(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 151 407**
A1

(12) EUROPEAN PATENT APPLICATION

(21) Application number: 85100382.2

(22) Date of filing: 16.01.85

(51) Int. Cl.[4]: F 04 F 11/02
F 02 B 33/42, F 02 B 39/10

(30) Priority: 18.01.84 JP 6814/84
18.01.84 JP 6815/84
27.01.84 JP 13048/84
30.01.84 JP 15655/84

(43) Date of publication of application:
14.08.85 Bulletin 85/33

(84) Designated Contracting States:
DE FR GB

(71) Applicant: Mazda Motor Corporation
No. 3-1, Shinchi Fuchu-cho
Aki-gun Hiroshima-ken(JP)

(72) Inventor: Sakurai, Shigeru c/o Mazda Motor Corp.
3-1,Shinchi Fuchu-cho
Aki-gun Hiroshima(JP)

(72) Inventor: Hinatase, Fumio c/o Mazda Motor Corp.
3,1, Shinchi Fuchu-cho
Aki-gun Hiroshima-ken(JP)

(74) Representative: Lorenz, Eduard et al,
Rechtsanwälte Eduard Lorenz - Bernhard Seidler Margrit Seidler - Dipl.-Ing. Hans-K. Gossel Dr. Ina Philipps - Dr. Paul B. Schäuble Dr. Siegfried Jackermeier
Widenmayerstrasse 23 D-8000 München 22(DE)

(54) Supercharger control for a supercharged internal combustion engine.

(57) A supercharged engine including a supercharger comprising a rotor having an axis of rotation and formed with a plurality of mutually separated, axially extending gas passages, and a casing supporting the rotor for rotation about the axis of rotation, the casing being formed with an exhaust gas inlet port and outlet opposing to an end of the rotor and offset with respect to each other in the direction of rotor rotation. The casing is further formed, at an end of the rotor opposite to the end to which the exhaust gas inlet and outlet ports are opposing, with an intake gas inlet and outlet port. There is provided an electric motor for rotationally driving the rotor of the supercharger and an electric control unit for controlling the operation of the motor so that the ratio of the speed of the motor to the speed of the engine is changed in accordance with the engine operating condition.

Croydon Printing Company Ltd

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a supercharged engine, and more particularly to an engine having a suchercharger of a type in which the intake air is compressed by the pressure of the exhaust gas before it is introduced into the combustion chamber.

Description of Prior Art

Hithertofore, proposals have already been made of an engine supercharger which utilizes pulsating pressure of the exhaust gas produced in the engine exhaust passage for compressing the intake air before the intake air is introduced into the combustion chamber. This type of supercharger is considered as being advantageous over turbo-supercharges because it can provide a higher supercharging effect under a low speed engine operation. A supercharger of this type generally includes a rotor having a plurality of mutually separated, axially extending gas passages and a casing supporting the rotor for rotation about an axis of rotation. The casing is provided with exhaust gas inlet and outlet openings and intake gas inlet and outlet openings which are located to oppose to axial ends of the rotor. The arrangements are such that the intake air is drawing into the gas passages through the intake gas inlet opening and compressed by the pressure of the exhaust gas introduced into the gas passages through the exhaust gas inlet opening.

As the rotor rotates, the gas passages are sequentially opened to the intake gas outlet topening so that the intake gas is forced by the exhaust gas to flow into the intake passage communicating with the intake gas outlet opening. Thereafter, the passages are opened to the exhaust gas outlet opening so that the exhaust gas is allowed to flow into the exhaust passage communicating with the exhaust gas outlet opening. Thus, it is required that the exhaust gas inlet opening and the intake gas outlet opening be located axially opposite to each other with respect to the rotor. An example of such supercharger is disclosed by Japanese utility model disclosure No.55-127839. The supercharger disclosed by the utility model is of a type wherein the exhaust gas inlet and outlet openings are located at one axial end of the rotor and the intake gas inlet and outlet openings are located at the other axial end so that the exhaust gas and the intake gas change their flow directions in the gas passages. As disclosed in detail by the Japanese magazine "Nainen-Kikan (Internal Combustion Engines)" Vol. 15, No.179, 1976 June issue, there is also known a so-called through-flow type wherein the gas inlet and outlet openings are arranged so that the exhaust gas and the intake gas flow axially through the gas passages without chaing the flow directions.

The supercharger of the aforementioned type is considered as being particularly suitable for diesel cycle engines but can of course be used in gasolive engines as well. The characteristic features of the supercharger of this type are not only that a supercharging effect can be obtained even in a low speed engine operation but also that an exhaust gas recirculation effect can be obtained because the exhaust gas is brought into contact with the intake gas in the rotor. However, since the rotor is driven in synchronism with the engine rotation, it is impossible to control the amount of recirculated exhaust gas in a desired manner. For example, if the rotating speed of the rotor is determined so that a desirable exhaust gas recirculation is accomplished in a low and medium speed operations, there will be an output loss under a high speed, heavy load operation due to a decrease in the intake charge.

OBJECT OF THE INVENTION

It is therefore an object of the present invention to provide a supercharger of the aforementioned type which can perform a desired exhaust gas recirulation effect.

Another object of the present invention is to provide a supercharger of the aforementioned type which can prevent the exhaust gas from being mixed with the intake air under a heavy load operation so that a high engine output can be obtained.

A further object of the present invention is to provide an engine supercharger which is effective to prevent misfire under a low temperature, light load engine operation.

Still further object of the present invention is to provide a supercharger which can present an exhaust gas brake effect.

SUMMARY OF THE INVENTION

According to the present invention, the above and other objects can be accomplished by a supercharged engine including a supercharger comprising a rotor having an axis of rotation and formed with a plurality of mutually separated, axially extending gas passages and a casing supporting the rotor for rotation about the axis of rotation. The casing is formed with exhaust gas inlet port means opposing to an end of the rotor and exhaust outlet port means opposing to the same or opposite end of the rotor. The exhaust gas outlet port means is offset with respect to the exhaust gas inlet port means in the direction of rotor rotation. The exhaust gas inlet port means is connected with exhaust port means of the engine whereas the exhaust gas outlet port means is opened to the atmosphere. The casing is further formed, at an end of the rotor opposite to the end where the exhaust gas inlet port means is formed, with intake gas outlet means which is connected with intake port means of the engine and, at an end of the rotor opposite to the end where the exhaust gas outlet port means is formed, with intake gas inlet port means for drawing the intake gas. According to the features of the present invention, an electric motor is provided for driving the rotor and the motor is controlled by a control unit in accordance with the engine operating condition so that a ratio of the rotor speed to the engine speed is changed in accordance with the engine operating condition.

In a preferable aspect of the present invention, the aforementioned ratio is increased under a heavy load operation of the engine. In another aspect of the present invention, the ratio is decreased under a low temperature, light load engine operation. In a further aspect of the present invention, the ratio is decreased in deceleration.

In the supercharger of the aforementioned type, the gas passages in the rotor are sequentially opened to the exhaust gas inlet port means so as to be subjected to the exhaust gas pressure and the pressure is transmitted at a sonic speed through the gas passages. Therefore, by appropriately determining the relative locations of the exhaust gas inlet port means and the intake gas outlet port means, the axial lengths of the gas passages and other factors, it is possible to transmit the pressure at the exhaust gas inlet port means to the intake gas outlet port means producing a supercharging effect. The flow speed of the exhaust gas in the gas passages in slower than the propagation of the gas pressure so tath it is unlikely that the exhaust gas in mixed with the intake air which is being introduced into the engine if the gas passage is disconnected from the intake gas outlet port means before the exhaust gas reaches the intake gas outlet port means.

In general, for the purpose of ensuring an appropriate amount of intake charge, the rotor speed is controlled proportionally to the engine speed. If, however, the rotor speed is controlled, under an engine operating condition wherein an exhaust gas recirculation is desired, so that the rotor speed is decreased with respect to the engine speed, the exhaust gas can reach the intake gas outlet port means before the port means is closed producing an exhaust gas recirculation effect. It is possible to control the quantity of the exhaust gas recirculation by changing the ratio of the rotor speed to the engine speed. In an engine operating condition wherein the exhaust gas recirculation is undesirable, such as a high speed, heavy load engine operation, the exhaust gas recirculation can be prevented by increasing the aforementioned ratio.

By decreasing the ratio of the rotor speed to the engine speed under a low temperature, light speed engine operation, it is possible to increase the amount of recirculated exhaust gas. Thus, the temperature of the intake air can be increased to thereby prevent possible misfire. Further, if the aforementioned ratio is decreased in deceleration, there will be an increase in the pressure in the rotor gas passages causing an increase in the back pressure at the engine exhaust port. Thus an effect of exhaust gas brake can be obtained without any additional mechanism.

The above and other objects and features of the present invention will become apparent from the following descriptions of a preferred embodiment taking reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a fragmentary sectional view of an engine having a supercharger in accordance with one embodiment of the present invention;

Figure 2 is an exploded perspective view of the supercharger;

Figure 3 is a diagram showing an example of controlling the rotor speed;

Figure 4 is a diagrammatical illustration of the gas flows in the rotor gas passages; and

Figure 5 is a diagrammatical illustration similar to Figure 4 but in a different rotor speed.

DESCRIPTIONS OF THE PREFERRED EMBODIMENT

Referring to the drawings, particularly to Figure 1, there is shown an embodiment in which the present invention is applied to a diesel cycle engine 1. The engine 1 includes a cylinder 2 and a cylinder head 3 attached to the top end portion of the cylinder 2. A piston 4 is disposed in the cylinder 2 for reciprocating movements and defines a combustion chamber 12 in the cylinder 2. The cylinder head 3 is formed with an intake port 5 and an exhaust port 6 which are respectively provided with an intake valve 7 and an exhaust valve 8. The intake port 5 is connected with a supercharging passage 9 whereas the exhaust port 6 is connected with an exhaust passage 10. Between the supercharging passage 9 and the exhaust passage 10, there is a supercharger 11.

Referring to Figure 2 together with Figure 1, it will be noted that the supercharger 11 includes a casing 14 shown in Figure 2(a) and a rotor 15 shown in Figure 2(b). The rotor 15 is rotatably disposed in the casing 14. As clearly shown in Figure 2(b), the rotor 15 has a plurality of mutually separated, axially extending gas passages 16. The casing 14 has end walls 14a and 14b respectively opposing to the opposite ends of the rotor 15. The end wall 14a is formed with an exhaust gas inlet port 17 and an exhaust gas outlet port 18 which are circumferentialy offset from each other. The end wall 14b is formed with an intake gas inlet port 19 and an intake gas outlet port 20 at circumferentially offset portions.

As shown in Figure 1, the exhaust gas inlet port 17 of the casing 14 is connected with the exhaust passage 10 and the intake gas outlet port 20 is connected with the supercharging passage 9. The exhaust gas outlet port 18 is connected with an exhaust pipe 21 whereas the intake gas inlet port 19 is connected with an intake pipe 22.

The rotor 15 has a drive shaft 23 which is secured thereto and extending axially outwardly from one end of the rotor 15. The drive shaft 23 is ratatably supported through bearings 24 and 25 by an intake housing 26 to which the casing 14 is secured. Thus, the rotor 15 is supported in a canti-lever fashion by the drive shaft 23. The axial outer end of the drive shaft 23 is connected through an electromagnetic clutch 27 with the output shaft of an electric motor 28. In order to control the operation of the motor 28, there is provided a control unit 29. The engine 1 is provided with an engine speed detector 30 and an engine control member position detector 32. The output of the engine speed detector 30 is applied to the control unit 29 and produces an output proportional to the engine speed. Where the motor 28 is a pulse motor, the control unit 29 produces an output pulse of which pulse frequency increases in proportion to an increase in the engine speed. The output of the control unit 29 is applied to a modifying circuit 31 which produces an output for operating the motor 28.

The output of the engine control member position detector 32 is applied to the modifying circuit 31 which functions to modify the output of the control unit 29 in accordance with the output of the detector 32 which represents the engine load. Thus, the speed of the motor 28 is controlled in accordance with the engine speed and the engine load.

There is also provided a light load discriminating circuit 36 having inputs connected with a reference circuit

35 and an engine temperature detector 38, respectively. The discriminating circuit 36 further has an input connected with the engine control member position detector 32. The reference circuit 35 produces a reference voltage which is compared in the discriminating circuit with the position signal from the detector 32 to discrimate 9 light load engine operating condition from the other operating conditions. The discriminating circuit 36 produces an output when the engine temperature is below a predetermined value under a light load engine operation. The output of the circuit 36 is applied to the modifying circuit 31.

There is further provided a deceleration discriminating circuit 40 which has inputs connected with the engine speed detector 30 and the engine control member position detector 32, respectively. The discriminating circuit produces an engine deceleration signal when the engine control member is at the minimum output position but the engine speed is above a predetermined value.

In operation, the engine 1 is stanted and the clutch 27 is engaged. The motor 28 is operated by the output of the modifying circuit 31 to drive the rotor 15. The intake air is drawn through the intake pipe 22 and the inlet port 19 into the gass passages in the rotor 15. The intake air in the gas passages 16 is then discharged to the supercharging passage 9 when the passages are opened to the outlet port 20 so that the intake air is charged to the combustion chamber 12. The exhaust gas from the engine exhaust port 6 is directed through the exhaust passage 10 and the inlet port 17 to the gas passages 16 in the rotor 15. The exhaust gas in then discharged to the exhaust pipe 21 through the outlet port 18 when the gas passages 16 are opened to the outlet port 18. In the casing 14, the exhaust gas inlet port 17 is located axially opposite to the intake gas outlet port 20 so taht the exhaust gas pressure in the exhaust passage 10 is applied to one end of the gas passage 16 when the gas passage 16 is opened to the inlet port 17. The pressure is then transmitted longitudinally through the passage 16 compressing the intake air in the passage 16 and reaches the other end of the passage 16 which is opened to the outlet port 20. Thus, the intake air is discharged into the supercharging passage 9 in a compressed condition.

Referring to Figure 4, there are shown the gas passages 16 in the rotor 15 in extended positions. The uppermost passage 16a is shown as being filled by the intake air. Since the passage 16a is closed at the both ends, the air in the passage 16a is in a stationary condition. The adjacent passage 16b is in a more advanced phase and has one end opened to the exhaust gas inlet port 17 so that a compression wave is produced at the end as shown by the numeral 33. The exhaust gas is admitted to the passage 16b as shown by the numeral 33. In the passages 16c and 16d which are more advanced in phase the compression waves are propagated as shown by the numerals 33a and 33b and the exhaust gas is admitted further deep in the passages as shown by the numerals 34a and 34b. These passages 16c and 16d are still closed at the other ends so that the intake air in the vicinity of these ends is stationary. In the passage 16e, the other end is opened to the intake gas outlet port 20 and the compression wave has reached the outlet port 20. Thus, the intake air is discharged under a supercharged condition into the passage 9. In the passages 16f, 16g and 16h, the discharge of the intake air is still continued and the exhaust gas flows in the passages in the direction of the intake air flow.

The passage 16i is disconnected from the exhaust gas inlet port 17 so that the flow of the exhaust gas is ceased at the end adjacent to the port 17 as shown by the numeral 34c. The passage 16j is disconnected from the intake gas outlet port 20 so that the flow in the passage is ceased. The passage 16k is opened at one end to the exhaust gas outlet port 18 so that the exhaust gas is expanded at this end as shown by the numeral 35. The expansion of the exhaust gas progresses as the phase advances. In the passage 16ℓ, the other end is opened to the intake air inlet port 19 so that the intake air under the atmospheric pressure is admitted to the passage expelling the expanded exhaust gas into the exhaust pipe 21.

Under the rotating speed of the rotor 15 shown in Figure 4, the gas passage is disconnected from the intake gas outlet port 20 before the exhaust gas reaches the port 20. Therefore, the intake air discharged into the supercharging passage 9 is substantially free from the exhaust gas although there may be a very small amount of residual exhaust gas which may be mixed with the exhaust gas in the gas passage 16. Figure 5 shows gas flows in a lower speed of the rotor 15. In other word, the ratio of the rotor speed to the engine speed is decreased in Figure 5 as compared with Figure 4. In this condition, the flow of the exhaust gas is faster than in the condition shown in Figure 4 so that the exhaust gas reaches the intake air inlet port 20 before the passage 16 is disconnected from the port 20. Thus, a part of the exhaust gas is discharged into the supercharging passage 9. The amount of the exhaust gas admitted to the passage 9 changes in accordance with a change in the ratio of the speed of the rotor 15 to the engine speed.

Referring to Figure 3, there is shown the relation between the amount of the exhaust gas admitted to the supercharging passage and the aforementioned ratio. The curve C shows the ratio of the rotor speed to the engine speed wherein the exhaust gas is not admitted to the passage 9. If the ratio is lower than the curve C, there will be a certain amount of exhaust gas flow into the passage 9 producing an exhaust gas recirculation effect. The amount of the recirculated exhaust gas is dependent on the difference between the curve C and the ratio. For example, if the ratio is changed as shown by the curve a in accordance with the amount of fuel supply, that is, the engine load, the amount of the recirculated exhaust gas changes as shown by the curve b. As shown in Figure 3, it is preferred to increase the ratio under a heavy load operation so that no exhaust gas is admitted to the supercharging passage. The above control is performed by modifying the output of the control unit 29 at the modifying circuit 31 in accordance with the signal from the detector 32.

In the specific ratio control shown by the curve a in Figure 3, the exhaust gas recirculation is performed in the medium load operation to decrease NO_x. Futher, under a heavy load operation the exhaust gas is prevented from entering the combustion chamebr so that it is possible to suppress smokes which may otherwise be produced in diesel engines. In heavy load region, there will be an increase in the exhaust gas temperature which will cause an increase in the temperature of the supercharger. However, with the aforementioned ratio control, the fresh intake air flows through the gas passages 16 to the exhaust pipe in the heavy load region so that the supercharger is cooled by the fresh intake air. At the maximum load region, the ratio is maintained substantially constant or slightly decreased so as to make the loss of the intake air as small as possible. With this control, it becomes possible to ensure sufficient supercharging effect simultaneously preveating overheat of the supercharger.

In an cold engine operation wherein the engine temperature is below a predetermined value, the discriminating circuit 36 produces a light load signal when the engine load is below a predetermined value. This signal is applied to the modifying circuit 31 to decrease the ratio as shown by a curve d to thereby increase the amount of the recirculated exhaust gas as shown by a curve e. This will cause an increase in the intake air temperature so that misfire can effectively be prevented. Further, in a deceleration, the discriminating circuit 40 produces a deceleration signal which is applied to the modifying circuit 31 to decrease the aforementioned ratio. This will produce an exhaust gas brake effect as described previously.

In an arrangement wherein the aforementioned deceleration control is not performed, the electromagnetic clutch 27 may be controlled in accordance with the output of the engine control member position detector 32 so taht the clutch 27 is desengaged when the engine load is below a predetermined value. Since the exhaust passage 36 is inclined with respect to the axis of the rotor 15 in the direction of the rotor rotation, the rotor 15 is slowly rotated by the exhaust gas flow even when the clutch 27 is disengaged. With this control, the ratio of the rotor speed to the engine speed changes as shown by a line f in Figure 3.

The invention has thus been shown and described with reference to a specific embodiment, however, it should be noted that the invention is in no way limited to the details of the illustrated structures but changes and modifications may be made without departing from the scope of the appended claims.

CLAIMS:

1. A supercharged engine including a supercharger comprising a rotor having an axis of rotation and formed with a plurality of mutually separated, axially extending gas passages, and a casing supporting the rotor for rotation about the axis of rotation, the casing being formed with exhaust gas inlet port means opposing to an end of the rotor and exhaust gas outlet port means apposing to an end of the rotor, said exhaust gas outlet port means being offset with respect to the exhaust gas inlet port means in the direction of rotor rotation, said casing being formed, at an end of the rotor opposite to the end to which the exahust gas inlet port means is opposing, with intake gas inlet means and, at an end of the rotor opposite to the end to which the exhaust gas outlet port means is opposing, with intake gas inlet port means, said exhausg gas inlet port means being connected with exhaust port means of the engine, said intake gas outlet port means being connected with intake port means of the engine, characterized by electric motor means for rotationally driving the rotor of the supercharger and electric control means for controlling the operation of the motor means, said control means including means for controlling the speed of the electric motor means so that the ratio of the speed of the motor means to the speed of the engine is changed in accordance with the engine operating condition.

2. A supercharged engine in accordance with claim 1 in which said control means includes means for controlling the speed of the motor means so taht said ratio is increased in a heavy load region than the ratio in a medium load region.

3. A supercharged engine in accordance with claim 1 in which said control means includes means for controlling the speed of the motor means so that said ratio is increased as the engine load increases from a medium load region to a certain value and then maintained substantially constant in the load region beyond the certain value.

4. A supercharged engine in accordance with claim 2 or 3, in which the control means includes means for controlling the speed of the motor means so that said ratio is increased in a light load region than in the medium load region.

5. A supercharged engine in accordance with claim 1 in which said supercharger includes a clutch between said motor means and said rotor, said control means including means for disengaging said clutch in a light load region of the engine operation.

6. A supercharged engine in acordance with claim 1 in which said control means includes means for detecting engine temperature and means for controlling the speed of the motor means so that said ratio is decreased when the engine temperature is below a predetermined value.

7. A supercharged engine in accordance with claim 1 in which said control means includes means for detecting engine temperature and means for controlling the speed of the motor means so that said ratio is decreased when the engine temperature is below a predetermined value in a light load operation.

8. A supercharged engine in accordance with claim 1 in which said control means includes means for detecting engine deceleration and means for controlling the speed of the motor means so that said ratio is decreased during the deceleration of the engine.

9. A supercharged engine in accordance with claim 1 in which said control means includes means for increasing said ratio under a light load operation than under a medium load operation.

FIG.1

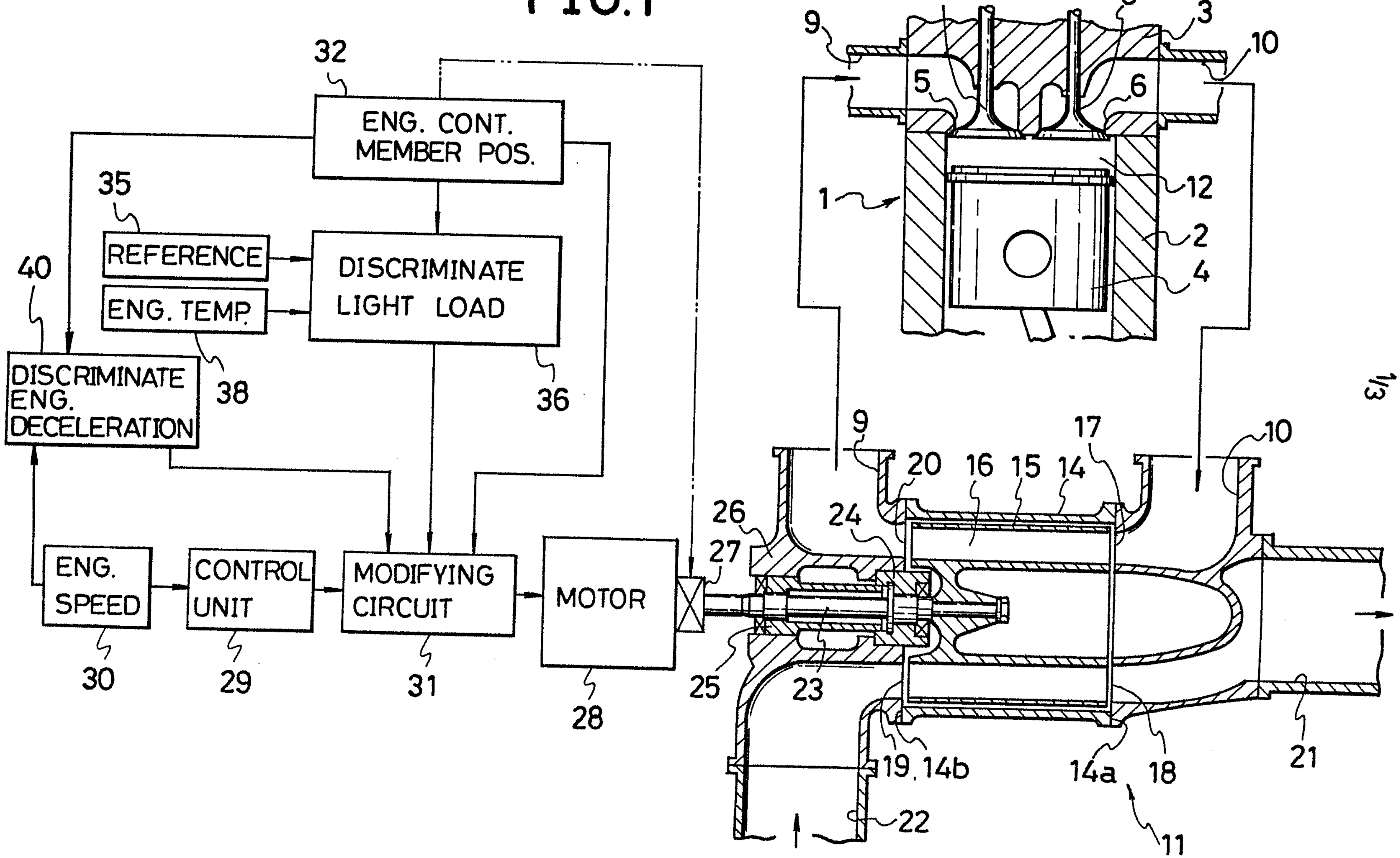

ENG. CONT. MEMBER POS.
32
REFERENCE
35
ENG. TEMP.
38
DISCRIMINATE LIGHT LOAD
36
DISCRIMINATE ENG. DECELERATION
40
ENG. SPEED
30
CONTROL UNIT
29
MODIFYING CIRCUIT
31
MOTOR
28
1
2
3
4
5
6
7
8
9
10
11
12
14
14a
14b
15
16
17
18
19
20
21
22
23
24
25
26
27

FIG.2

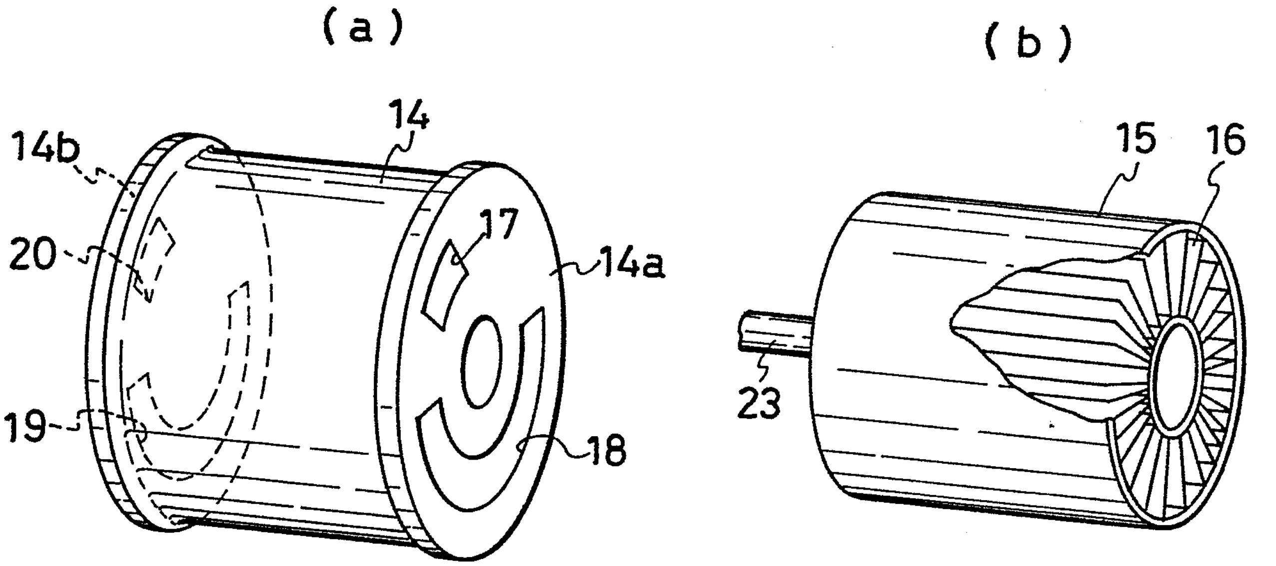

(a)
14
14b
20
17
14a
19
18
(b)
15
16
23

FIG.3

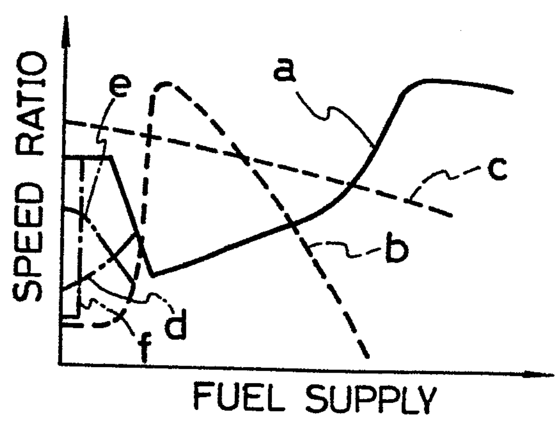

SPEED RATIO
FUEL SUPPLY
a
b
c
d
e
f

FIG.5

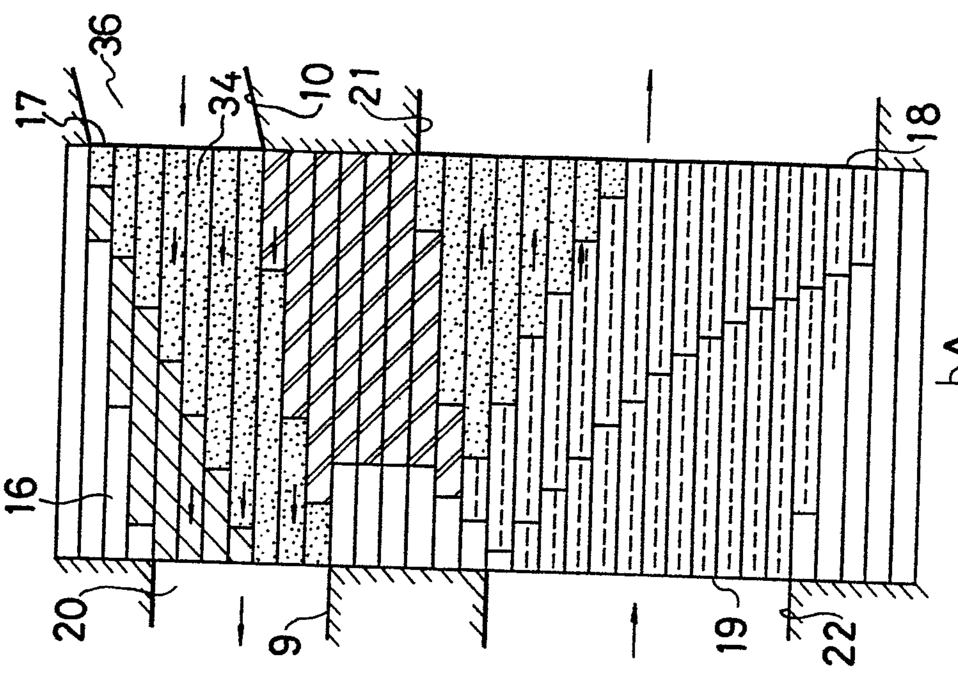
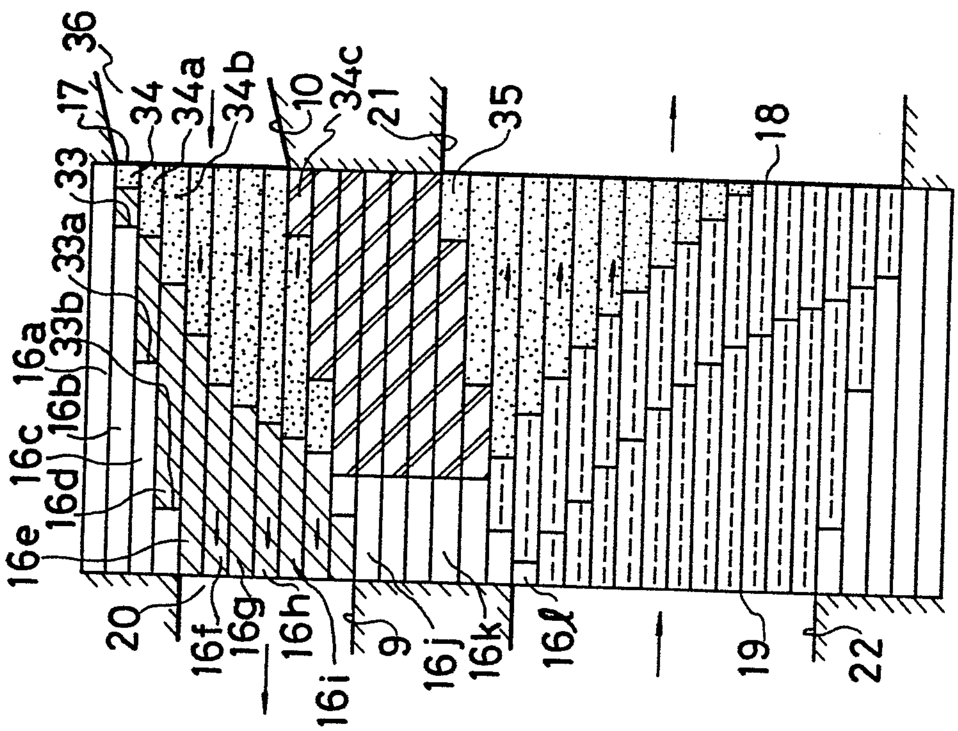

36
17
34
10
21
18
16
A
20
9
19
22

FIG.4


36
17
34
34a
34b
10
34c
21
35
18
33
33a
33b
16a
16b
16c
16d
16e
A
20
16f
16g
16h
16i
9
16j
16k
16ℓ
19
22

European Patent Office

0151407

EUROPEAN SEARCH REPORT

Application number

EP 85 10 0382

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)
Y	US-A-1 428 924 (C.C. THOMAS) * Figures; page 2, lines 13-20, 44-49 *	1	F 04 F 11/02 F 02 B 33/42 F 02 B 39/10

Y	DE-A-2 206 450 (DAIMLER BENZ AG) * Figures 1-3; page 5, paragraph 2; claim 1 *	1	
A		3	

Y	US-A-4 360 317 (J.K. VALLANCE et al.) * Abstract; figures 1-3 *	1	

A	FR-A-2 488 330 (M. CHAUVIERRE) * Figures; claim 1 *	1	**TECHNICAL FIELDS SEARCHED (Int. Cl.4)**

A	DE-C- 597 089 (A.G. BROWN BOVERI) * Figures; page 2, lines 26-36 *	1,3	F 04 F F 02 B

A	US-A-3 076 422 (D.B. SPALDING)		

A	US-A-3 078 034 (D.B. SPALDING)		

A	GB-A- 571 426 (G. GOLLIEZ)		

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	24-04-1985	THIBO F.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
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

EPO Form 1503. 03.82