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(54) **Two-stroke internal combustion engine with scavenging device.**

(57) A two-stroke engine incorporates a scavenging device which includes an auxiliary cylinder (31), an auxiliary piston (33) disposed in the cylinder (31) and capable of operating in conjunction with the piston (15) of the engine to deliver the fuel mixture in the combustion chamber (14) for scavenging. The scavenging device can deliver fresh air into the combustion chamber (14) before the fuel mixture for initial scavenging.

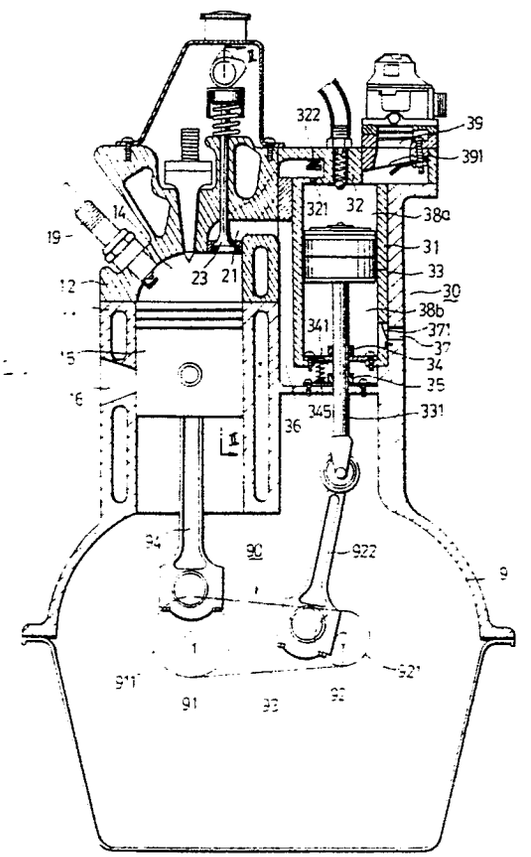

FIG 1

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"TWO-STROKE INTERNAL COMBUSTION ENGINE WITH SCAVENGING DEVICE"

This invention relates to a two-stroke internal combustion engine, and particularly to an improved scavenging device for a two-stroke engine which includes an auxiliary cylinder and an auxiliary piston operating in relation with the piston of the engine to deliver fresh air and fuel-and-air mixture together through a passage at the cylinder head of the engine so as to scavenge the exhaust gas efficiently.

A two-stroke engine with a scavenging fan has been known in the art, in which the scavenging fan delivers fresh fuel-and-air mixture into the combustion chamber, through a port in the wall of the cylinder, to remove and replace the burned spent gases. There is also another two-stroke engine which is scavenged by using the crank-case of the engine as a pump to deliver fuel-and-air mixture into the combustion chamber to replace the burned gases, wherein the scavenging fuel-and-air mixture is drawn into the crank case and is forced to flow into the combustion chamber by the action of the piston of the engine. In both types of engines, some of the fuel-and-air mixture may escape from the cylinder together with the exhaust gases during the scavenging operation. Such engines are not suitable for use in high power vehicles, since the power is produced is low, generally about 5 to 200 horsepower.

One of the reasons why the power of such engines is low is that the exhaust gases cannot be removed from the cylinder completely so that efficiency of the combustion is low. During the scavenging operation, unburnt fuel escapes from the cylinder together with the exhaust gases, thus wasting fuel and resulting in a high fuel consumption.

The known crank-case scavenged engine has another disadvantage in that the fuel-and-air mixture is delivered into the combustion chamber through an inlet port which is at the lower side of the cylinder and near the exhaust port, and lubricating oil must be mixed with the fuel-and-air mixture. Since the fuel-and-air mixture contains lubricating oil, the efficiency of combustion is low and fuel consumption thus increases.

The general object of the invention is to provide a two-stroke engine of enhanced efficiency. In particular the invention seeks to provide a two-stroke engine with an improved scavenging device which can efficiently remove exhaust gases from the combustion chamber, and can also minimise loss of fuel together with the exhaust gases, thereby reducing fuel consumption.

The invention may also provide a two-stroke engine with an improved scavenging device which can compress the fuel-and-air mixture prior to it's delivery to the combustion chamber so that the efficiency of combustion can be enhanced.

In particular also the invention may provide a two-stroke engine in which the fuel-and-air mixture need not be mixed with a lubricating oil.

The invention is characterised by a device for scavenging exhaust gases from a two-stroke engine which comprises an auxiliary cylinder and piston movably disposed therein, provided adjacent the engine. In one aspect of the invention, the auxiliary cylinder has a first variable-volume closed chamber at one side of the auxiliary piston for receiving a fuel-and-air mixture and a second variable-volume closed chamber at the other side of the piston for receiving fresh air. The auxiliary cylinder also has a fuel inlet port and a fuel outlet port communicating with the first closed chamber, and an air inlet port and an air outlet port communicating with the second closed chamber. The scavenging device further includes a passage communicating with the fuel outlet port, the air outlet port and the combustion chamber of the engine cylinder. The passage extends to the cylinder head of the engine cylinder and communicates with the combustion chamber. The auxiliary piston operates in conjunction with the engine piston to deliver fresh air into the combustion chamber to remove the exhaust gas at a first stage and then to deliver the fuel-and-air mixture into the combustion chamber to remove and replace the exhaust gases at a second stage. Since fresh air is delivered into the combustion chamber before the fuel-and-air mixture, escape of fuel together with the exhaust gases can be eliminated. Moreover, the fresh air or the fuel-and-air mixture are admitted in the combustion chamber through a port at the cylinder head to remove and replace the burned spent gases efficiently.

In another aspect of the invention, the passage includes a first passage to intercommunicate the first closed chamber and the combustion chamber, and a second passage to intercommunicate the second closed chamber and the combustion chamber.

In still another aspect of the invention, the scavenging device further includes a compressed fresh air receiving chamber communicating with the second closed chamber and the passage.

In still another aspect of the invention, the auxiliary cylinder and the engine cylinder are arranged side by side with their axes parallel. The crank mechanism of the engine includes a means

for transmitting the movement of the engine piston to the auxiliary piston. The transmission means may include a change speed gear assembly. The transmission ratio may be 2:1 so that the auxiliary piston operates at a faster rate than the engine piston.

In still another aspect of the invention, the auxiliary cylinder is disposed at the top side of the engine cylinder, and the auxiliary piston and the engine piston are aligned co-axially and interconnected by an axial connecting rod.

Some embodiments of the invention which are at present preferred will be hereinafter described by way of example, and in detail, with reference to the following drawings, in which:

Fig. 1 is a sectional view of a two-stroke engine of a first embodiment according to the present invention;

Fig. 2 is a fragmentary sectional view along line II-II of Fig. 1;

Fig. 3 is a fragmentary sectional view showing the lubricating system of the auxiliary cylinder;

Fig. 4 is a sectional view of a second embodiment of a two-stroke engine according to the present invention; and

Fig. 5 is a schematic view of a third embodiment of a two-stroke engine.

Referring firstly to Figs. 1 and 2, a first embodiment of a two-stroke engine according to the invention is shown, including an engine cylinder 11, a scavenging unit 30, and a crank case 9. The engine cylinder 11 has a cylinder head 12 with two inlet passages 21 and 22, and a piston 15 movable in the cylinder 11. The cylinder head 12, the wall of the cylinder 11 and the top side of the piston 15 co-operatively confine a variable volume combustion chamber 14 at the top side of the cylinder 11. A spark plug 19 is fitted in the cylinder head 12 to ignite the gases in the combustion chamber 14, and two inlet valves 23 and 24 are disposed in the inlet passages 21 and 22. The inlet valves 23 and 24 are controlled by two cams 25 and 26 of a valve operating system (not shown) which is known in the art. At a certain location in the wall of the cylinder 11 there is an exhaust port 16.

The scavenging unit 30 is disposed adjacent the cylinder 11. It includes an auxiliary cylinder 31 with a cylinder head 32, and a piston 33 movable in the cylinder 31. The piston 33 divides the cylinder 31 into a chamber 38a for receiving a fuel-and-air mixture flowing from a carburettor (not shown) and a chamber 38b for receiving fresh air. Outside the cylinder 31 is a compressed-air storage chamber 36. To the piston 33 is connected a piston rod 331 which passes through a first sealing cover 34 and a second sealing cover 35. In the sealing cover 34 is disposed an opening 341 to interconnect the chambers 38b and 36. A valve 345 is mounted on the sealing cover 35 to control the opening and closing of the opening 341. The compressed-air storage chamber 36 communicates with the inlet passage 21 of the engine cylinder 11. When the valve 23 is opened, the chamber 36 communicates with the combustion chamber 14 of the engine cylinder 11 through the inlet passage 21.

In the lower side of the wall of the auxiliary cylinder 31 is an air inlet port 37 which is open to the atmosphere. In the inlet port 37 there is a valve 371. When the piston 33 ascends, a vacuum develops in the chamber 38b below the piston 33 and the valve 371 will open.

The upper chamber 38a of the cylinder 31 communicates with a fuel inlet port 39 in the cylinder head 32 which is regulated by a valve 391, and with a fuel outlet port 321 which is regulated by a valve 322. When the piston 33 descends, the fuel-and-air mixture is drawn into the chamber 38a through the valve 391. When the piston 33 ascends, the valve 391 is closed, and the fuel-and-air mixture is forced to flow through the fuel outlet port 321 to the passage 22 which connects the chamber 38a with the combustion chamber 14 of the engine cylinder 11.

In the crank case 9 is a crank mechanism 90 including a crank shaft 91 on which is mounted a driving toothed crank disc 911, and a crank shaft 92 on which is mounted a driven toothed crank disc 921. The two toothed crank discs 911 and 921 are interconnected by a chain 93. A piston rod 94 is connected to the crank disc 911 and the piston 15, and a crank arm 922 is connected to the crank disc 921 and to the piston rod 331. The ratio of the number of teeth on the discs 911 and 921 is 2:1 so that the speed of the piston 33 is faster than that of the piston 15. Alternatively, the crank mechanism may include a change speed gear assembly instead of the toothed crank disc 911 and 921 to maintain the piston 33 at a rate which allows the movement of the piston 33 to best match the operation of the engine piston and the opening and closing operation of the inlet valves 23 and 24 of the engine cylinder so as to achieve an efficient scavenging effect.

In operation, the piston 15 is reciprocated up and down through the crank mechanism 90 by power produced by the combustion of the gases.

When the piston 15 is in its highest position, the valves 23 and 24 are closed and compression is completed. After the spark plug 19 ignites the fuel mixture, the resultant gases thrust the piston 15 downward. In the auxiliary cylinder 31, the piston 33 moves upward, drawing fresh air into the chamber 38b and forcing the fuel-and-air mixture which is drawn into the chamber 38a to flow into the passage 27 through the outlet port 321.

When the exhaust port 16 is uncovered by the piston 15 which moves downward, the exhaust gas begins to escape through the port 16. At this moment, the piston 33 moves downward, and the valve 23 of the cylinder 11 and the valves 345 and 391 of auxiliary cylinder 31 are opened. Compressed fresh air from the chambers 36 and 36b is forced to flow into the combustion chamber 14. The fresh air enters the combustion chamber 14 from the cylinder head 12 and removes and replaces the exhaust gases as an initial scavenging stage. As such, the problem of waste of the fuel-and-air mixture is avoided due to it's undesirable escape together with the exhaust gas as occurs with conventional scavenging units using the fuel-and-air mixture for scavenging purposes.

The subsequent downward movement of the piston 33 continuously pushes fresh air into the chamber 36 from the chamber 38b, and draws the fuel-and-air mixture into the chamber 38a. When the piston 15 begins to move upward from its lowest position, the piston 33 again moves upward. The exhaust port 16 is still opened. The valve 23 is closed and the valve 24 is opened. The ascending piston 33 forces the fuel mixture into the combustion chamber 14 to remove and replace the exhaust gas subsequent to the initial fresh-air scavenging stage.

As the piston 15 continues to ascend, it covers the port 16, the valves 23 and 24 are closed and the fuel-and-air mixture is compressed. In the cylinder 31, the piston 33 descends, compressing fresh air into the chamber 36 and drawing the fuel mixture into the chamber 38a. In this way, the pistons 15 and 33 move reciprocally in the cylinders respectively to perform the engine operation.

The lubricating system for the auxiliary cylinder 31 is incorporated in the piston 33 as shown in Fig. 3. The piston 33 has an interior chamber 333 for receiving lubricating oil and oil passages (not shown) which communicate with the chamber 333 and open at the periphery of the piston 33. The piston rod 331 is of hollow construction and has an oil passage 331 a. At the top side of the piston 33 is an oil inlet port 335 in which is disposed a ball valve 336 and a spring 337 biasing the valve 336 to close the port 335. In the cylinder head 32 is an oil injecting port 338 and a spring-loaded ball valve 339 to close the port 388.

The oil injecting port 338 communicates with an oil conduit 340. When the piston 33 reaches the highest position, the ball valves 336 and 339 push against one another so that they retract into and open the respective ports 335 and 338. In this situation, the ports 335 and 338 approach and communicate with one another, and the lubricating oil from the conduit 340 flows into the chamber 333 of the piston 33. The excess lubricating oil will flow into the hollow piston rod 331.

Referring to Fig. 4, a second embodiment of the present invention includes an engine cylinder 41 with a piston 45 movable therein and defining the wall of the cylinder 41 a combustion chamber 44. The wall of the cylinder 41 has an exhaust port 46 and the cylinder head 42 has an inlet passage 48 controlled by a valve 49.

At the upper side of the engine cylinder 41 is an auxiliary cylinder 51 having an auxiliary piston 53. The piston 53 divides the cylinder 51 into two variable-volume closed chambers 58a and 58b for receiving the fuel-and-air chamber and fresh air respectively. A fuel inlet port 59 controlled by a valve 591 and a fuel outlet port 52 contrlled by a valve 522 are provided in the cylinder 51 and communicate with the chamber 58 a. An air inlet port 57 controlled by a valve 571 and an air outlet port 572 controlled by a valve 573 are communicated with the chamber 58 b.

The auxiliary piston 53 and the engine piston 45 are interconnected by an axial connecting rod 47 which passes slidably through and is kept in a gas-tight relationship with sealing covers 54 and 55 and the cylinder head 42. The piston 45 is further connected to a piston rod 451 which in turn is connected to a crank mechanism (not shown) provided in a crank disposed at the lower side of the cylinder 41. When the piston 53 ascends, it compresses fresh air admitted through the port 57 and forces it to flow through the port 572 into a compressed fresh air receiving chamber 56 which communicates with the passage 48 of the cylinder 41. The compressed fresh air flows out of the chamber 58b until the valve 573 is closed as soon as the piston 53 reverses it's direction to descend. The space between the sealing covers 54 and 55 form a part of the chamber 56. The compressed fresh air accumulates in the chamber 56 until the port 48 is opened.

In operation, pistons 53 and 45 ascend and descend at the same speed. When the piston 45 is at it's highest position, the valve 49 is closed. The spark plug ignites the compressed fuel-and-air mixture admitted in the combustion chamber, and the burning gases thrust the piston 45 downward. As the piston 45 descends, the piston 53 descends, drawing fresh air into the chamber 58b and compressing the fuel-and-air in the chamber 58a. When the exhaust port 46 is uncovered by the piston 45, the exhaust gases escape. At this time, the valve 49 of the cylinder 41 opens. The piston 53 forces the fuel mixture to flow out of the chamber 58 a. The fuel mixture is delivered into the combustion chamber together with the compressed fresh air

which fills the lower part of the chamber 56, and the compressed fresh air and the fuel-and-air mixture together remove and replace the exhaust gases.

When the piston ascends, it covers the exhaust port 46. The valve 49 then closes, and the piston 45 compresses the fresh fuel-and-air mixture until it reaches it's highest position. As the piston 45 ascends, the piston 53 ascends, drawing in the fuel-and-air mixture from the carburettor 60 to the chamber 58a and compressing the fresh air in the chamber 58b.

The lubricating system in the auxiliary cylinder 51 is the same as that provided in the auxiliary cylinder of the first embodiment.

A third embodiment of the present invention is schematically shown in Fig. 5 in which the members which are the same as those illustrated in Fig. 1 are represented by the same reference numerals. The auxiliary cylinder 31 and the auxiliary piston 33 define a single closed chamber 38a at the upper side of the cylinder 31 for receiving the fuel-and-air mixture. The engine piston 15 and the auxiliary piston 33 are connected respectively to two piston rods 94 and 331 which in turn are connected to crank means 95 and 96 mounted on a crank shaft 97. There is no fresh air receiving chamber 38b and no compressed fresh air receiving chamber 36, as in the first embodiment, in this case.

In operation, the pistons 15 and 33 ascend and descend simultaneously at the same rate. The fresh fuel-and-air mixture from the chamber 38a is forced to flow into the combustion chamber 14 when the engine piston 15 ascends from it's lowest position. This is because the valve 322 is opened when the piston 33 ascends simultaneously with the piston 15. Although no fresh air is delivered into the combustion chamber to constitute an initial scavenging stage, such an arrangement can reduce the escape of the fuel together with the exhaust gases since the exhaust gases are first flushed out by the pressure itself, and the fuel mixture is delivered to replace the remaining exhaust gases only when the exhaust port is about to be covered by the piston.

With the invention thus explained, it is apparent that various modifications and variations can be made without departing from the invention as defined in the appended claims.

Claims

1. A two-stroke engine including an engine cylinder (11 or 41) having an engine cylinder head (12 or 42) with an intake port means (21, 22 or 49) therein and an exhaust port (16 or 46) in the wall of the engine cylinder, a piston (15 or 45) movable in the engine cylinder and forming with the wall of the engine cylinder and the cylinder head a combustion chamber (14 or 44), a crank case (9) connected to the engine cylinder encasing a crank mechanism (90), the crank mechanism having a first crank shaft (91 or 97) mounted in the crank case, a first crank member (911 or 95) mounted on the first crank shaft, a first piston rod (94 or 451) connected to the engine piston (15 or 45) and to the first crank member (911 or 95), characterised by a device for scavenging exhaust gas from the engine cylinder comprising an auxiliary cylinder (31 or 51) closed at one end thereof and disposed outside the crank case adjacent the engine cylinder, an auxiliary piston (33 or 53) movably disposed in the auxiliary cylinder and forming with the wall of the auxiliary cylinder a first variable-volume chamber (38a or 58a) at one side of the auxiliary piston for receiving a fuel-and-air mixture, the auxiliary cylinder having a fuel inlet port (39 or 59), a fuel outlet port (321 or 52) communicating with the first closed chamber, and a first passage (21 or 48) communicating with the fuel outlet port (321 or 52) and extending to the cylinder head to communicate with the intake port (21 or 481) of the engine cylinder, the auxiliary piston operating in conjunction with the engine piston to deliver the fuel-and-air mixture into the combustion chamber through the first passage to scavenge the burned gases.

2. A two-stroke engine as claimed in Claim 1, wherein the auxiliary cylinder (31) is disposed adjacent and side by side with the engine cylinder (11), and the crank mechanism further includes a second crank member (96) mounted on the first crank shaft (97), and a second piston rod (331) connected to the auxiliary piston (33) and to the second crank member (96).

3. A two-stroke engine as claimed in Claim 1, wherein the auxiliary cylinder (31 or 51) is closed at both ends thereof, the auxiliary piston (33 or 53) further forming with the wall of the auxiliary cylinder at another side of the auxiliary piston a second closed chamber (38 b or 58b) for receiving fresh air, the auxiliary cylinder further including an air inlet port (37 or 57) and an air outlet port (341 or 572) communicating with the second closed chamber, the scavenging device further including a compressed fresh air chamber (36 or 56) communicating with the air outlet port of the auxiliary cylinder and the intake port means of the engine cylinder.

4. A two-stroke engine as claimed in Claim 3, wherein the auxiliary cylinder (31) is disposed side by side with and adjacent the engine cylinder (11), the crank mechanism further including a second crank shaft (92) mounted in the crank case parallel with the first crank shaft (91), a second crank member (921) mounted on the second crank shaft

(92), a second piston rod (331) connected to the auxiliary piston (33) and the second crank member (921), and a transmission means associated with the first and second crank shafts (91 and 92), the scavenging device further including a second passage means (24) connecting the compressed fresh air chamber (36) and the intake port (22) of the engine cylinder (11).

5. A two-stroke engine as claimed in Claim 4, in which the first crank member (911) is a first toothed crank disc and the second crank member (921) is a second toothed crank disc, wherein the transmission means is a transmission chain (93) passing over the first and second toothed crank discs.

6. A two-stroke engine as claimed in Claim 5, wherein the first toothed crank disc has twice as many teeth as the second toothed crank disc.

7. A two-stroke engine as claimed in Claim 3, wherein the auxiliary cylinder (51) is disposed above the engine cylinder (41), and the cylinder head (42) of the engine cylinder is adjacent one of the closed ends of the auxiliary cylinder 51, the scavenging device further including a third piston rod (47) connected to the auxiliary piston (53), extending through the cylinder head and the closed end of the auxiliary cylinder, and connected to the engine piston (45).

8. A two-stroke engine as claimed in Claim 1, wherein the auxiliary piston (33) is hollow and has a cavity (333) therein for receiving lubricating oil, an oil inlet passage (335) at one side of the auxiliary piston facing one of the closed ends of the auxiliary cylinder, and a first ball valve (336) disposed in the inlet passage and biased normally to block the inlet passage and to project partially from the auxiliary piston, the closed end of the auxiliary cylinder facing the inlet passage (335) of the auxiliary piston having an oil delivering passage (338) which is aligned axially with the oil inlet passage, and a second ball-shaped valve (339) disposed in the oil delivering passage and normally biased to block the oil delivering passage to project partially from the closed end of the auxiliary piston, the inlet passage (335) of the auxiliary piston communicating with the oil delivering passage (338) when the auxiliary piston ascends to a highest position.

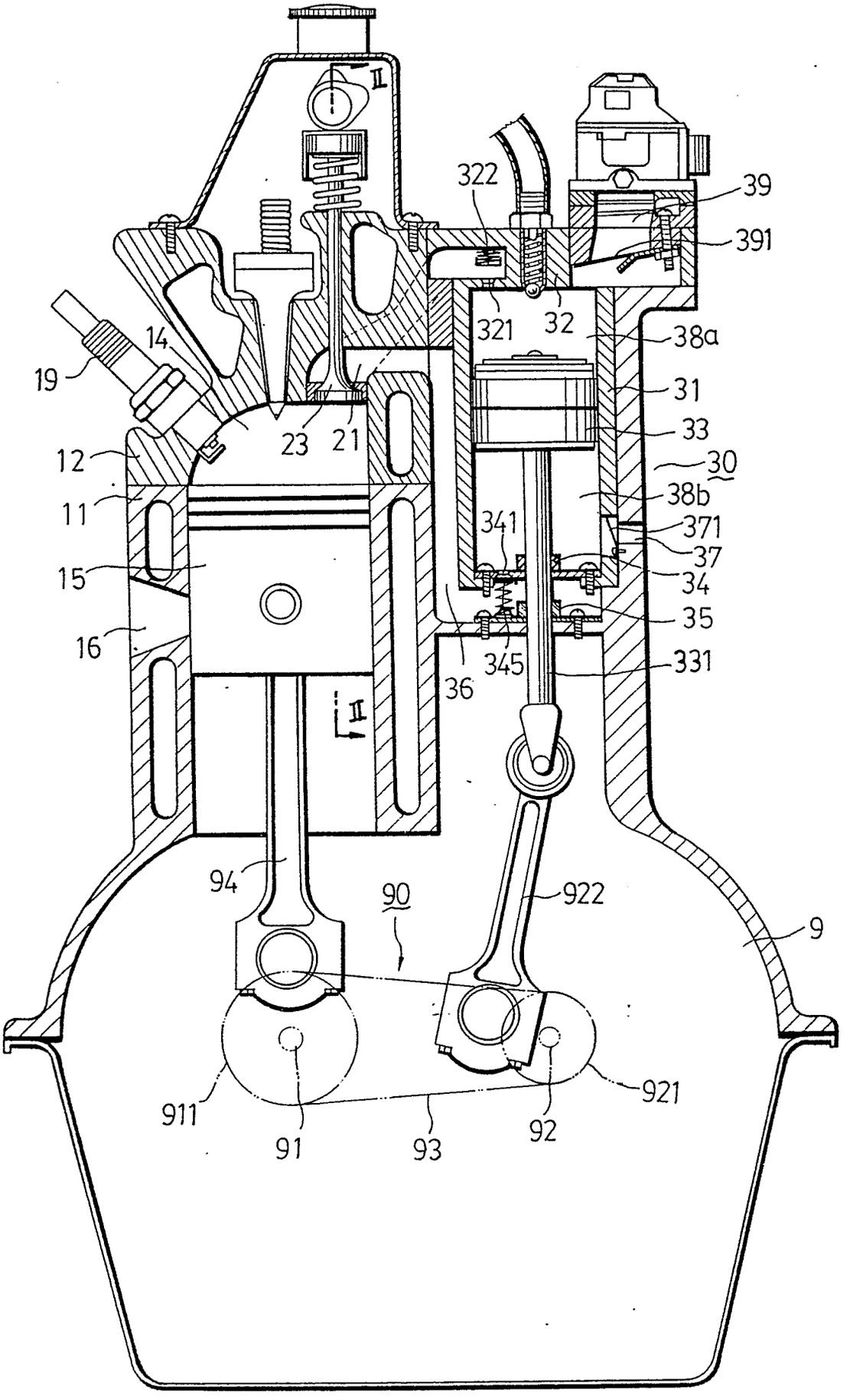
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FIG . 1

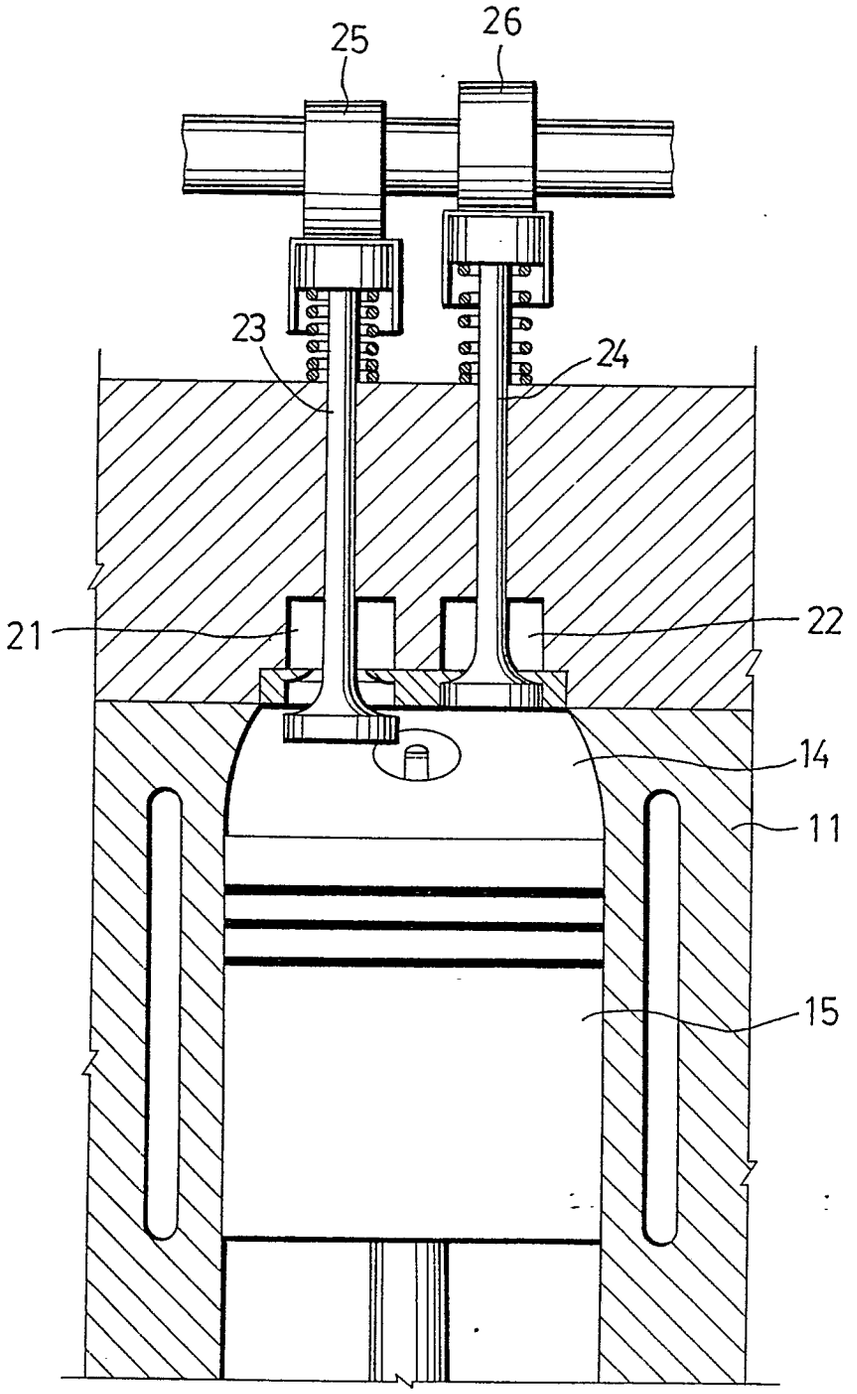

FIG. 2

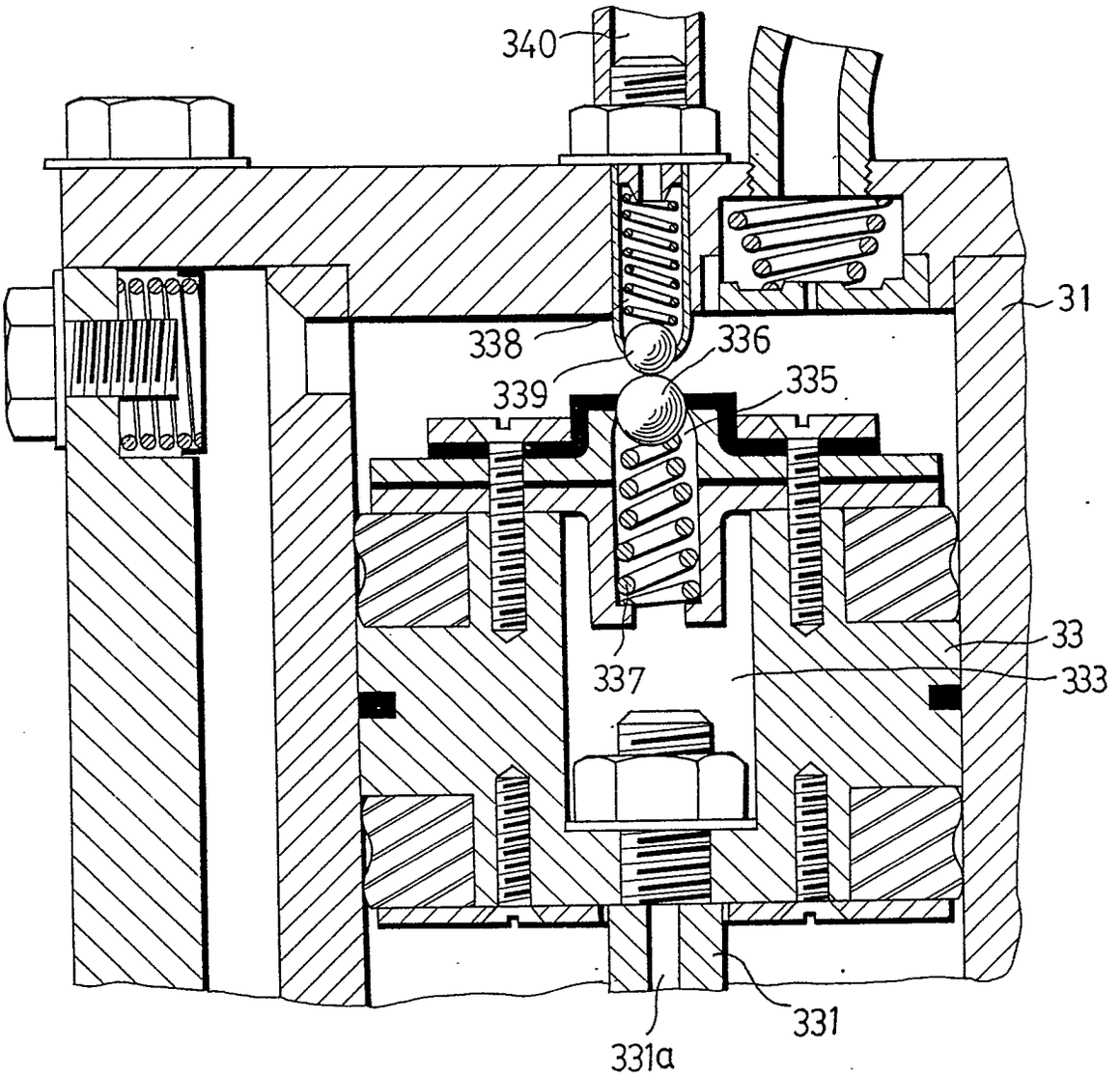

FIG. 3

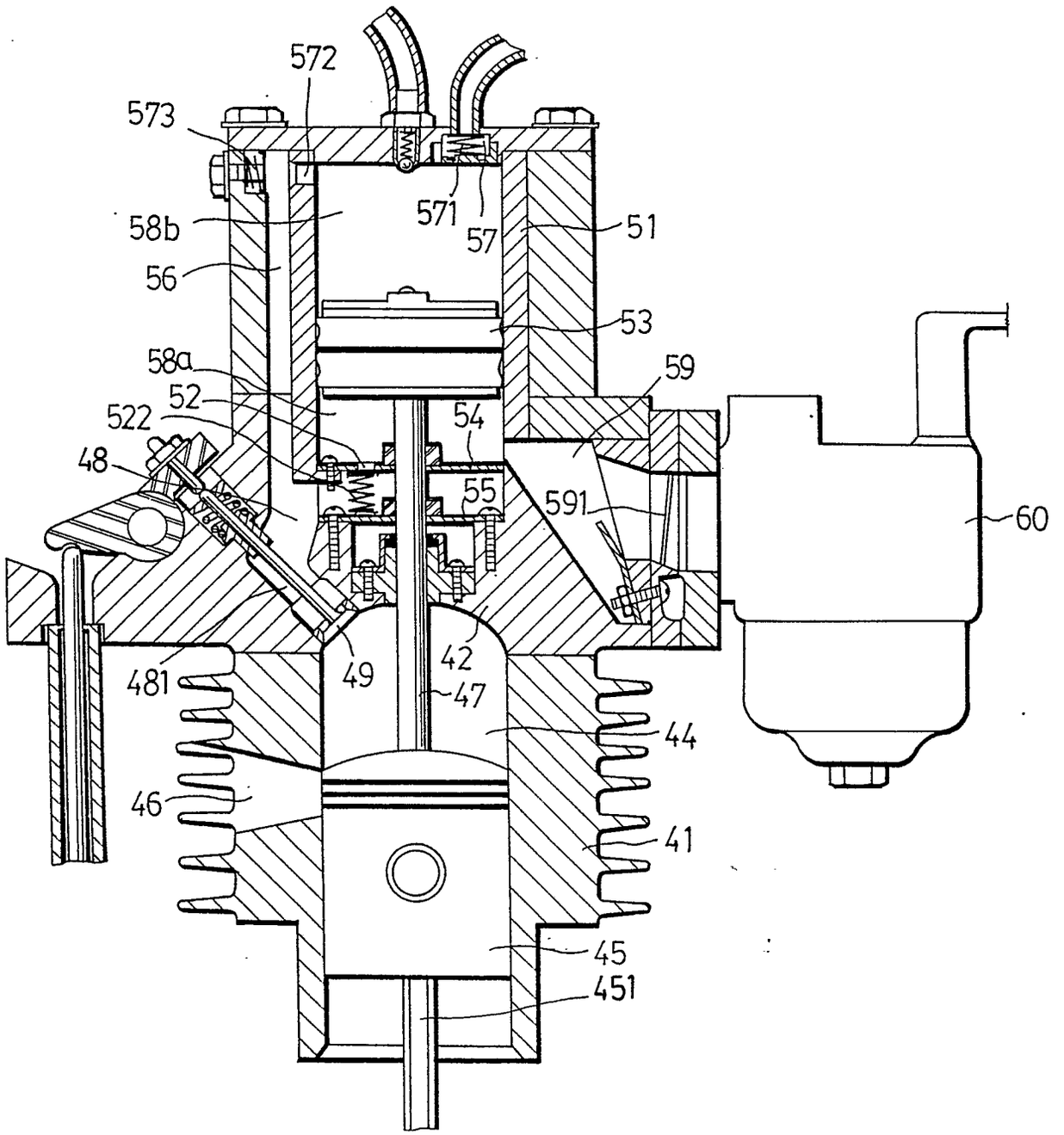
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FIG. 4

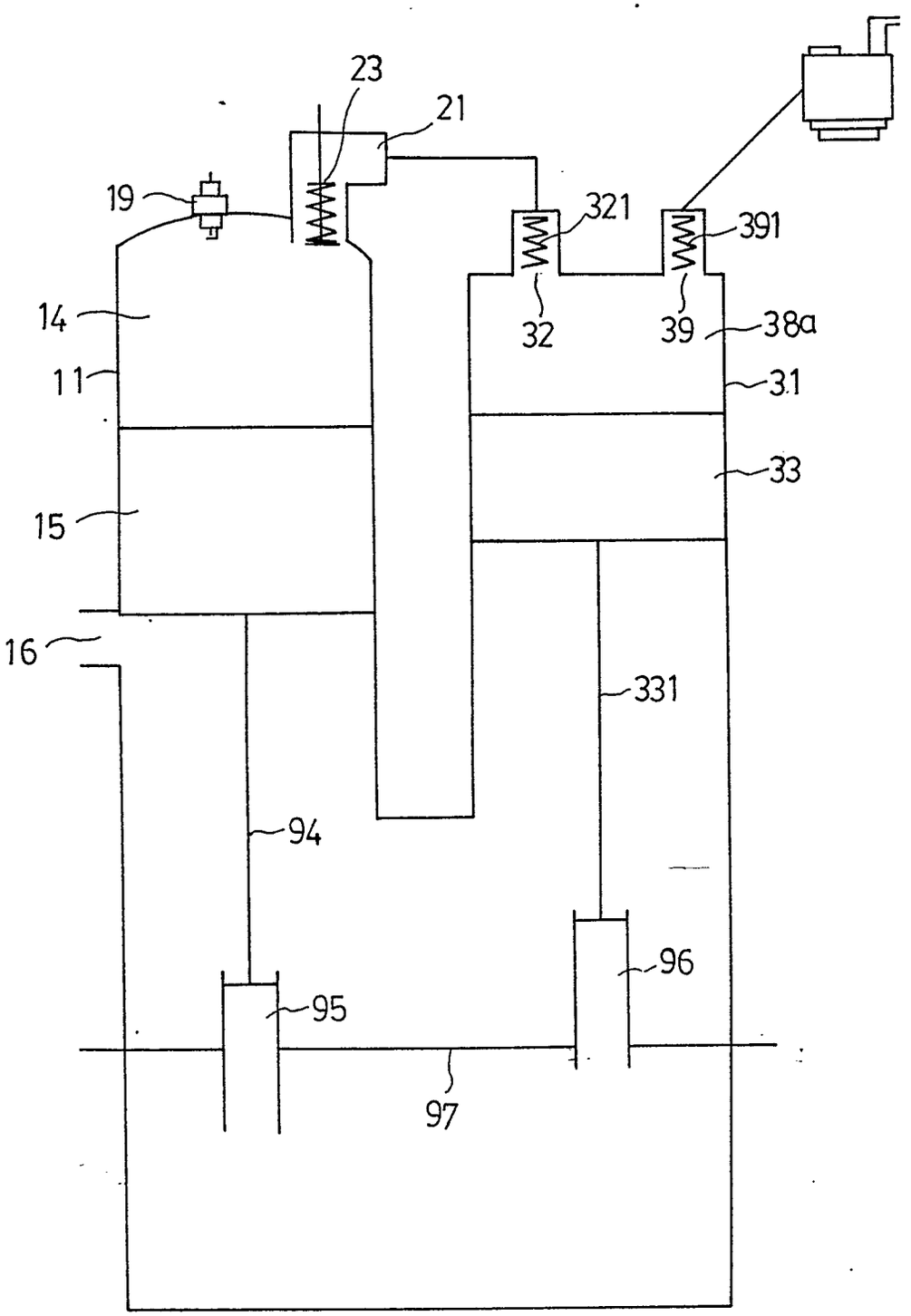

FIG. 5

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EUROPEAN SEARCH REPORT

Application number

EP 86 30 3877

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-2 384 422 (KINDER) * page 1, column 2, line 1 - page 2, column 2, line 34; figures 1-5 *	1,3,7	F 02 B 33/08 F 02 B 33/22
X	DE-C- 941 827 (ZIMMERMANN) * page 2, line 60 - page 3, line 12; figure 1 *	1,2	
X	DE-C- 809 264 (WUTTIG) * page 2, line 38 - page 3, line 2; figures 1-8 *	1	
Y		3-6	
Y	DE-C- 391 396 (FIERKE) * page 1, lines 1-11, 35-66; figure 1 *	3-6	TECHNICAL FIELDS SEARCHED (Int. Cl.4) F 02 B 25/00 F 02 B 33/00 F 02 B 39/00
A	DE-C- 874 225 (SCHNÜRLE) * page 2, lines 24-102; figures 1, 2 *	1-3	
A	DE-C- 205 378 (KLEIN) * figure 9 *	1,3	
A	DE-C- 847 087 (WILLE) * page 2, line 40 - page 3, line 7; figures 1, 2 *	1,2	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	07-01-1987	NORDSTROEM U.L.N.

CATEGORY OF CITED DOCUMENTS

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