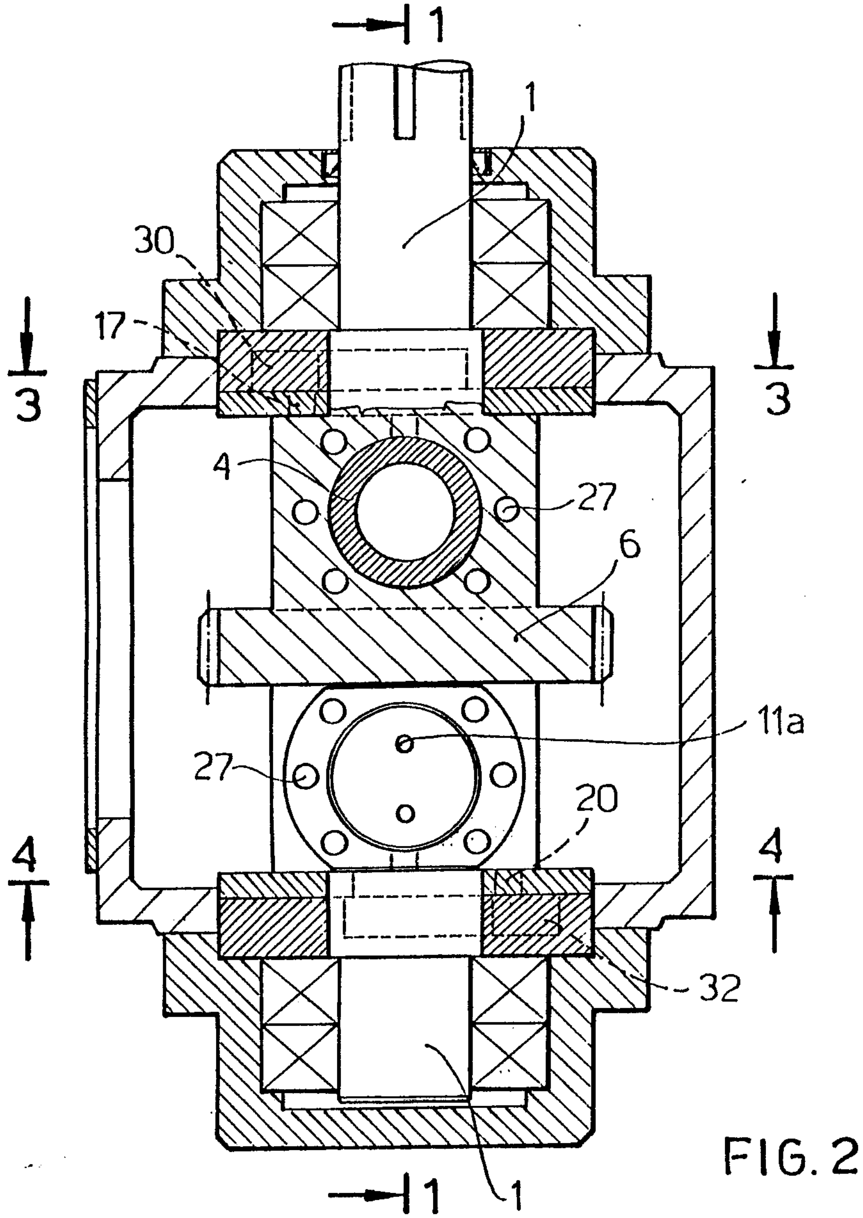


FIG. 2

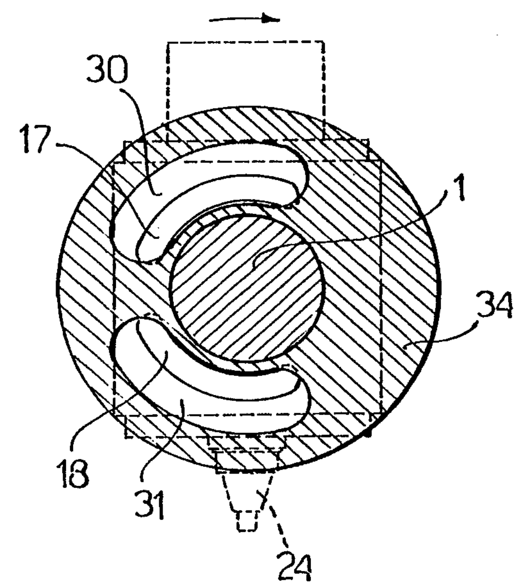


FIG. 3

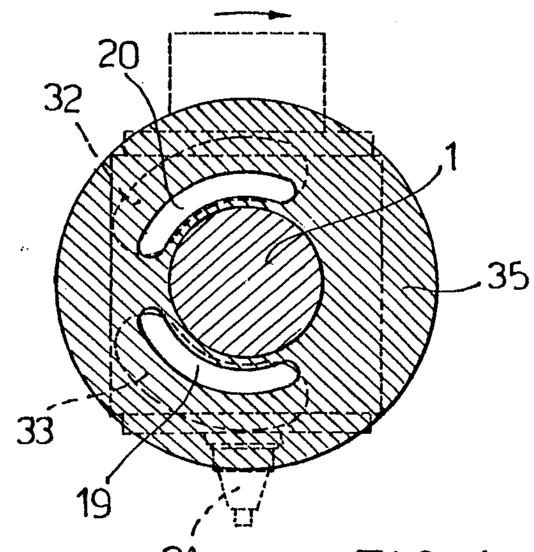
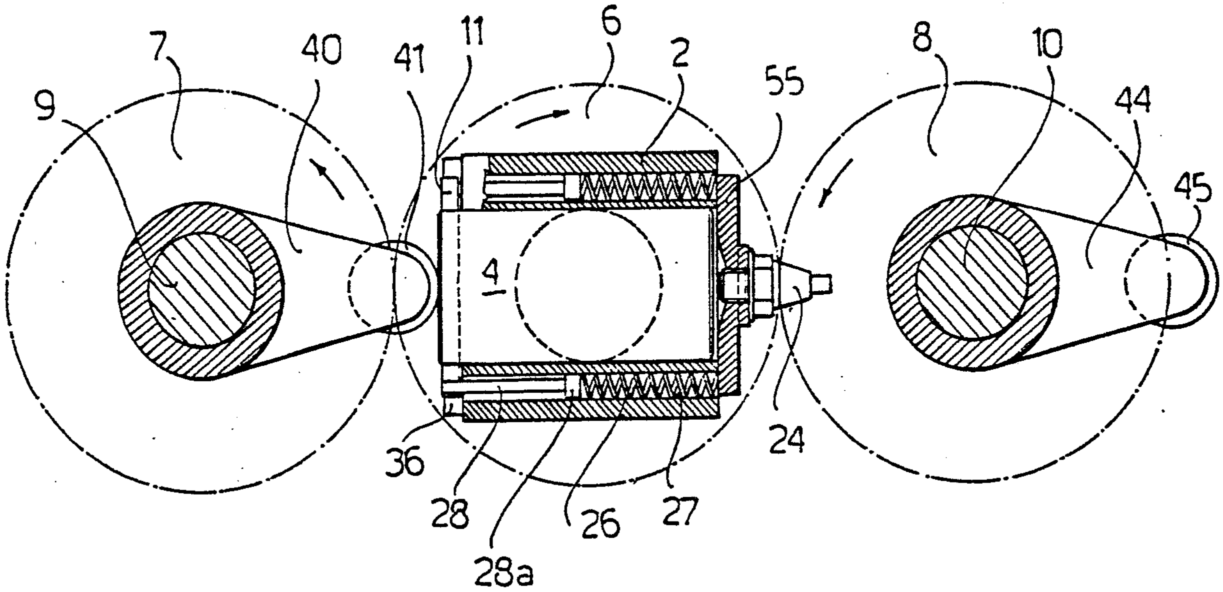


FIG. 4

FIG. 5



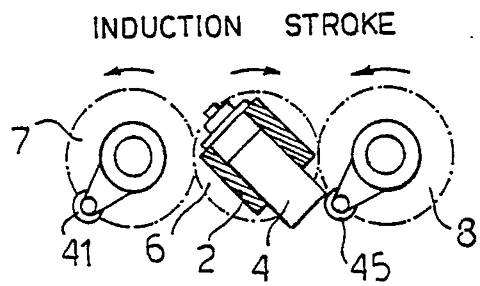


FIG. 6

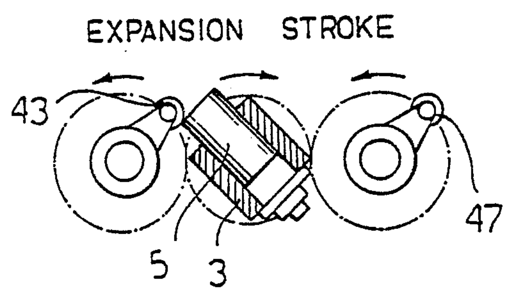


FIG. 14

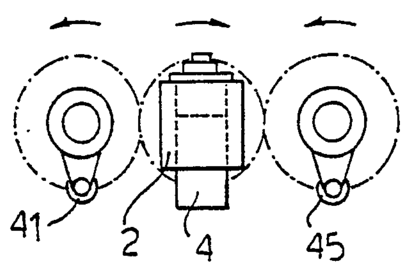


FIG. 7

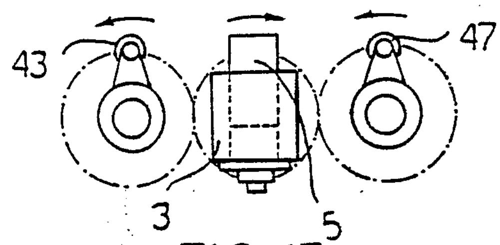


FIG. 15

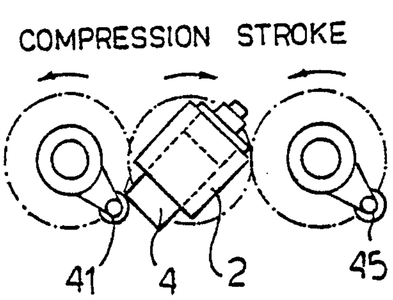


FIG. 8

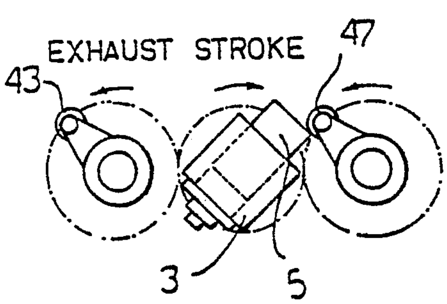


FIG. 16

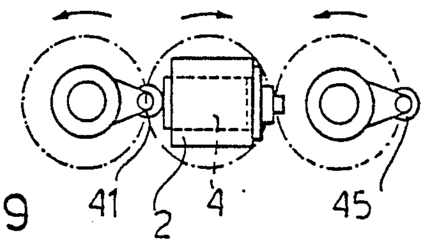


FIG. 9

EXPANSION STROKE

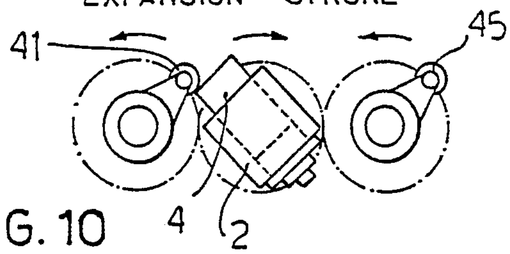


FIG. 10

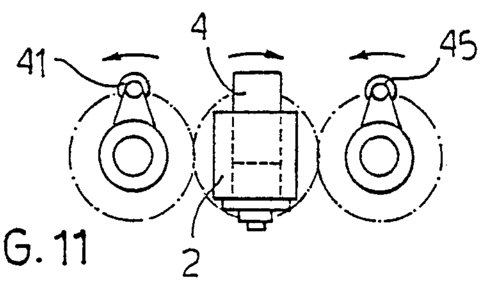


FIG. 11

EXHAUST STROKE

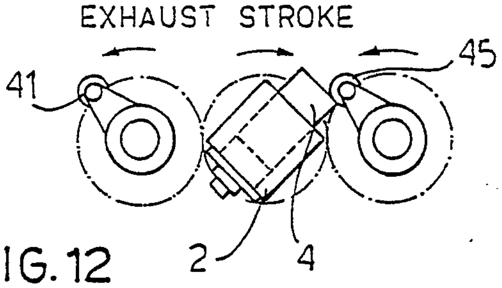


FIG. 12

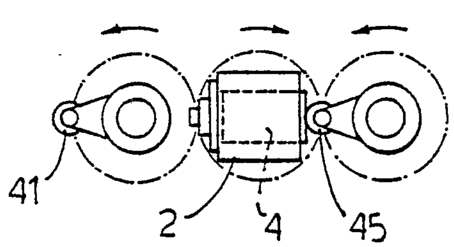


FIG. 13

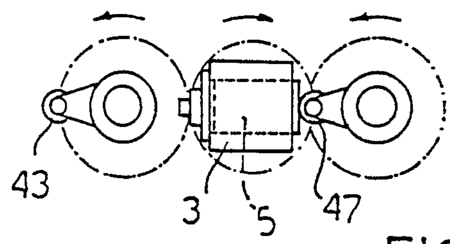


FIG. 17

INDUCTION STROKE

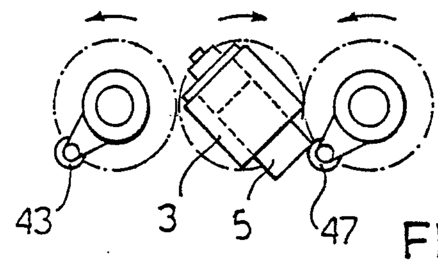


FIG. 18

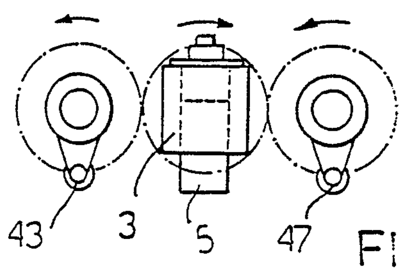


FIG. 19

COMPRESSION STROKE

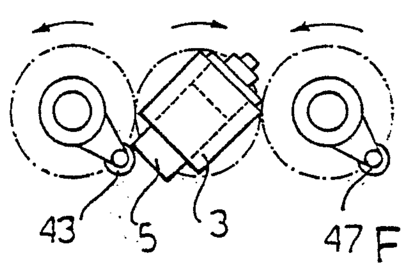


FIG. 20

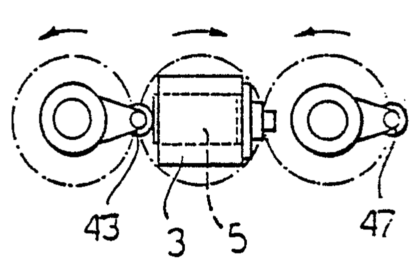


FIG. 21

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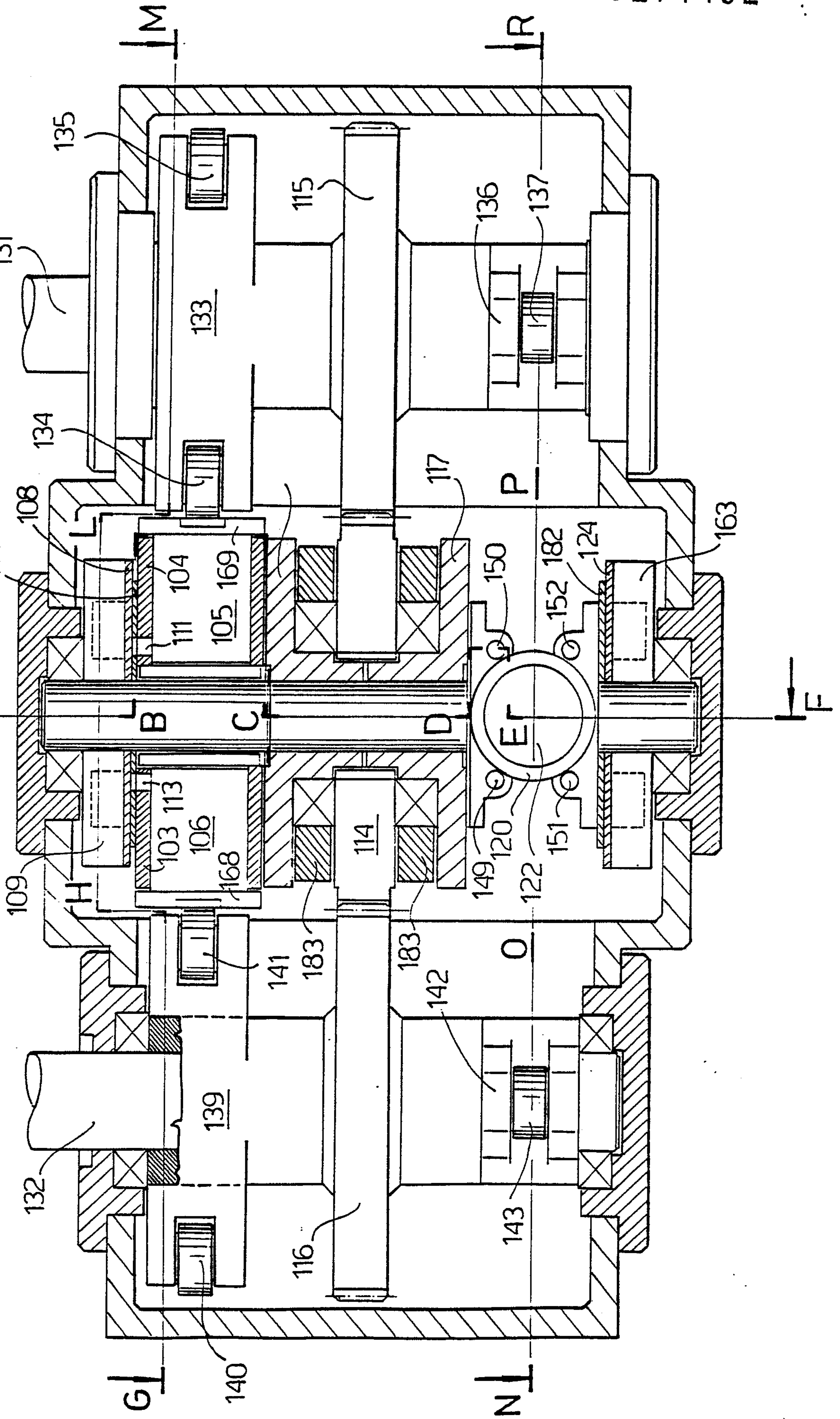
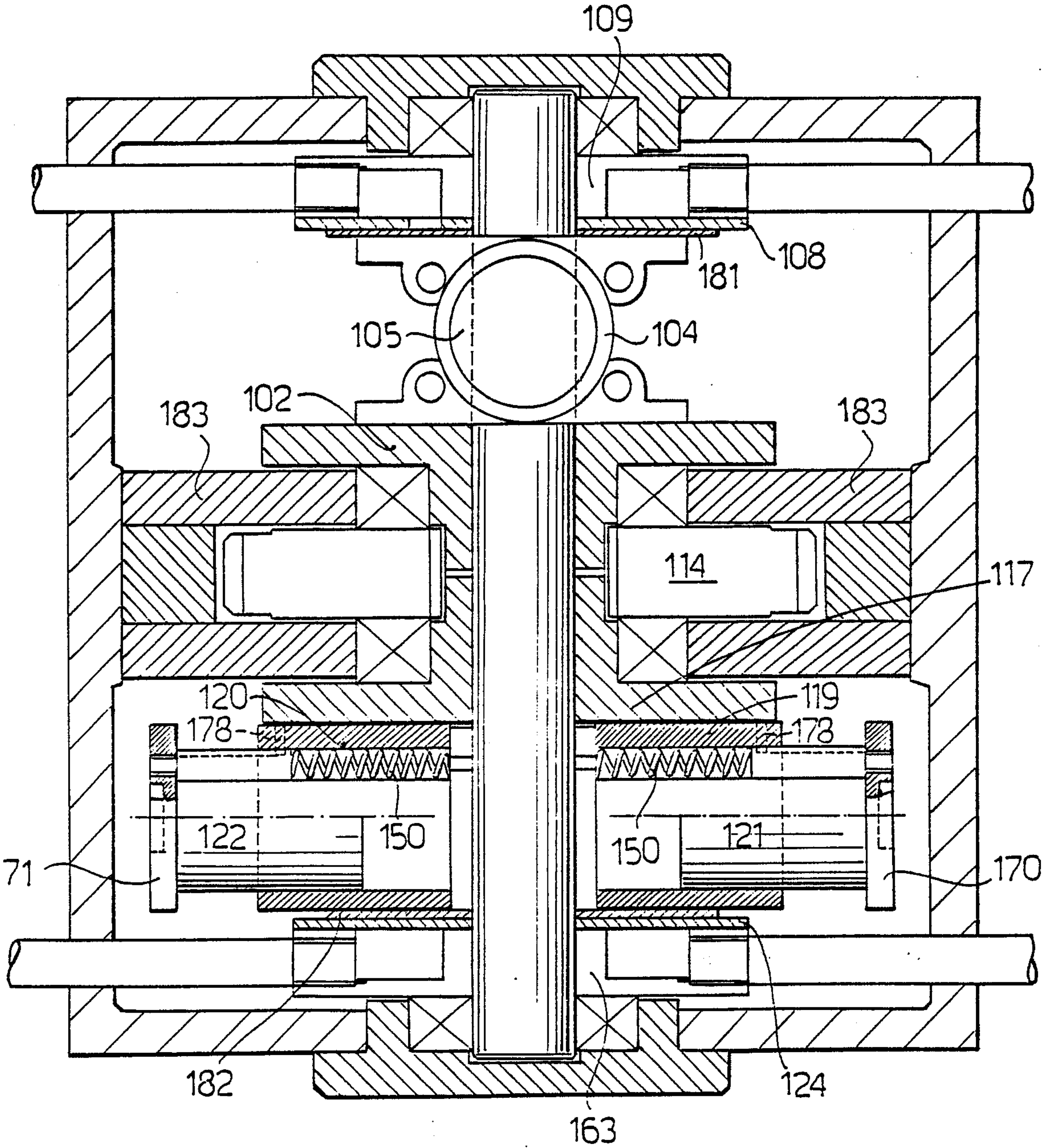


FIG. 22

FIG. 23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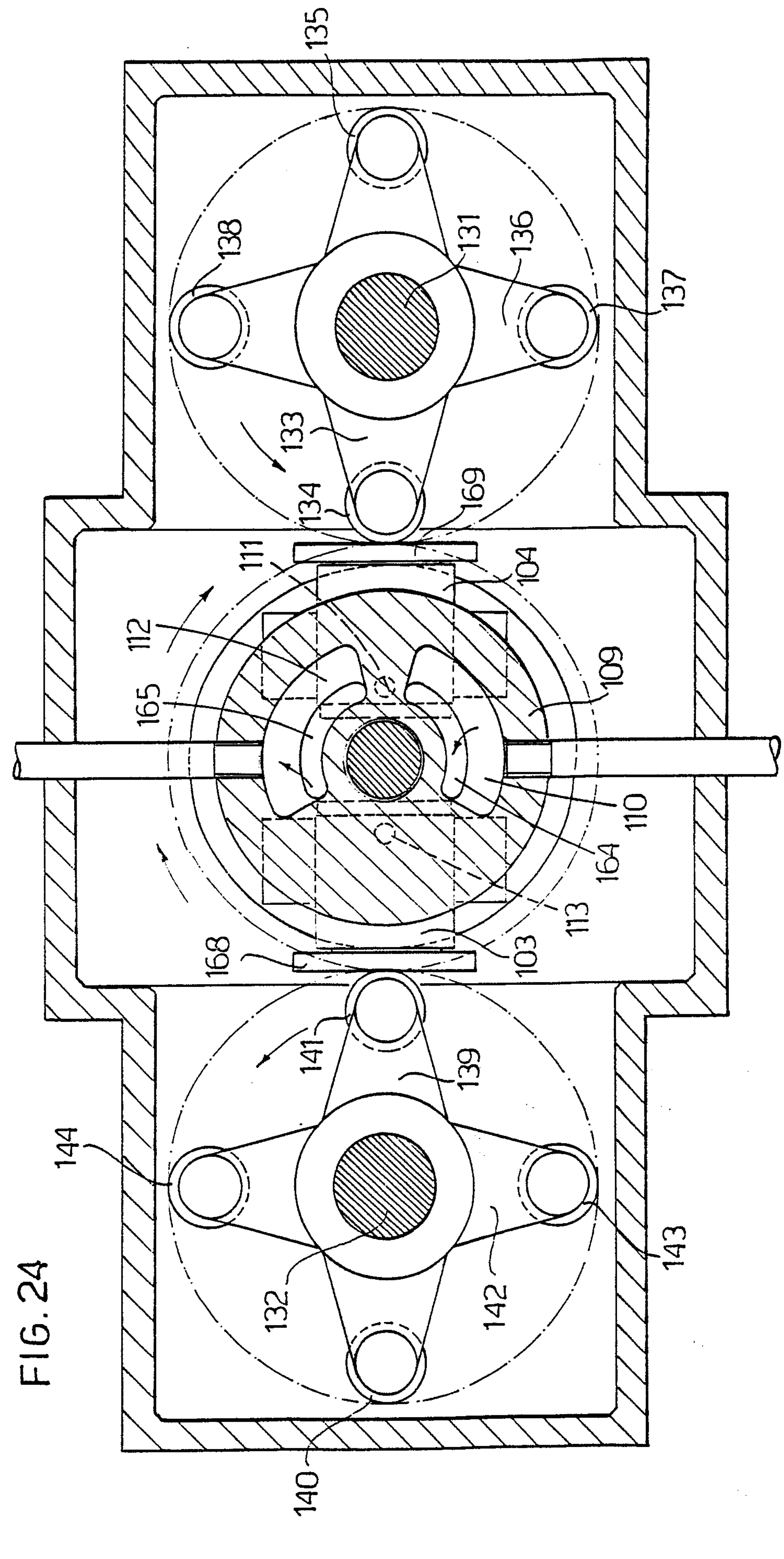
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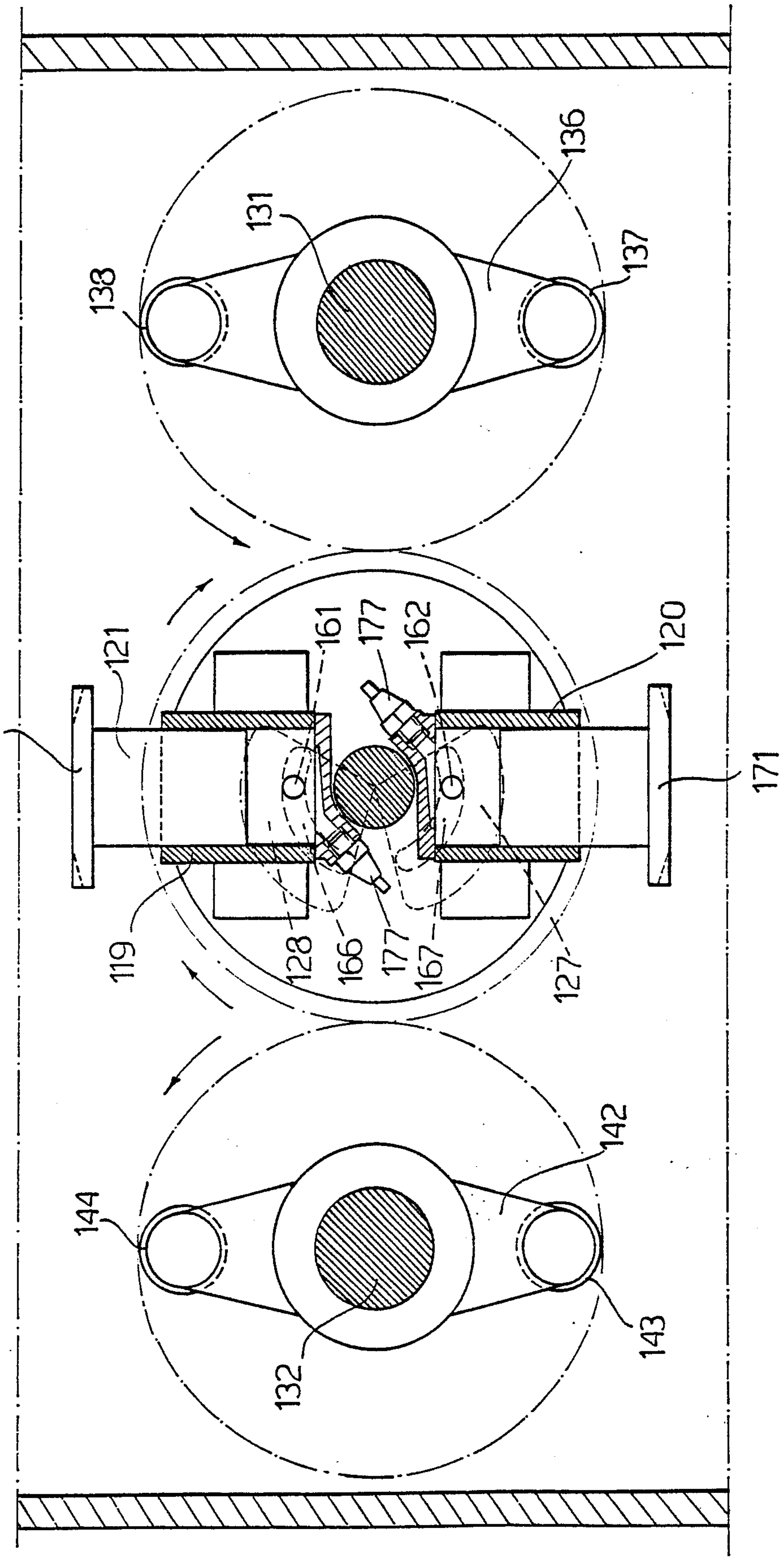
FIG. 24

FIG. 25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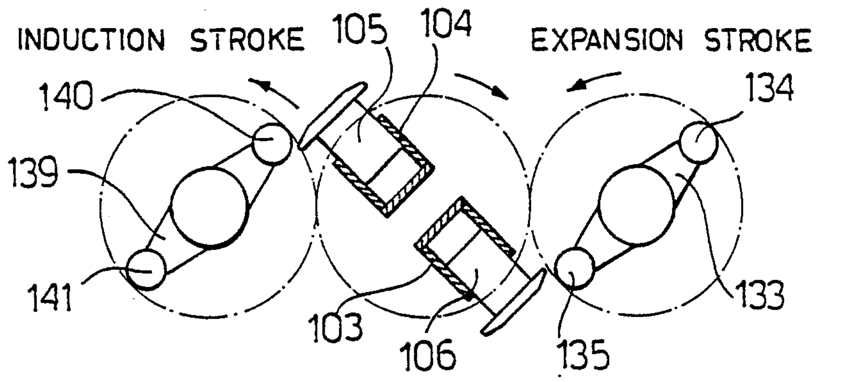

FIG. 26

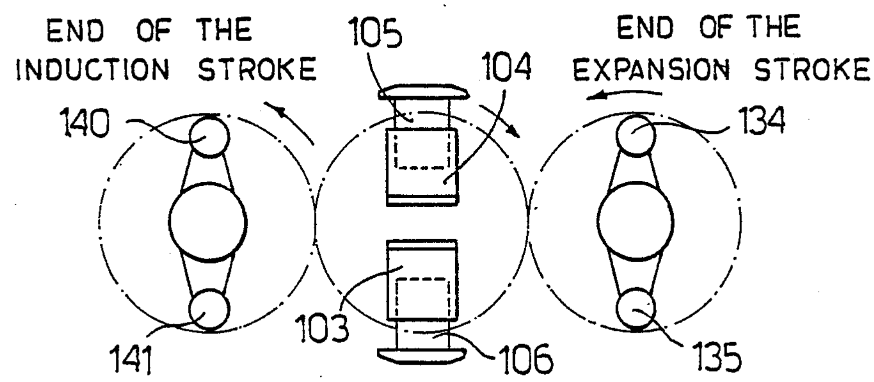

FIG. 27

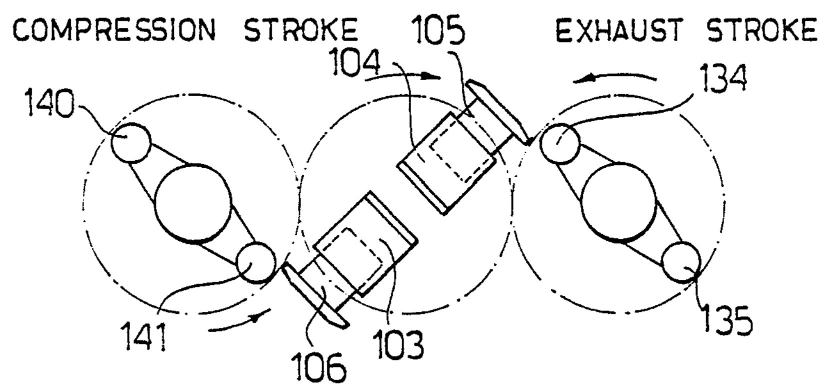

FIG. 28

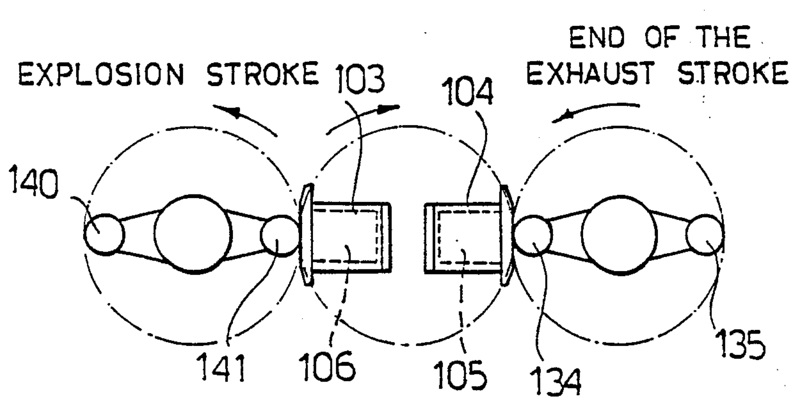

FIG. 29

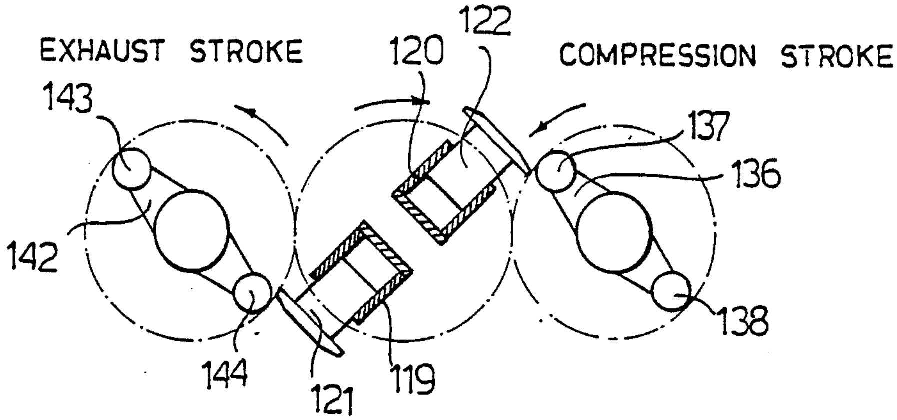

FIG. 30

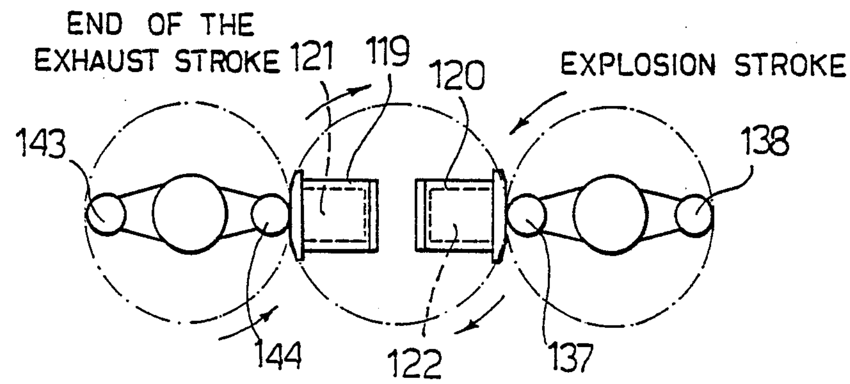

FIG. 31

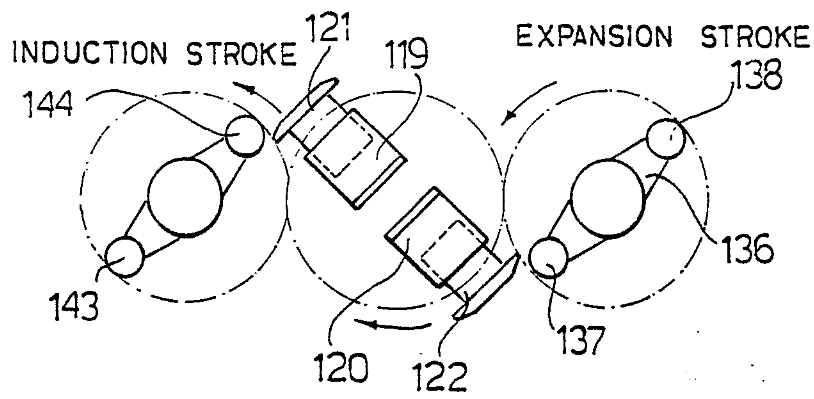

FIG. 32

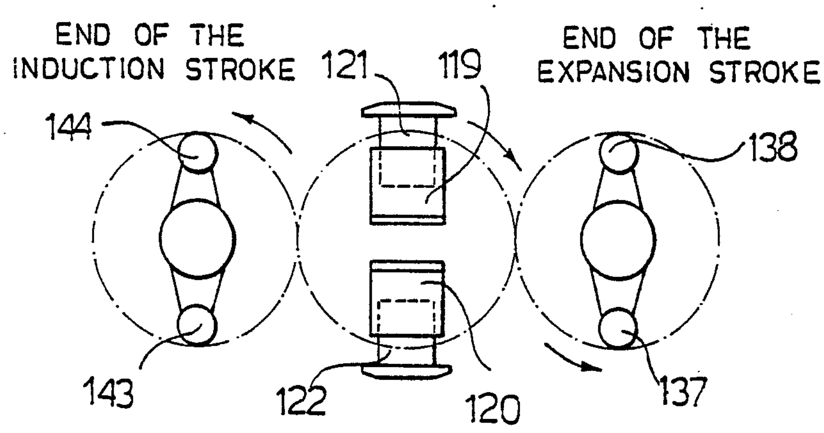

FIG. 33

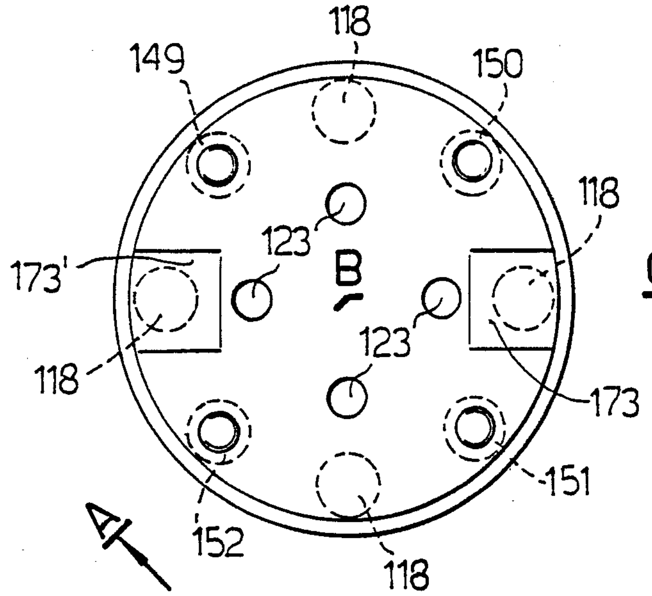
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FIG. 34

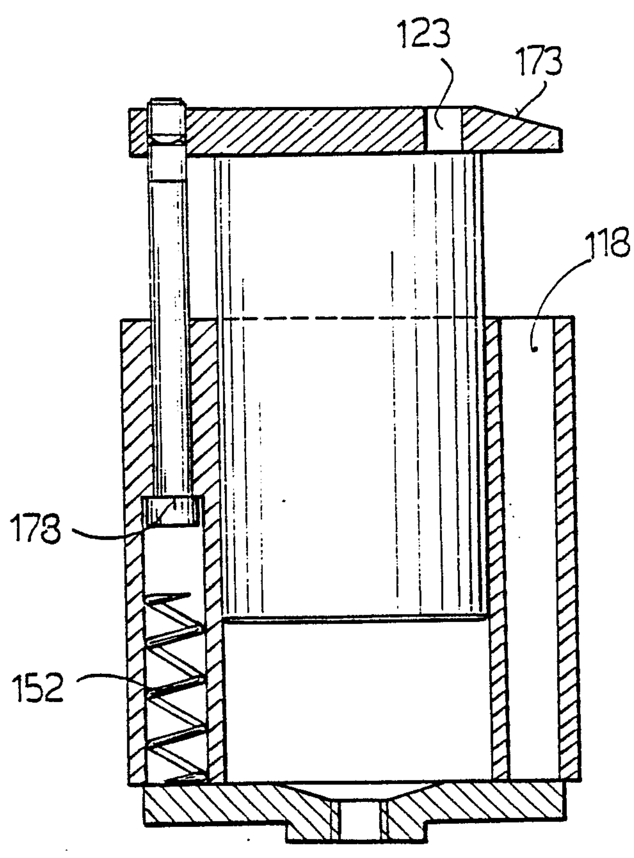
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FIG. 35

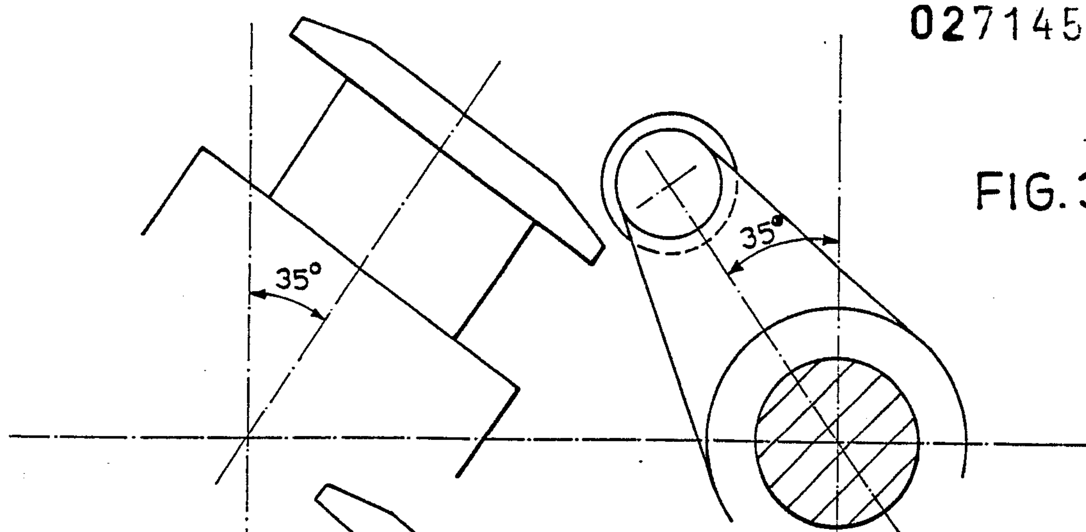

FIG. 36a

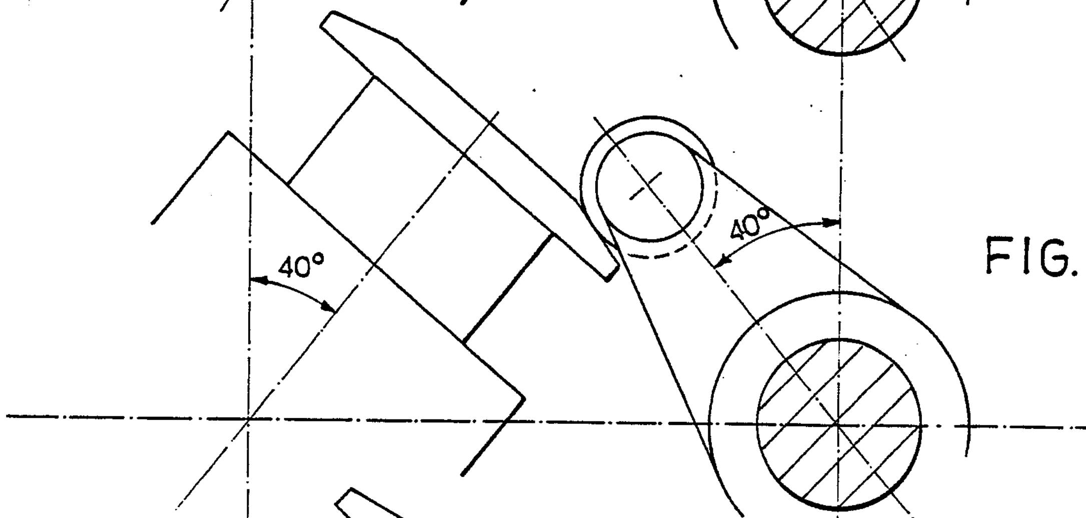

FIG. 36b

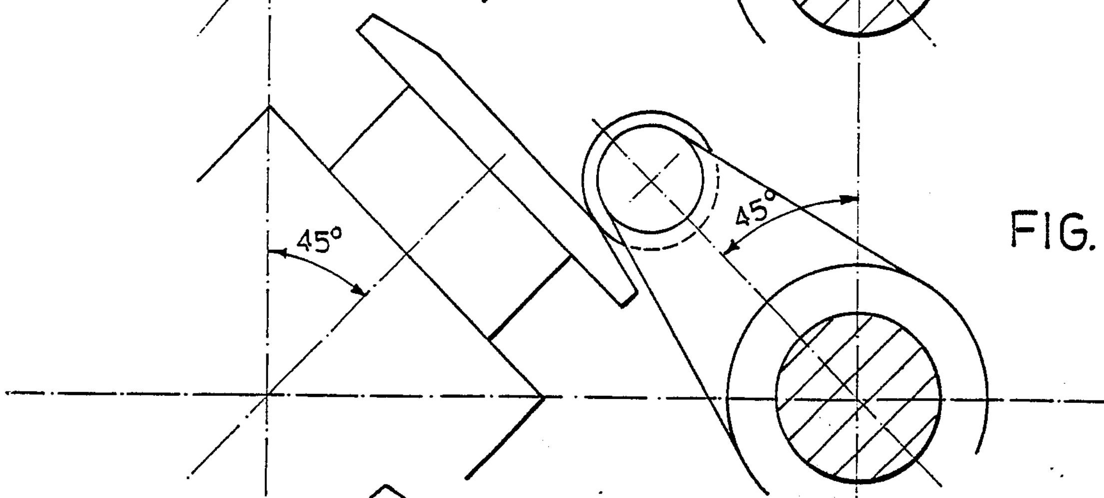

FIG. 36c

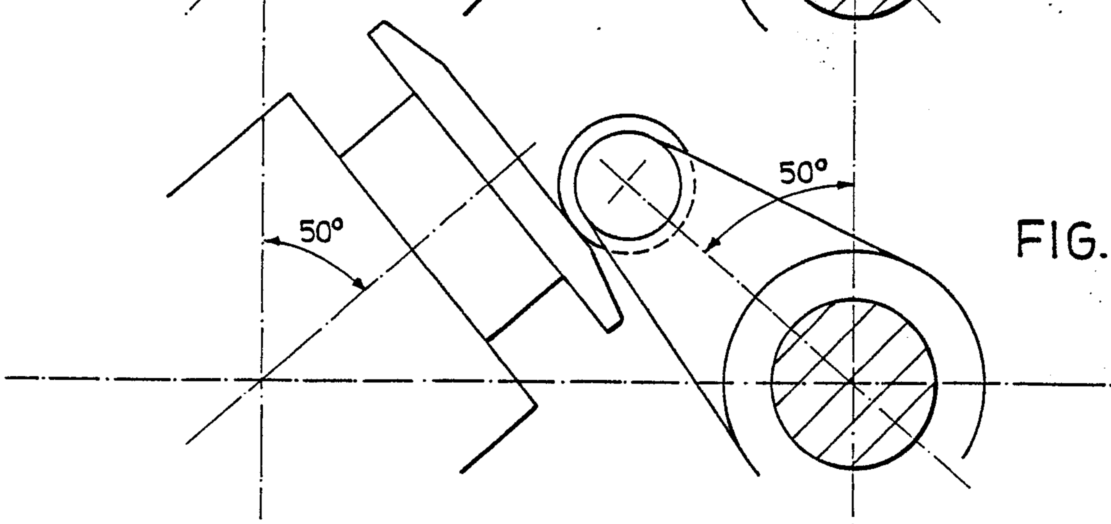

FIG. 36d

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 87 83 0400

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)
A	NL-A-6 505 191 (OOSTROM) * Figure III; page 5 * ---	1-3	F 02 B 57/08 F 01 B 13/06
A	FR-A-2 577 987 (MASSAL) * Figure 2; page 1 * -----	1,3	

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	19-02-1988	WASSENAAR G.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

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