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(54) **TWO-STAGE VARIABLE RELIEF VALVE FOR OIL PUMP**

ZWEISTUFIGES VARIABLES ENTLASTUNGSVENTIL FÜR ÖLPUMPE

SOUPAPE DE DÉCHARGE VARIABLE À DEUX ÉTAGES POUR POMPE À HUILE

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(56) References cited:
EP-A2- 2 600 004
KR-A- 20050 048 151
US-A- 5 921 274
US-A1- 2008 041 472

Description

BACKGROUND OF THE DISCLOSURE

Field of the Disclosure

[0001] The present disclosure relates to a relief valve for controlling a flow rate of an oil pump for supplying oil to a vehicle engine side.

Description of Related Art

[0002] In general, since an internal combustion engine such as a vehicle is driven in high temperature and high pressure conditions inside a cylinder due to the high-speed movement of a piston and the explosion stroke of a mixer, it is important to continuously supply oil to the sliding surface of a cylinder wall and the piston, a crankshaft, a camshaft, etc.

[0003] As described above, an oil pump for pumping oil is used to feed oil for lubrication and cooling of an engine, and as illustrated in FIG. 1, the oil pump discharges an oil pressure to an outlet while a rotor R connected to the engine side is driven.

[0004] Then, a relief valve for preventing the discharge pressure discharged from the oil pump from rising by a certain pressure or more is used in the oil pump.

[0005] As illustrated, the relief valve is received to be elevated in the figure by elastically supporting a plunger 120 by a spring 130 inside a valve housing 110, bypass passages 111, 112, 113, 114 are formed in the valve housing 110, and the plunger is formed with a bypass hole.

[0006] Therefore, the relief valve adjusts the discharge degree of the oil by repeatedly opening and closing the bypass passages 111, 112, 113, 114 according to the degree of the plunger 120 pressing the spring 130 by the discharge pressure of the oil.

[0007] That is, as illustrated, the bypass passage of a two-stage variable relief valve is formed of the primary bypass inlet passage 111, the primary bypass outlet passage 112, the secondary bypass inlet passage 113, and the secondary bypass outlet passage 114 to be operated to bypass to a suction side through the primary bypass outlet passage 112 through the primary bypass inlet passage 111 at the time of the primary bypass according to the displacement of the plunger 120, and to bypass to the suction side through the secondary bypass outlet passage 114 through the secondary bypass inlet passage 113 at the time of the secondary bypass.

[0008] However, in case of the oil pump to which such a two-stage variable relief valve has been applied, an oil pressure hysteresis phenomenon easily occurs in the RPM speed-up or speed-down condition.

[0009] That is, the oil pressure hysteresis means a phenomenon that a timing difference occurs in the section between the closing and the opening of the valve due to the inherent phenomena of the spring and the valve.

[0010] The contents described in Description of Related Art are to help the understanding of the background of the present disclosure, and can include what is not previously known to those skilled in the art to which the present disclosure pertains.

[Related Art Documents]

[0011] From KR 2005 0048151 A, US 5 921 274 A and US 2008/041472 A1 relief valves according to the preamble of claim 1 are known. Further, from EP 2 600 004 A2, a variable oil pump is known.

SUMMARY OF THE DISCLOSURE

[0012] The present disclosure is intended to solve the above problem, and an object of the present disclosure is to provide a two-stage variable relief valve for an oil pump, which can reduce an oil pump hysteresis phenomenon, thereby improving oil lubrication performance.

[0013] The present invention provides a two-stage variable relief valve for an oil pump according to claim 1. Further embodiments of the relief valve are described in the dependent claims.

[0014] The opening/closing timings of the bypass in the oil pump are closely related to the fuel efficiency and function of the engine.

[0015] In the main fuel efficiency section, the bypass is opened to suppress the occurrence of a high oil pressure to maintain a constant and low pressure level, and in the high speed section requiring the high oil pressure, the bypass is temporarily closed to transmit the oil of a high pressure to various hydraulic mechanisms side.

[0016] Therefore, the valve timing for opening and closing the bypass is an important design factor that is determined by considering both the performance/function of the engine.

[0017] However, when the oil pressure hysteresis becomes excessive, the valve does not operate as intended, thereby becoming disadvantageous all in terms of the performance/function of the engine.

[0018] The present disclosure can reduce the area of the primary bypass inlet passage of the two-stage variable relief valve by 50% or more or reduce the places thereof compared to the primary bypass outlet passage, thereby minimizing or completely avoiding the hysteresis phenomenon.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019]

FIG. 1 is a diagram illustrating a general relief valve for an oil pump.

FIG. 2 is a diagram illustrating a performance map between the pressure and the flow rate of the oil pump.

FIG. 3 is a diagram illustrating an oil pressure hysteresis phenomenon.

FIGS. 4A to 5B are diagrams illustrating the area reduction results of a bypass passage.

FIG. 6 is a diagram illustrating the hysteresis result according to a reduction ratio of a primary bypass inlet passage.

FIG. 7 is a diagram illustrating a performance map between the pressure and the flow rate of the oil pump according to the reduction ratio of the primary bypass inlet passage.

FIG. 8 is a diagram illustrating an embodiment of a relief valve for an oil pump according to the present disclosure.

FIG. 9 is a diagram illustrating the hysteresis result according to FIG. 8.

FIG. 10 is a diagram illustrating the hysteresis result according to another embodiment of the present disclosure.

FIG. 11 is a diagram comparatively illustrating the performance map between the pressure and the flow rate of the oil pump according to an embodiment of the present disclosure.

DESCRIPTION OF SPECIFIC EMBODIMENTS

[0020] In order to fully understand the present disclosure, operational advantages of the present disclosure, and objects achieved by the embodiment of the present disclosure, reference should be made to the accompanying drawings exemplifying the preferred embodiments of the present disclosure and the contents illustrated in the accompanying drawings.

[0021] In describing the preferred embodiments of the present disclosure, a description of known technology or repeated descriptions that can unnecessarily obscure the subject matter of the present disclosure will be reduced or omitted.

[0022] FIG. 1 is a diagram illustrating a general relief valve for an oil pump, FIG. 2 is a diagram illustrating a performance map between the pressure and the flow rate of the oil pump, and FIG. 3 is a diagram illustrating an oil pressure hysteresis phenomenon.

[0023] The present disclosure is for solving the oil pressure hysteresis of an oil pump by a two-stage variable relief valve.

[0024] As illustrated in FIG. 2, in the oil pump illustrated in FIG. 1, when the pressure applied to the oil pump and the front end of a valve rises, the displacement of the plunger 120 increases, such that the primary bypass inlet passage 111 and the primary bypass outlet passage 112 are opened.

[0025] Then, as the pressure rises, the oil pump operates by opening the secondary bypass passages 113, 114 after the primary bypass passages 111, 112 are closed.

[0026] As illustrated, the slope of the bypass section (a ratio of a change in a flow rate according to a change in pressure) is related to the area of each corresponding passage of the oil pump.

[0027] That is, the wider the area of the bypass passage, the larger the amount of the oil flows, such that the slope becomes sharp.

[0028] Herein, the number and the area of the primary bypass inlet passage 111 and the primary bypass outlet passage 112 are designed to be the same.

[0029] In case of such a conventional oil pump, the oil pressure hysteresis phenomenon easily occurs in the RPM speed-up/speed-down conditions.

[0030] That is, as illustrated in FIG. 3, the pressure rises as the primary bypass passages 111, 112 starts closing at about 4,500 rpm in the speed-up condition, but a pressure rising section occurs at about 3,200 rpm in the speed-down condition.

[0031] The oil pressure hysteresis phenomenon of about 1,300 rpm occurs as a difference of the bypass closing timing occurs according to the speed-up/speed-down conditions.

[0032] The present disclosure solves the oil pressure hysteresis by optimizing the area of the oil pump bypass passage considering the relevance between the area of the oil pump bypass passage and the oil pressure hysteresis phenomenon.

[0033] FIGS. 4A to 5B are diagrams illustrating the results of reducing the area of the bypass passage compared to the conventional one.

[0034] FIG. 4A is a diagram illustrating the result of reducing the area of the primary bypass inlet passage 111 by 60%, FIG. 4B is a diagram illustrating the result of reducing the area of the primary bypass outlet passage 112 by 60%, FIG. 5A is a diagram illustrating the result of reducing the area of the secondary bypass outlet passage 114 by 60%, and FIG. 5B is a diagram illustrating the result of reducing the area of the secondary bypass inlet passage 113 by 60%.

[0035] As can be seen in the figure, it was found that the result of reducing the area of the primary bypass inlet passage 111 is the most effective in reducing the hysteresis.

[0036] The result of reducing the area of the primary bypass outlet passage 112 is also somewhat effective in reducing the hysteresis, but the bypass performance is reduced at 2,000 to 3,000 rpm that is the primary bypass section compared to the conventional one to highly form the oil pressure compared to the conventional one, thereby becoming disadvantageous in terms of fuel efficiency.

[0037] Then, it was found that there was no hysteresis phenomenon reduction effect by the change in the secondary bypass passages 113, 114.

[0038] Therefore, the present disclosure reduces the area of the primary bypass inlet passage of the two-stage variable relief valve, thereby reducing the hysteresis phenomenon.

[0039] Next, the hysteresis reduction effect according to a reduction ratio will be described.

[0040] FIG. 6 is a diagram illustrating the hysteresis result according to a reduction ratio of a primary bypass inlet passage, and FIG. 7 is a diagram illustrating a performance map between the pressure and the flow rate of the oil pump according to the reduction ratio of the primary bypass inlet passage.

[0041] As illustrated in FIG. 6, it was found that when the area of the primary bypass inlet passage 111 was reduced by 50% or more, the oil pressure hysteresis was recovered to a normal level that is within 500 rpm.

[0042] FIG. 7 is a graph illustrating the flow rate measured by increasing the pressure applied to the rear end of the oil pump at the same rpm, and it can be seen that when the primary bypass inlet passage 111 is reduced compared to the primary bypass outlet passage 112, a change in the bypass flow rate according to the same pressure change becomes small. That is, it can be seen that the slope becomes gentle in the bypass opening section and closing section.

[0043] As a result, the flow-in and the flow-out of the bypassed flow rate are not rapidly made but are gently made by reducing the area of the primary bypass inlet passage, thereby reducing the hysteresis phenomenon, and as illustrated in FIG. 8, based on this, the present disclosure reduces the area of a primary bypass inlet passage 11 of the two-stage variable relief valve having a pair of the bypass inlet passages and a pair of the bypass outlet passages compared to the area of a primary bypass outlet passage 12, thereby reducing the oil pressure hysteresis.

[0044] FIG. 9 is a diagram illustrating the hypothesis result according to the two-stage variable relief valve for the oil pump according to the present disclosure of FIG. 8.

[0045] As illustrated, the time point at which the primary bypass passage is closed becomes early from 3,200 rpm to 2,300 rpm, thereby reducing the hysteresis.

[0046] In the relief valve for the oil pump according to the present disclosure, the bypass passage can be configured in the form of dividing a plurality of passage holes. That is, the primary bypass inlet passage, the primary bypass outlet passage, the secondary bypass inlet passage, and the secondary bypass outlet passage can be arranged, respectively, so that a plurality of the passage holes are spaced apart from each other in parallel.

[0047] Therefore, as illustrated in FIG. 8, the present disclosure can reduce the area of each of the plurality of passage holes of the primary bypass inlet passage to 1/2 or less of the primary bypass outlet passage.

[0048] Furthermore, for example, it is possible to reduce the area of the primary bypass inlet passage by reducing the primary bypass inlet passage composed of two passage holes to one passage hole, that is, by reducing the places thereof by 1/2 or less.

[0049] FIG. 10 is a diagram illustrating the hypothesis result in case of reducing the primary bypass inlet passage from two places to one place. Through this, it can be seen that the oil pressure hysteresis can also be reduced to the level of about 600 rpm, and as illustrated in FIG. 11, it can be seen that the slope becomes gentle in the bypass section.

Claims

1. A two-stage variable relief valve for an oil pump, comprising:

   a valve housing (110) formed with bypass inlet passages (111, 113) and bypass outlet passages (112, 114), a plunger (120) operated in the valve housing (110) and a spring (130) for elastically supporting the plunger (120),
   wherein the bypass inlet passages (111, 113) and/or the bypass outlet passages (112, 114) are opened or closed according to the displacement of the plunger (120), **characterized in that** the bypass inlet passage comprises a primary bypass inlet passage (11) and a secondary bypass inlet passage and the bypass outlet passage comprises a primary bypass outlet passage (12) and a secondary bypass outlet passage,
   the primary bypass inlet passage (11) and the primary bypass outlet passage (12) are opened and closed at the same time, and the secondary bypass inlet passage and the secondary bypass outlet passage are opened and closed at the same time,
   the primary bypass inlet passage (11) and the primary bypass outlet passage (12) are opened when the displacement of the plunger (120) is relatively small compared to the secondary bypass inlet passage and the secondary bypass outlet passage, and
   the area of the primary bypass inlet passage (11) is smaller than the area of the primary bypass outlet passage (12).

2. The two-stage variable relief valve for the oil pump of claim 1,
   wherein the area of the primary bypass inlet passage (11) is smaller than 1/2 or less of the area of the primary bypass outlet passage (12).

3. The two-stage variable relief valve for the oil pump of claim 1 or 2,

   wherein each of the bypass inlet passage and

the bypass outlet passage is disposed so that a plurality of passage holes are spaced apart from each other in parallel, and
wherein the area of each primary passage hole of the bypass inlet passage (11) is smaller than the area of each primary passage hole of the bypass outlet passage (12).

4. The two-stage variable relief valve for the oil pump of claim 1 or 2,

wherein each of the bypass inlet passage (11) and the bypass outlet passage (12) is disposed so that a plurality of passage holes are spaced apart from each other in parallel, and
wherein the number of primary passage holes of the bypass inlet passage (11) is smaller than the number of primary passage holes of the bypass outlet passage (12).

Patentansprüche

1. Ein zweistufiges variables Entlastungsventil für eine Ölpumpe, aufweisend:

ein Ventilgehäuse (110), das mit Bypass-Einlasskanälen (111, 113) und Bypass-Auslasskanälen (112, 114), einem Kolben (120), der in dem Ventilgehäuse (110) betätigt wird, und einer Feder (130) zum elastischen Abstützen des Kolbens (120) ausgebildet ist,
wobei die Bypass-Einlasskanäle (111, 113) und/oder die Bypass-Auslasskanäle (112, 114) in Abhängigkeit von der Verschiebung des Kolbens (120) geöffnet oder geschlossen werden,
dadurch gekennzeichnet, dass
der Bypass-Einlasskanal einen primären Bypass-Einlasskanal (11) und einen sekundären Bypass-Einlasskanal aufweist und der Bypass-Auslasskanal einen primären Bypass-Auslasskanal (12) und einen sekundären Bypass-Auslasskanal aufweist,
der primäre Bypass-Einlasskanal (11) und der primäre Bypass-Auslasskanal (12) gleichzeitig geöffnet und geschlossen werden und der sekundäre Bypass-Einlasskanal und der sekundäre Bypass-Auslasskanal gleichzeitig geöffnet und geschlossen werden,
der primäre Bypass-Einlasskanal (11) und der primäre Bypass-Auslasskanal (12) geöffnet werden, wenn die Verschiebung des Kolbens (120) im Vergleich zu dem sekundären Bypass-Einlasskanal und dem sekundären Bypass-Auslasskanal relativ klein ist, und
die Fläche des primären Bypass-Einlasskanals (11) kleiner ist als die Fläche des primären Bypass-Auslasskanals (12).

2. Das zweistufige variable Entlastungsventil für die Ölpumpe gemäß Anspruch 1,
wobei die Fläche des primären Bypass-Einlasskanals (11) kleiner als 1/2 oder weniger als die Fläche des primären Bypass-Auslasskanals (12) ist.

3. Das zweistufige variable Entlastungsventil für die Ölpumpe gemäß Anspruch 1 oder 2,

wobei jeder vom Bypass-Einlasskanal und vom Bypass-Auslasskanal so angeordnet ist, dass eine Mehrzahl von Kanallöchern parallel zueinander in Abstand ist und
wobei die Fläche jedes primären Kanallochs des Bypass-Einlasskanals (11) kleiner ist als die Fläche jedes primären Kanallochs des Bypass-Auslasskanals (12).

4. Das zweistufige variable Entlastungsventil für die Ölpumpe gemäß Anspruch 1 oder 2,

wobei jeder vom Bypass-Einlasskanal (11) und vom Bypass-Auslasskanal (12) so angeordnet ist, dass eine Mehrzahl von Kanallöchern parallel zueinander in Abstand ist, und
wobei die Anzahl der primären Kanallöcher des Bypass-Einlasskanals (11) kleiner ist als die Anzahl der primären Kanallöcher des Bypass-Auslasskanals (12).

Revendications

1. Soupape de décharge variable à deux étages pour une pompe à huile, comprenant :

un boîtier de soupape (110) formé avec des passages d'entrée de dérivation (111, 113) et des passages de sortie de dérivation (112, 114), un plongeur (120) actionné dans le boîtier de soupape (110) et un ressort (130) pour soutenir élastiquement le plongeur (120),
dans laquelle les passages d'entrée de dérivation (111, 113) et/ou les passages de sortie de dérivation (112, 114) sont ouverts ou fermés en fonction du déplacement du plongeur (120),
caractérisée en ce que
le passage d'entrée de dérivation comprend un passage d'entrée de dérivation primaire (11) et un passage d'entrée de dérivation secondaire et le passage de sortie de dérivation comprend un passage de sortie de dérivation primaire (12) et un passage de sortie de dérivation secondaire,
le passage d'entrée de dérivation primaire (11) et le passage de sortie de dérivation primaire (12) sont ouverts et fermés en même temps, et le passage d'entrée de dérivation secondaire et

le passage de sortie de dérivation secondaire sont ouverts et fermés en même temps,

le passage d'entrée de dérivation primaire (11) et le passage de sortie de dérivation primaire (12) sont ouverts lorsque le déplacement du plongeur (120) est relativement faible par rapport au passage d'entrée de dérivation secondaire et au passage de sortie de dérivation secondaire, et

la surface du passage d'entrée de dérivation primaire (11) est inférieure à la surface du passage de sortie de dérivation primaire (12).

2. Soupape de décharge variable à deux étages pour la pompe à huile selon la revendication 1, dans laquelle la surface du passage d'entrée de dérivation primaire (11) est inférieure à une moitié ou moins de la surface du passage de sortie de dérivation primaire (12).

3. Soupape de décharge variable à deux étages pour la pompe à huile selon la revendication 1 ou 2,

dans laquelle chacun du passage d'entrée de dérivation et du passage de sortie de dérivation est disposé de sorte qu'une pluralité de trous de passage sont espacés les uns des autres en parallèle, et

dans laquelle la surface de chaque trou de passage primaire du passage d'entrée de dérivation (11) est inférieure à la surface de chaque trou de passage primaire du passage de sortie de dérivation (12).

4. Soupape de décharge variable à deux étages pour la pompe à huile selon la revendication 1 ou 2,

dans laquelle chacun du passage d'entrée de dérivation (11) et du passage de sortie de dérivation (12) est disposé de sorte qu'une pluralité de trous de passage sont espacés les uns des autres en parallèle, et

dans laquelle le nombre de trous de passage primaires du passage d'entrée de dérivation (11) est inférieur au nombre de trous de passage primaires du passage de sortie de dérivation (12).

FIG.1

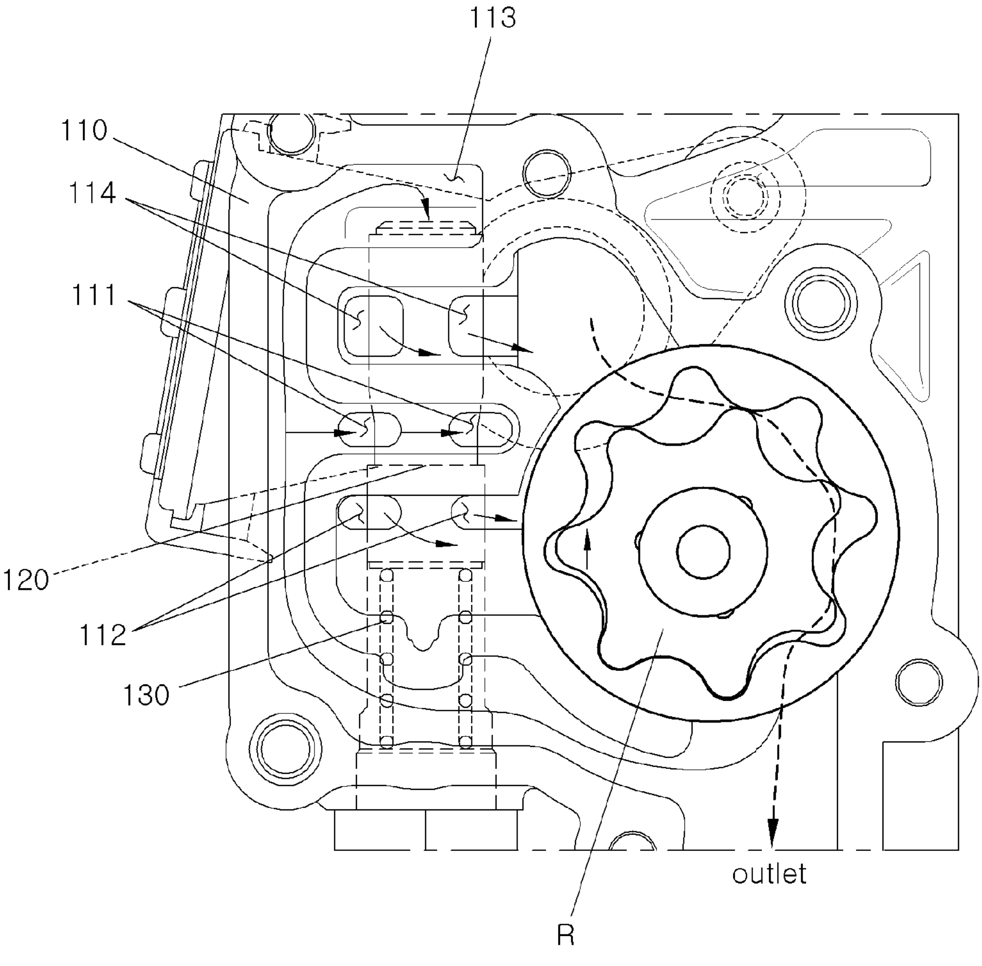


FIG.2

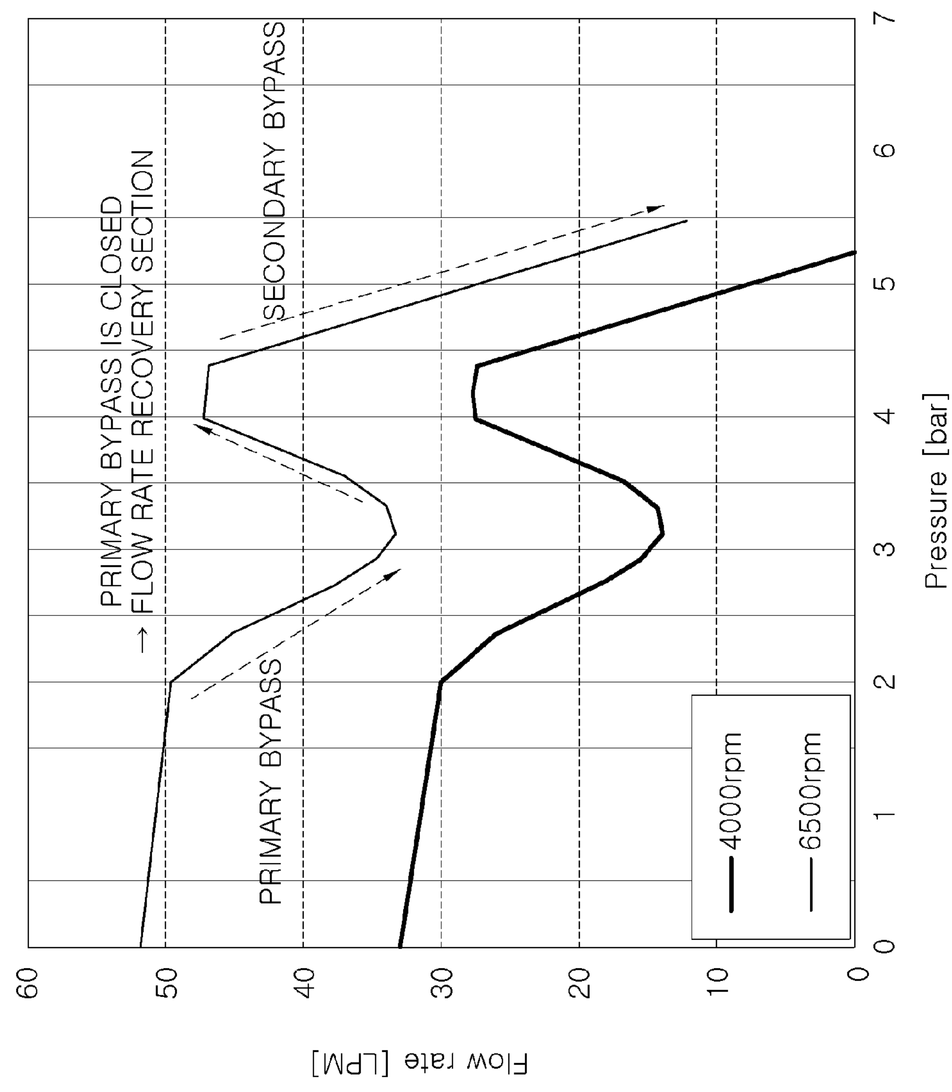

PRIMARY BYPASS IS CLOSED
→ FLOW RATE RECOVERY SECTION
SECONDARY BYPASS
PRIMARY BYPASS
4000rpm
6500rpm
Flow rate [LPM]
Pressure [bar]
0
10
20
30
40
50
60
1
2
3
4
5
6
7

FIG.3

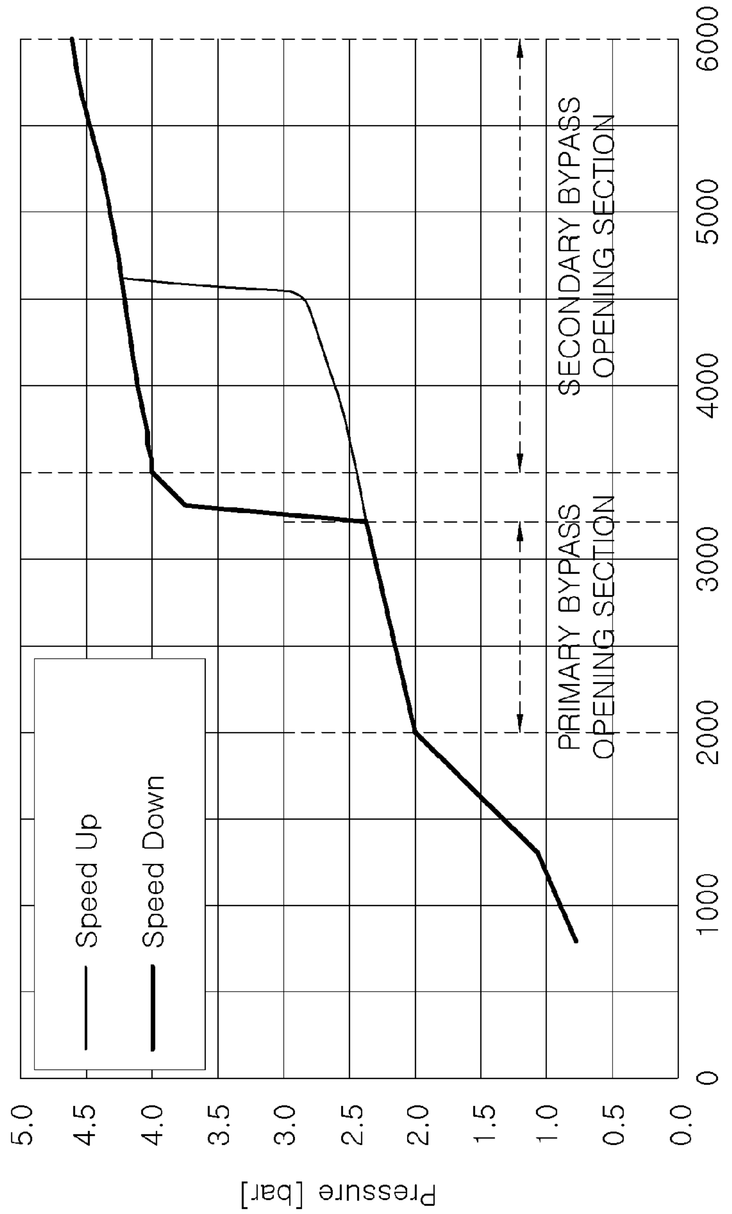

Speed Up
Speed Down
PRIMARY BYPASS
OPENING SECTION
SECONDARY BYPASS
OPENING SECTION
Pressure [bar]
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
1000
2000
3000
4000
5000
6000

FIG.4A

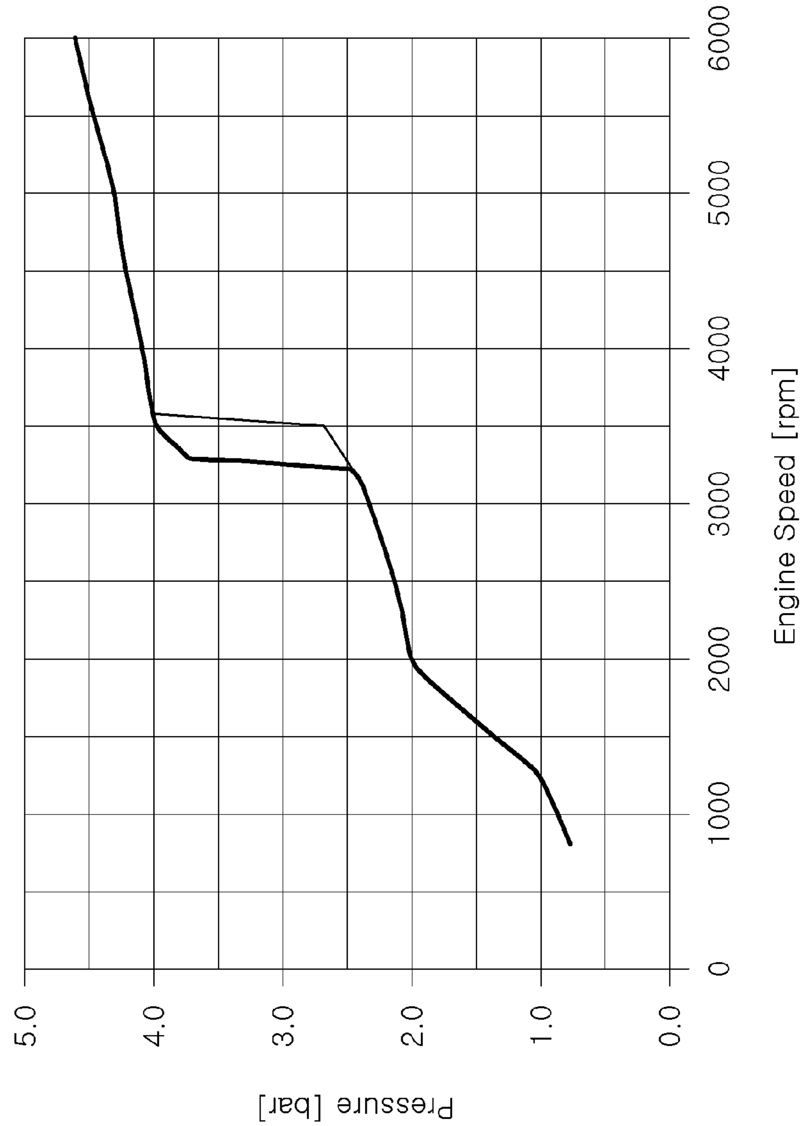

Pressure [bar]
5.0
4.0
3.0
2.0
1.0
0.0
0
1000
2000
3000
4000
5000
6000
Engine Speed [rpm]

FIG.4B

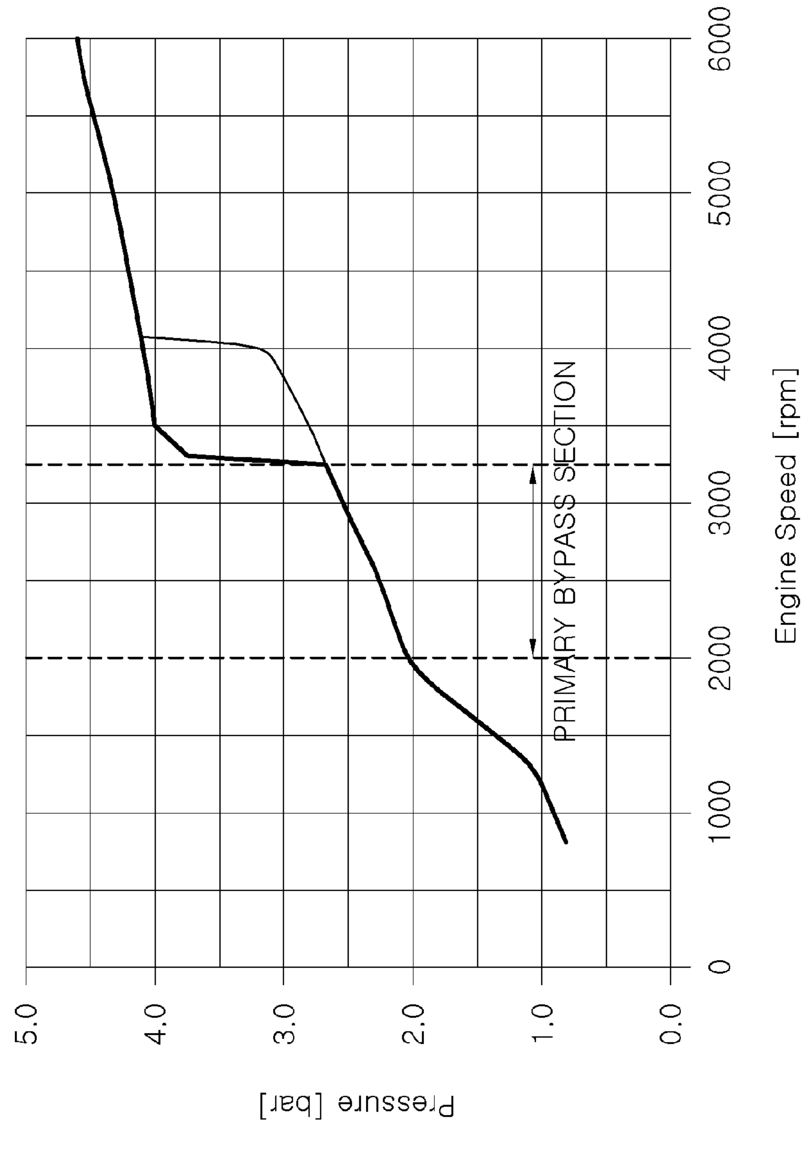

PRIMARY BYPASS SECTION
Engine Speed [rpm]
Pressure [bar]
0
1000
2000
3000
4000
5000
6000
0.0
1.0
2.0
3.0
4.0
5.0

FIG.5A

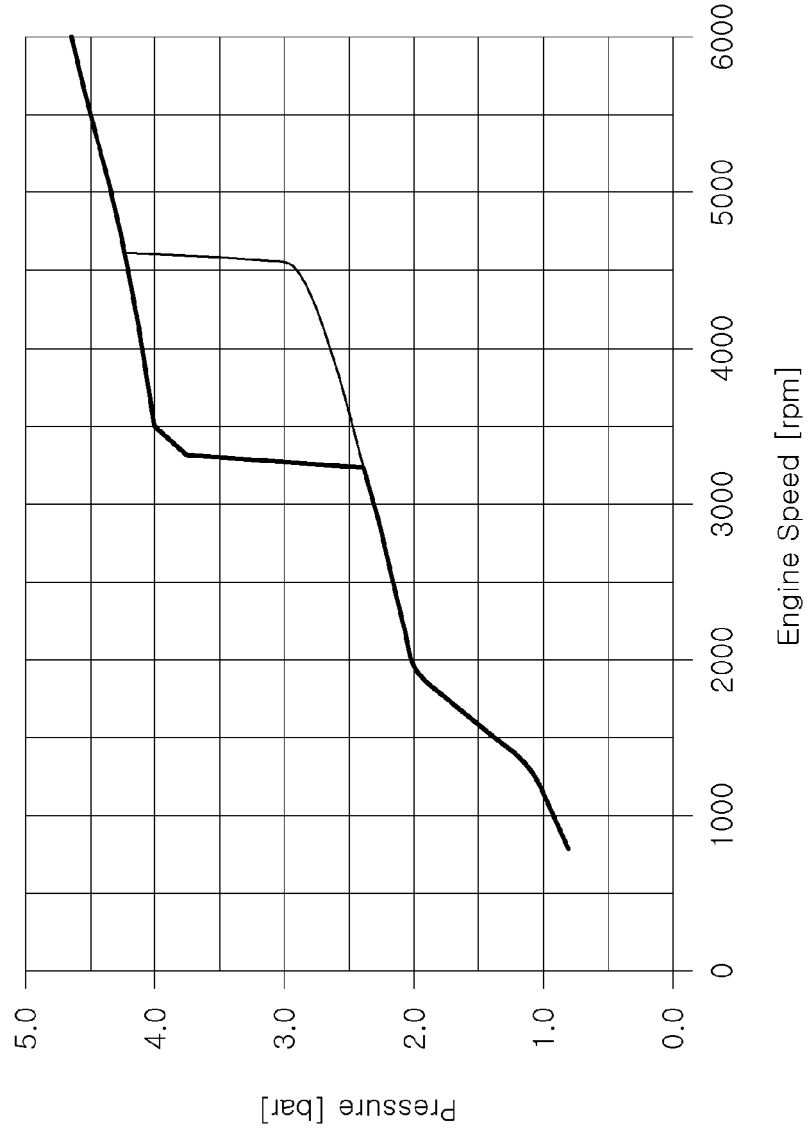

Pressure [bar]
5.0
4.0
3.0
2.0
1.0
0.0
Engine Speed [rpm]
0
1000
2000
3000
4000
5000
6000

FIG.5B


Pressure [bar]
5.0
4.0
3.0
2.0
1.0
0.0
Engine Speed [rpm]
0
1000
2000
3000
4000
5000
6000

FIG.6

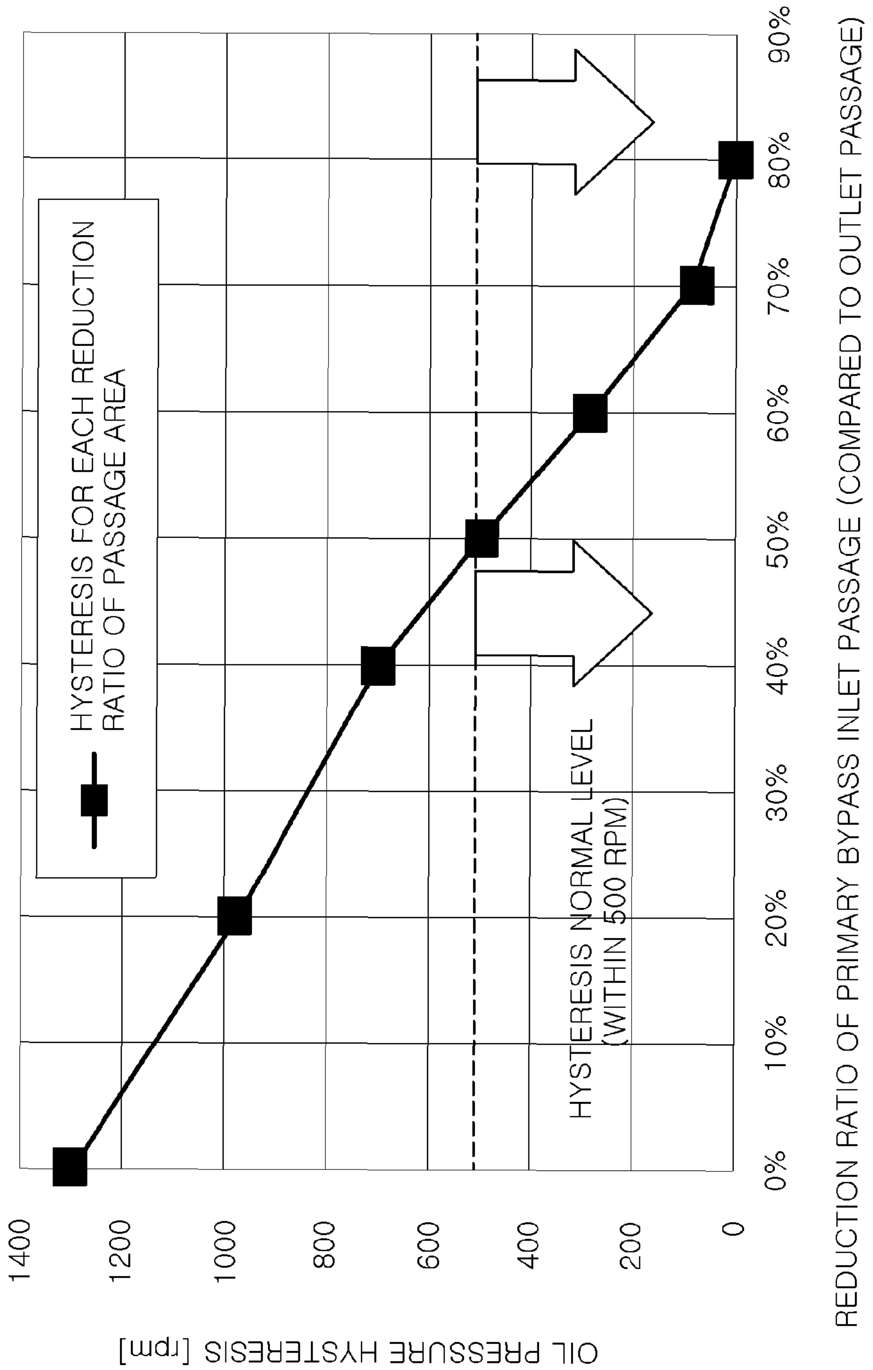

HYSTERESIS FOR EACH REDUCTION RATIO OF PASSAGE AREA
HYSTERESIS NORMAL LEVEL (WITHIN 500 RPM)
OIL PRESSURE HYSTERESIS [rpm]
1400
1200
1000
800
600
400
200
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
REDUCTION RATIO OF PRIMARY BYPASS INLET PASSAGE (COMPARED TO OUTLET PASSAGE)

FIG.7

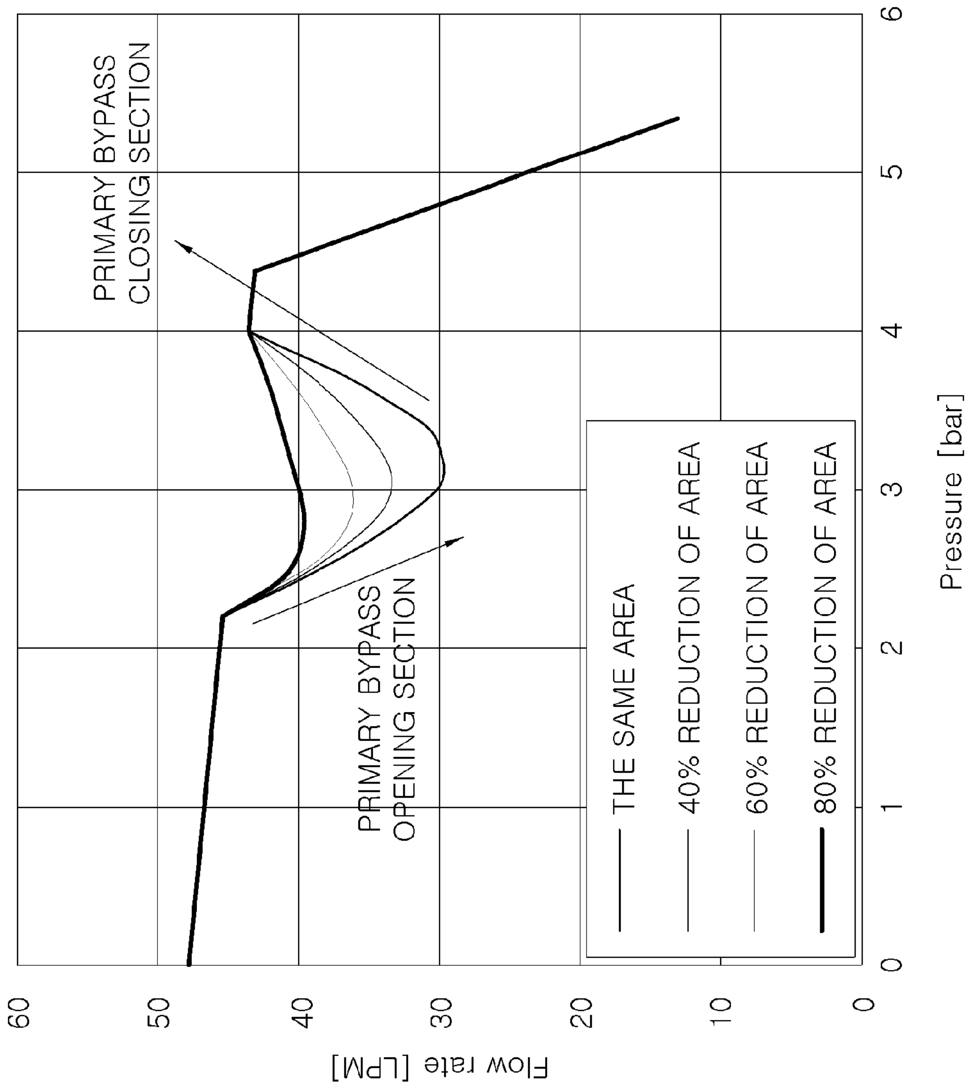

Flow rate [LPM]
60
50
40
30
20
10
0
1
2
3
4
5
6
Pressure [bar]
PRIMARY BYPASS
CLOSING SECTION
PRIMARY BYPASS
OPENING SECTION
THE SAME AREA
40% REDUCTION OF AREA
60% REDUCTION OF AREA
80% REDUCTION OF AREA

FIG.8

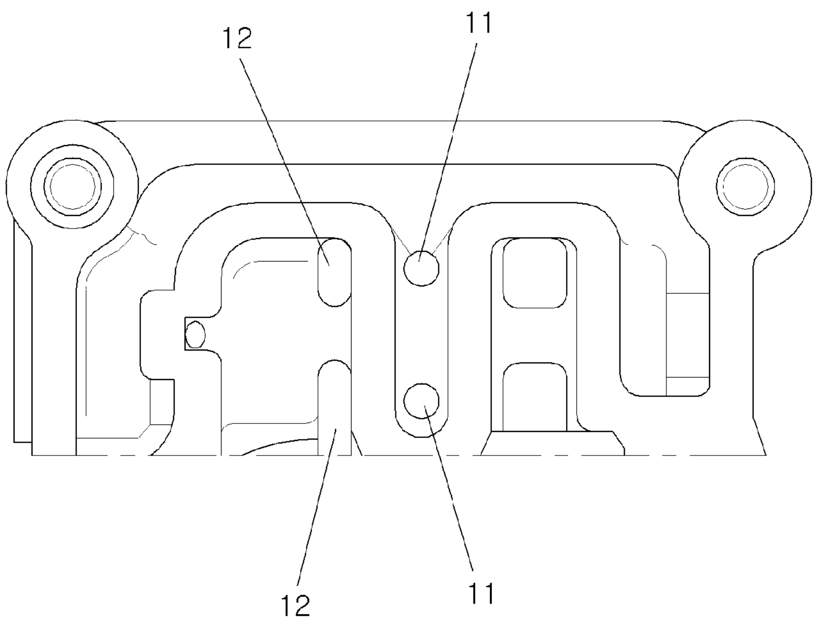


FIG.9

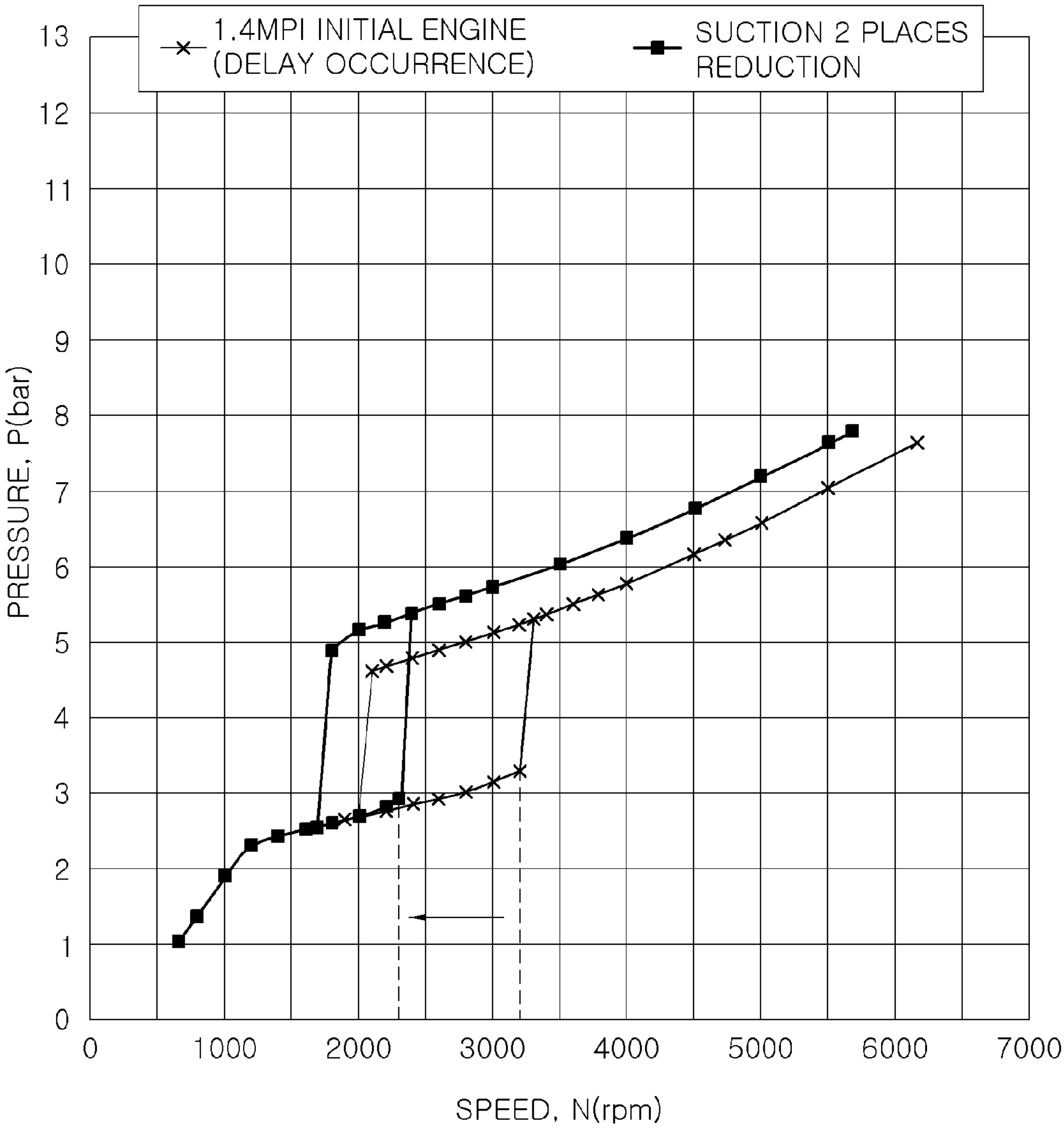
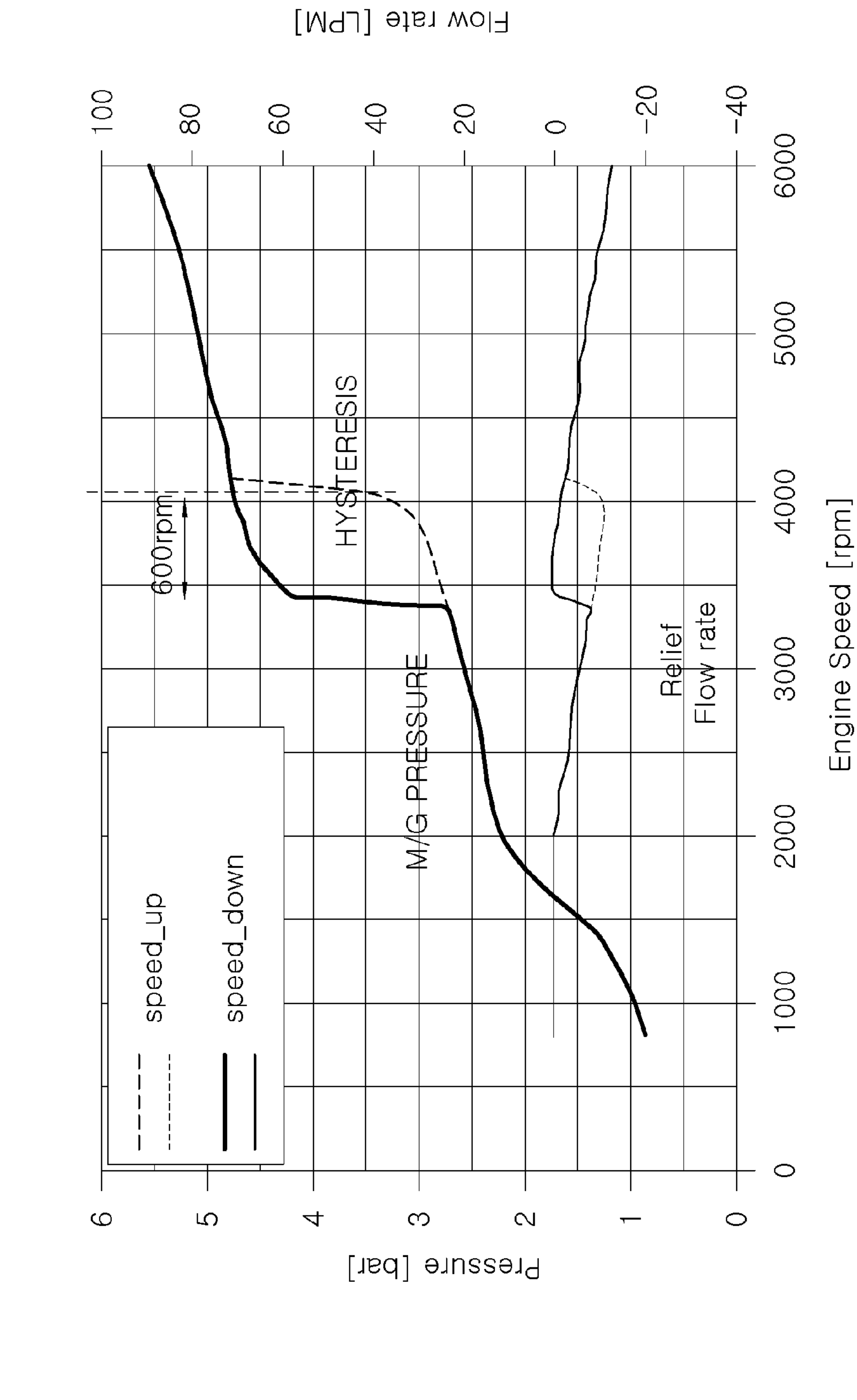
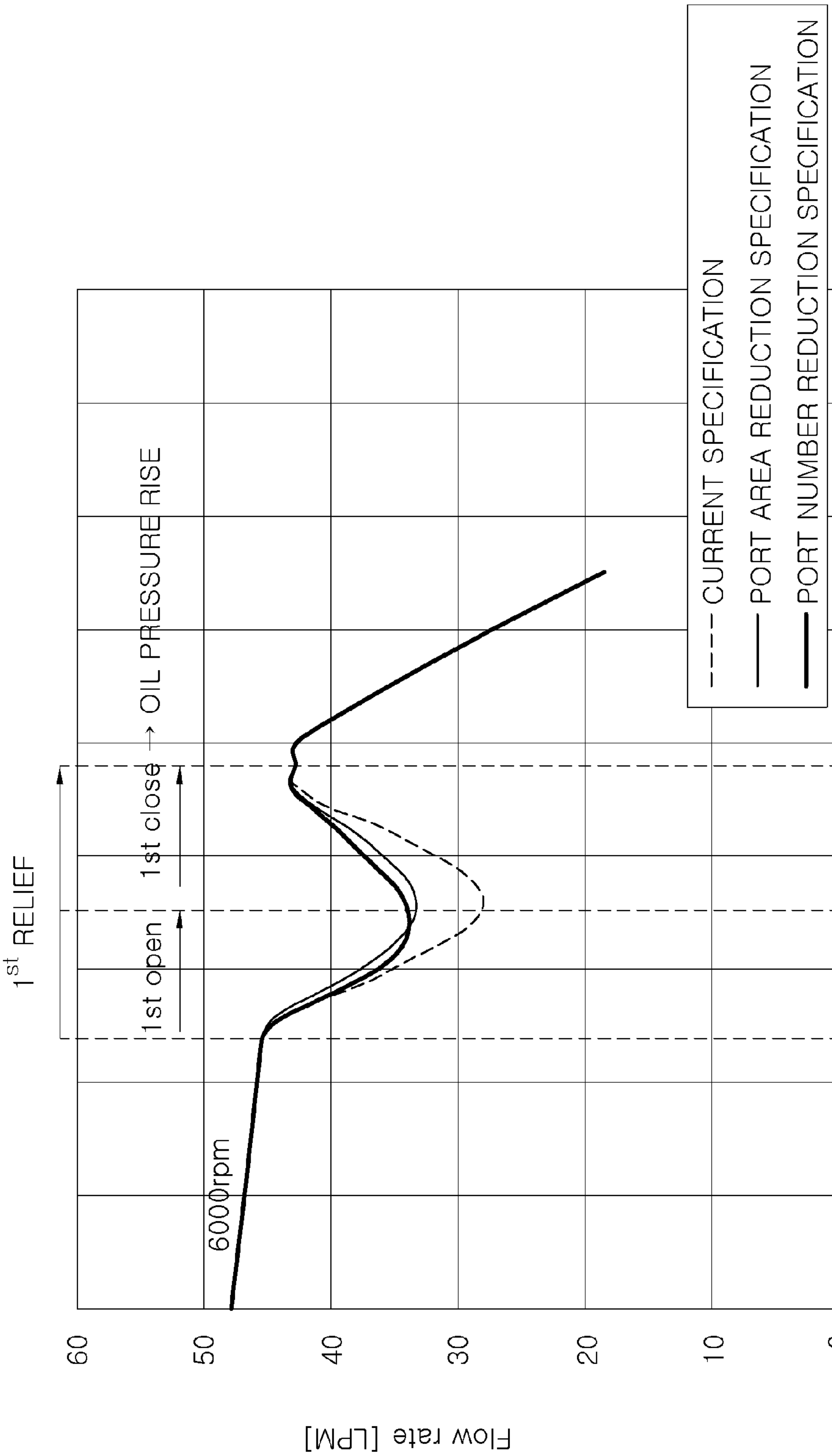

1.4MPI INITIAL ENGINE
(DELAY OCCURRENCE)
SUCTION 2 PLACES
REDUCTION
PRESSURE, P(bar)
SPEED, N(rpm)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
0
1000
2000
3000
4000
5000
6000
7000

FIG.10



speed_up
speed_down
HYSTERESIS
600rpm
M/G PRESSURE
Relief
Flow rate
Engine Speed [rpm]
Pressure [bar]
Flow rate [LPM]
0
1000
2000
3000
4000
5000
6000
0
1
2
3
4
5
6
100
80
60
40
20
0
-20
-40

FIG.11


1st RELIEF
1st open
1st close → OIL PRESSURE RISE
6000rpm
Flow rate [LPM]
60
50
40
30
20
10
0
0
1
2
3
4
5
6
7
8
9
CURRENT SPECIFICATION
PORT AREA REDUCTION SPECIFICATION
PORT NUMBER REDUCTION SPECIFICATION

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