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(54) A three cylinder internal combustion engine with an intermediate feed and exhaust cylinder.

(57) A three cylinder internal combustion engine (1) comprising an auxiliary or complementary cylinder (6), positioned between the two working cylinders (5), with a larger diameter and a crank pin (14), set at a 180° angle to the other two and with the feeding and exhaust operations of the lateral working cylinders (5) carried out through the central auxiliary or complementary cylinder (6) using a duct (18) between the auxiliary cylinder and each working cylinder wherein the auxiliary cylinder (6) works to a two stroke cycle and the working cylinders (5) work to a four stroke cycle.

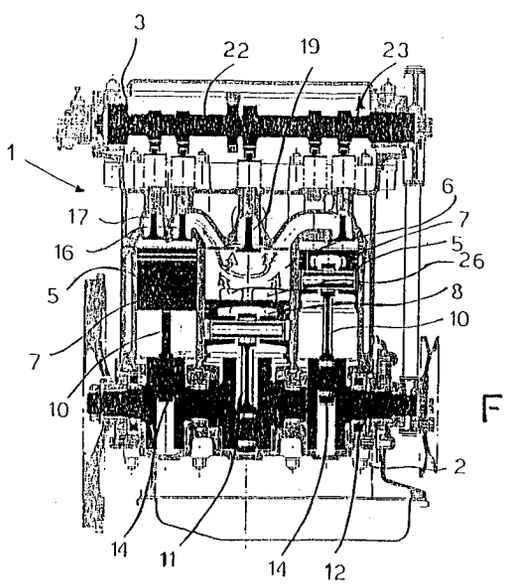

FIG.1

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This invention refers to an internal combustion engine with two in line cylinders provided with a third cylinder which works as a balancing cylinder and as a silencer.

An engine of this type is described in the Italian patent n° 1224473 from the same applicant, wherein a two cylinder engine, with a third interposed balancing and complementary cylinder of preferably larger diameter than the other two, is claimed.

The third cylinder, apart from being used as a balance against the alternating mass flows, also serves as a compressor during delivery strokes and as an expansion chamber during return strokes, and furthermore as a silencer and as a heat exchanger to reduce emissions. The two end cranks of the driving shaft are parallel and therefore set at a 360° angle, meanwhile the crank of the intermediate cylinder is set at a 180° angle. The feeding to the working cylinders, since ignition and combustion occur in them, is carried out for each by means of a duct regulated by one or more valves which is connected to the chamber of the central cylinder, while discharge outwards from the central cylinder is also regulated by one or more valves.

An engine of this type is particularly suitable for use in small city motor vehicles which must be highly compact, economical, powerful and silent and which, at the same time, must respect strict emission levels.

The aim of this invention is to improve the features of the engine described above by realizing a motor with more power and lower emissions but with substantially the same dimensions as the above.

Said aim is reached by means of an engine of said type characterized in that the feeding and the discharge of the lateral working cylinders take place through the central auxiliary or complementary cylinder, with at least one connecting duct between said auxiliary cylinder and each lateral working cylinder and characterized in that the auxiliary or complementary cylinder works to a two stroke cycle and the lateral working cylinders work on a four stroke cycle.

Furthermore all three of said cylinders are used as pumps to feed, through their block, a corresponding pressurized air plenum chamber, since at every stroke of the piston towards the bottom dead centre, a volume of air about double the volume moved by each piston is sent to the pressurized storage chamber.

Further features and advantages are made clear by the following description which refers to the enclosed drawings supplied by way of example only, in which:

-Figure 1 is a section view of an internal combustion engine according to the invention, taken along a plane comprising the engine axes,

-Figure 2 is a section view of the engine in figure 1 taken along a plane perpendicular to the engine axes at the height of the first cylinder,

-Figure 3 is a section view of the engine in figure 1 taken along a plane perpendicular to the engine axes at the height of the median cylinder,

-Figures 4 to 10 are are a series of diagrams showing the various working phases of the engine according to the invention.

With reference to figures 1-3, a complete internal combustion engine is indicated by the number (1), comprising the cylinder block (2) and the head (3).

In the cylinder block (2) two in line working cylinders (5) and an intermediate auxiliary or complementary cylinder (6), having a larger diameter than said cylinders (5), are obtained. In the cylinders (5 and 6) there are sliding pistons (7 and 8) mounted which are connected by means of connecting rods (10,11) to the driving shaft (12) which has crank pins (14) on the same axes, at a 360° angle, and the crank of the central cylinder at a 180° angle to the other two. In each of the cylinders (5) there are an inlet valve (16) and an exhaust valve (17), which are placed on the two ducts (18) which connect the cylinders (5) to the cylinder (6). Obviously the number of valves and ducts does not influence the way the engine of this invention works. A solution using valves for both inlet and discharge is also provided for.

The cylinder (6) is provided with at least one exhaust valve (19) which regulates an exhaust duct (20). All the valves (16,17,19) are driven by means of a camshaft (22) positioned on the engine cylinder head (3), together with the fuel injectors (24) and with the spark plugs (25). In the wall of the cylinder (6), corresponding to the bottom dead point of the piston (8), there are the inlet ports (26) for a feeding duct (27) from the pressurized air plenum chamber (28), described later, which are activated by the alternate movements of the piston (8). Said plenum chamber (28) is connected by means of ducts (30) to the cylinder block of the three cylinders, with the interposition of nonreturn blade valves (32), oriented towards the chamber so that the air in the cylinder block, having been sucked in from outside through the ducts (35) which are also provided with nonreturn, inwardly oriented, blade valves (36), is pumped into the chamber by the same movement of the pistons thus taking advantage of a principle typical of a two stroke engine. The pressure in the chamber results from the inflow of a volume of air into it equal, each time, to the total volume of the cylinder.

The cranks of the working cylinders are, as said, coaxial meanwhile the crank of the intermediate cylinder is at a 180° angle and therefore they balance each other. In a simpler solution, the valve of the lateral cylinders can be used both for the feeding and the discharge operations of the central cylinder.

The engine according to this invention has a working cycle which will be briefly described hereinafter with reference to figures 4 to 10, following, clockwise, the table of enclosed drawings.

As it will be noted, the working cycle of the two lateral working cylinders (5) is that normally associated with a four stroke internal combustion engine, while the auxiliary cylinder(6), although without ignition, can be defined as a two stroke cycle. In fact it works as a feeding and as a discharge for both cylinders the strokes of which cylinders are displaced by one complete rotation of the crank. Therefore, while one cylinder is in its **inlet phase**, the other is in its expansion **phase**, as shown in figure 4. In the next figure, the positions and strokes of the pistons are shown for every 60° rotation of the driving shaft which both, obviously, share. Regarding the movement of the valves, the exhaust valve of the central auxiliary cylinder (6) will always open together with the exhaust valves of the lateral cylinders, while for aspiration, the inlet ports (26) will supply the necessary compressed fluid from the plenum chamber (28). This fluid is further compressed by the piston (8) during the feeding phase into the lateral cylinder, given that the chamber of cylinder (6) has a greater volume than that of the cylinders (5).

Claims

1. A three cylinder internal combustion engine comprising an auxiliary or complementary cylinder, positioned between two working cylinders, with a larger diameter and a crank pin set at a 180° angle to the other two, characterized in that the feeding and the discharge operations of the two lateral working cylinders take place through the central auxiliary or complementary cylinder, with at least one connection duct between said central auxiliary cylinder and each lateral working cylinder and further characterized in that the auxiliary or complementary cylinder works to a two stroke cycle and the lateral working cylinders work to a four stroke cycle.

2. An engine according to claim 1 characterized in that the cylinder block of the three cylinders is manufactured in such a way to realize, through the rotatory movement of the connecting rods on the suitably shaped block, the air flow, by means of the three connecting rods, through nonreturn valves, into a common plenum chamber for the three cylinders.

3. An engine according to claim 1 characterized in that for the air intake, the cylinder block is connected to the exterior through one or more nonreturn valves.

4. An engine according to claims 1 and 2 characterized in that the auxiliary cylinder is connected to the pressurized air chamber by means of at least one duct and at least one inlet port opened in the cylinder wall corresponding to the bottom dead point of the piston stroke.

5. An engine according to claim 1 characterized in that the auxiliary cylinder is provided with at least one exhaust duct regulated by a valve.

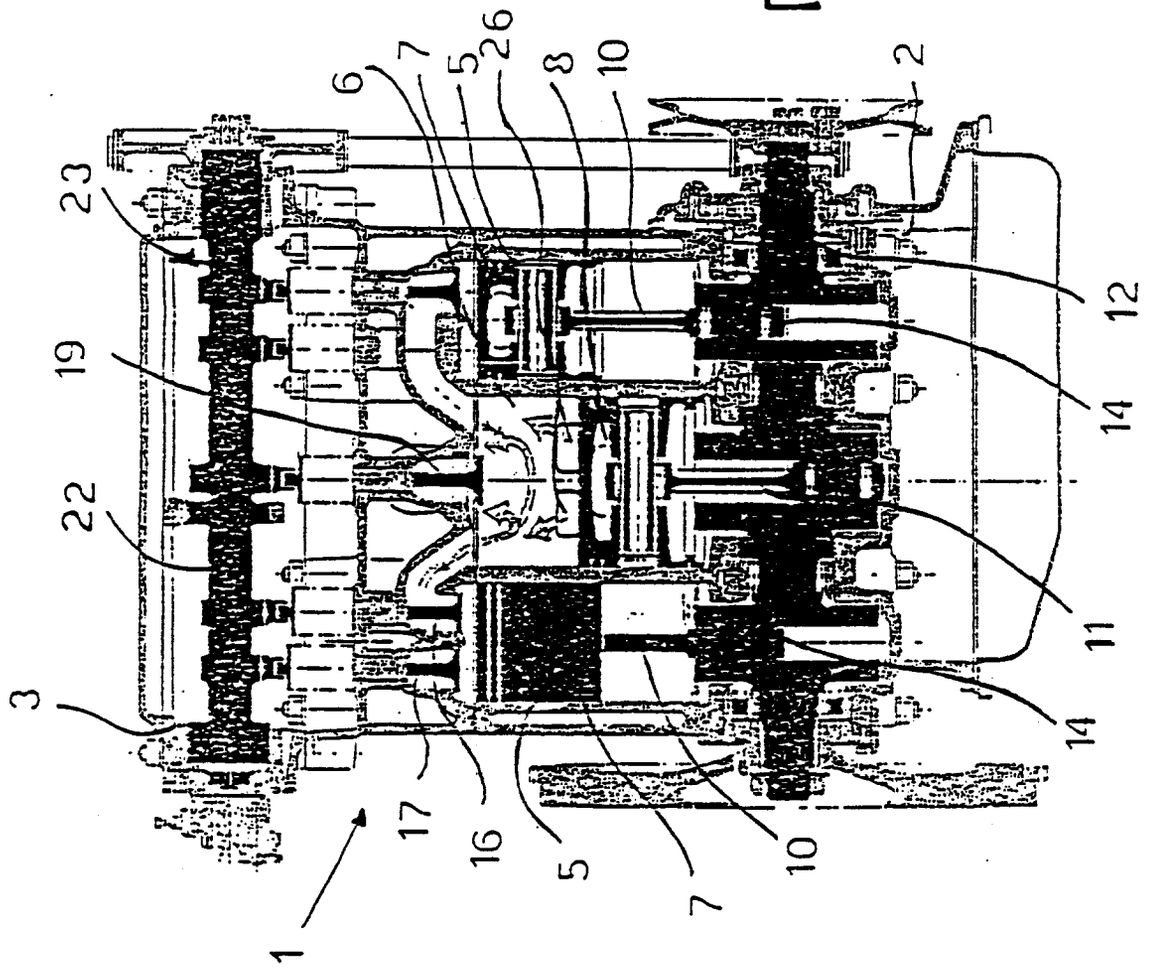


FIG.1

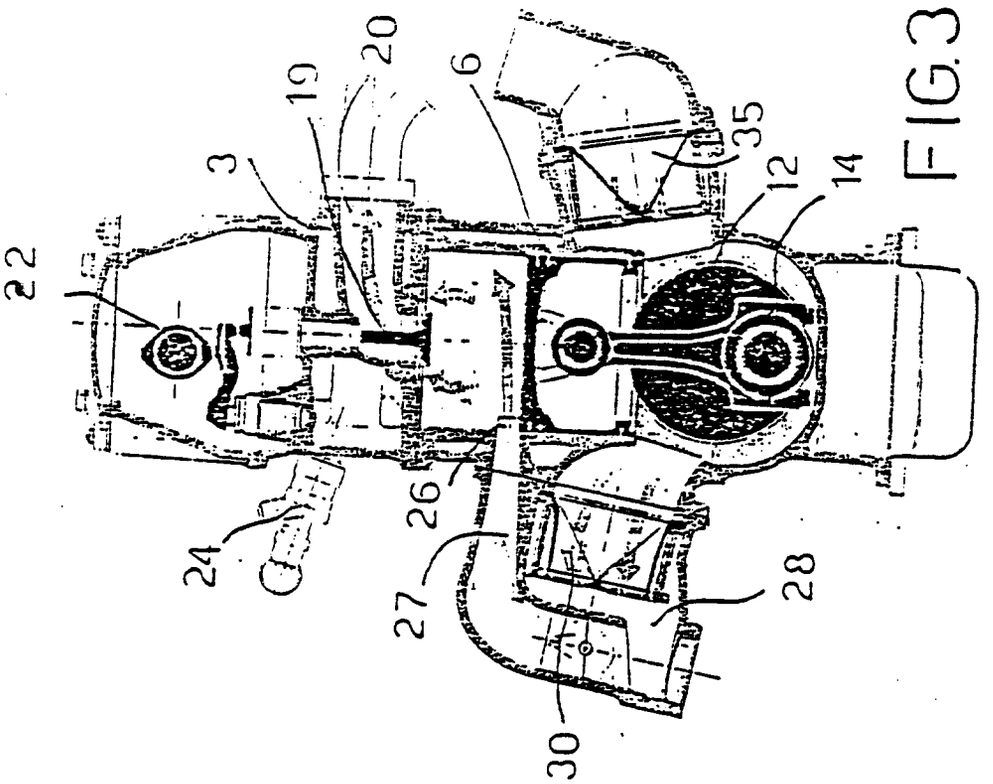


FIG.3

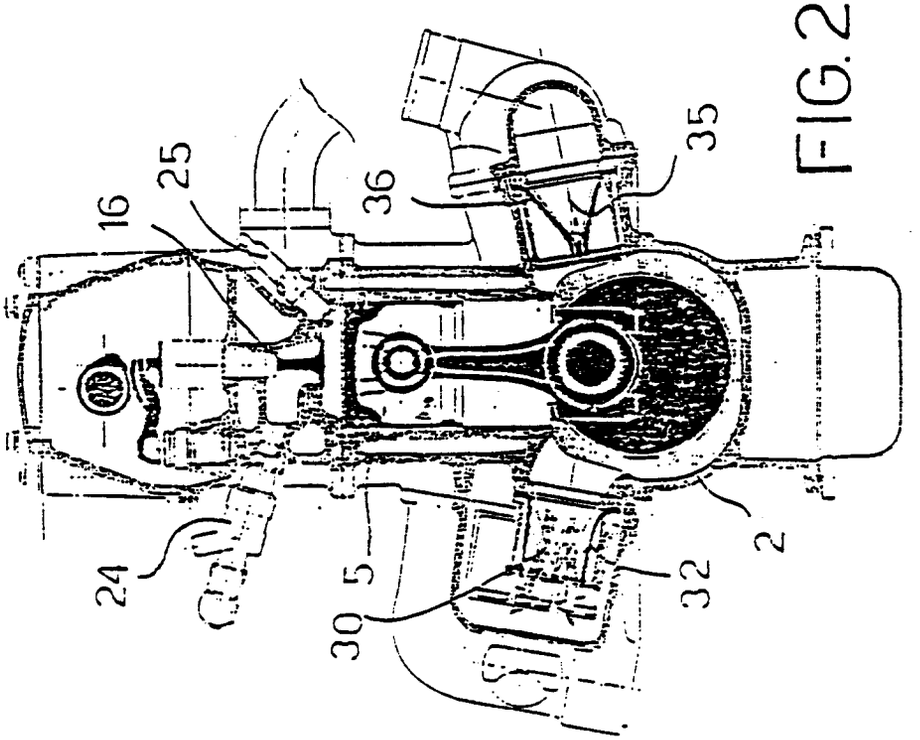


FIG.2

FIG.4

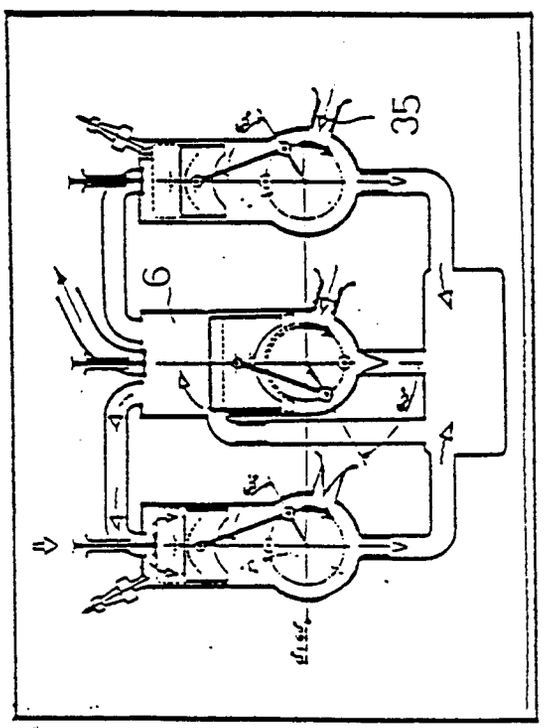


FIG.5

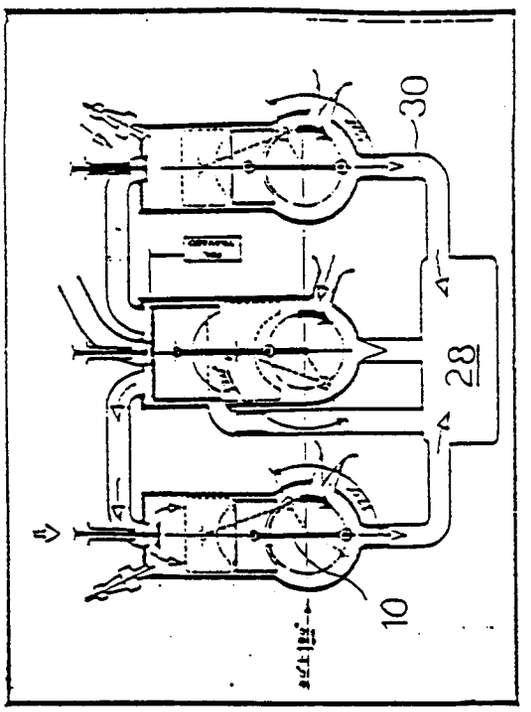


FIG.6

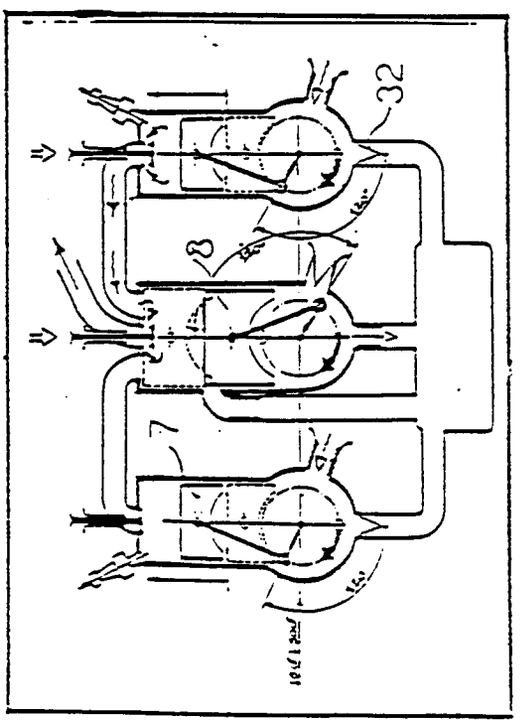


FIG.8

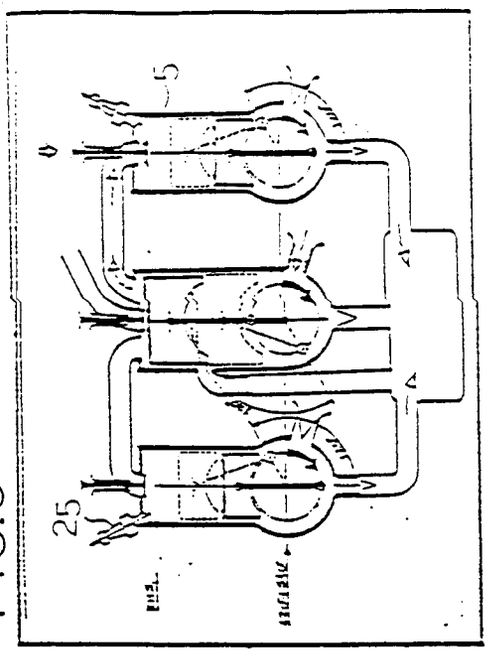


FIG.9

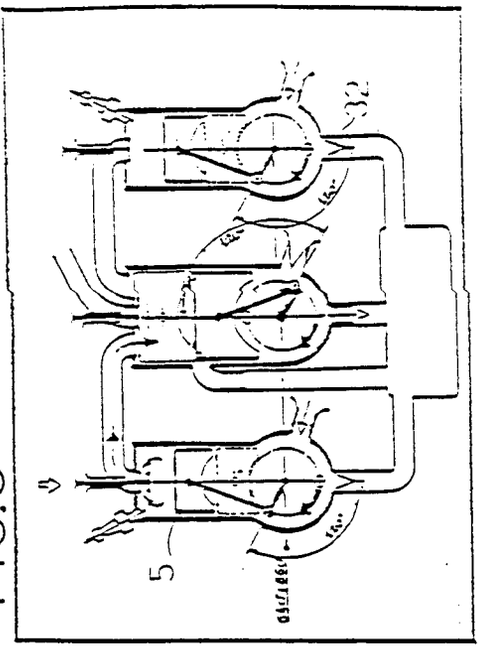


FIG.7

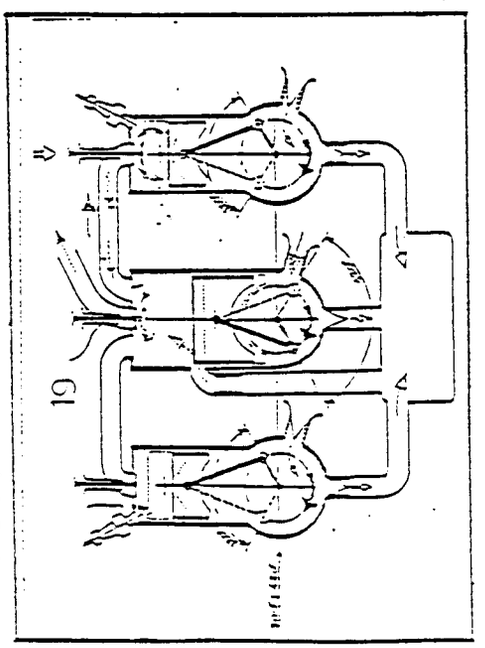
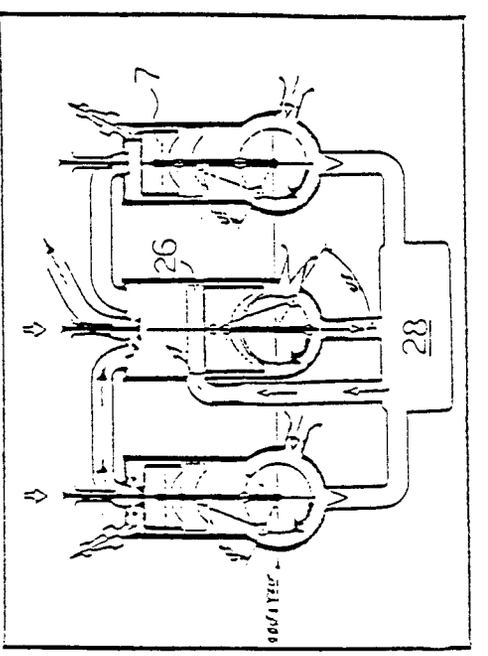


FIG.10



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EUROPEAN SEARCH REPORT

Application Number
EP 94 10 4482

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.5)
X	GB-A-169 799 (GERNANDT) * the whole document * ---	1,2,4	F02B75/02 F02B33/26 F02B41/06
A	DE-A-38 32 013 (DONKOV) * the whole document * ---	1,3	
A	EP-A-0 200 714 (BRÜCKER) * the whole document * ---	1	
A	PATENT ABSTRACTS OF JAPAN vol. 7, no. 98 (M-210) (1243) 26 April 1983 & JP-A-58 020 927 (KAZUHIKO NISHIYAMA) 7 February 1983 * abstract * -----	1-4	

TECHNICAL FIELDS SEARCHED (Int.Cl.5)

F02B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	22 June 1994	Wassenaar, G

CATEGORY OF CITED DOCUMENTS

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