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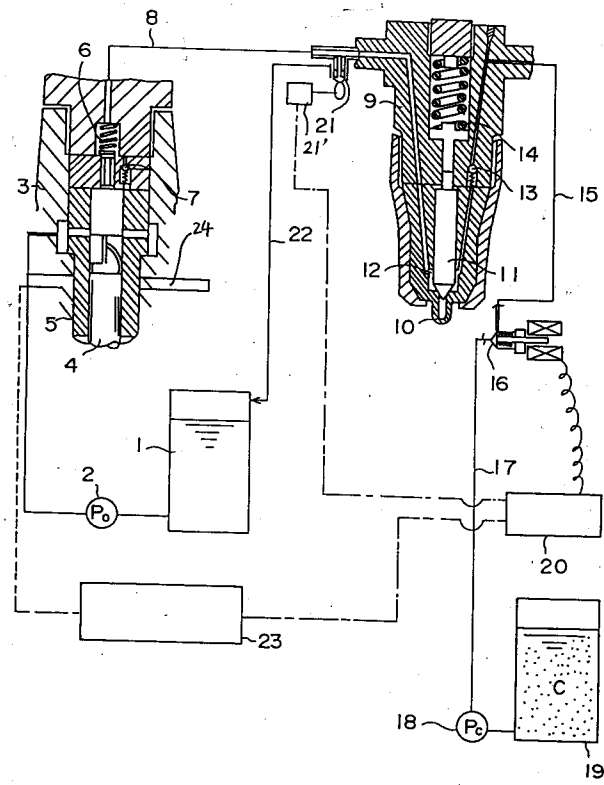
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W-8000 München 80 (DE)**(54) **System and method for feeding fuel to a fine-particle-mixed fuel burning diesel engine.**

(57) An improved system and method for feeding fuel, which obviates the shortcomings of the fuel feeding system in the prior art, in which mixed fuel consisting of fine particles of solid fuel such as pulverized coal or the like and fuel oil, is directly sent under a pressure by means of a high-pressure pump but seizure of a pump plunger is caused, and which enables the fuel feeding system in the prior art to achieve good operations, are disclosed. A predetermined amount of fuel oil containing fine particles of solid fuel is fed into an oil reservoir (12) within an injection valve (9) through a control valve (16), and this fuel oil is injected through a nozzle hole (10) of the injection valve (9) with the aid of oil pressurized by means of a high-pressure pump (3).

Thereby, only the above-mentioned fuel oil is injected, but the above-described pressurized oil is not injected, and also it never occurs that the aforementioned fuel oil enters the high-pressure pump (3), resulting in seizure of a plunger of the pump. The oil fed to the oil reservoir (12) is returned to an oil tank (1) via a circulation valve (21), and so, deterioration of the oil can be precluded. In addition, since the control valve (16) is regulated by a signal indicating a position of a control rack which controls a delivery amount of the high-pressure pump (3), fuel oil of the amount corresponding to the delivery amount of the high-pressure pump (3) is sent to the aforementioned oil reservoir (12), and so, only the above-mentioned fuel oil can be reliably injected.

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Fig. 1



BACKGROUND OF THE INVENTION:

Field of the Invention:

The present invention relates to a system and a method for feeding fuel to a diesel engine which make use of fuel oil containing fine particles of solid fuel such as pulverized coal or the like.

Description of the Prior Art:

In a conventional diesel engine, as shown in Fig. 2 fuel oil is fed from a fuel tank 101 through a fuel feed pump 102 to a fuel injection pump 103, then it is introduced into a fuel valve 108 as high-pressure fuel, and it is injected from a nozzle hole 109 into a combustion chamber of the engine, but in the case where in place of fuel for use in a diesel engine, mixed fuel consisting of pulverized coal and water or fuel oil is pressurized to a high pressure and injected to be burnt, seizure of a plunger would occur due to solid material of the mixed fuel within a plunger chamber and continued operations of the engine could not be effected.

It is to be noted that in Fig. 2, reference numeral 104 designates a plunger accommodated within a barrel 105 of a fuel injection pump 103, numeral 106 designates a delivery valve of the fuel injection pump 103, numeral 107 designates a feed pipe of fuel, numeral 110 designates a needle valve of the fuel injection valve 108, numeral 111 designates an oil reservoir provided on the upstream side of the needle valve 110 within the fuel injection valve 108, and numeral 112 designates a spring for biasing the needle valve 110.

Inherently, in a high-pressure fuel injection pump, fuel having solid material contained therein filtered out is employed, and it is improper in view of the mechanism of fuel injection to directly feed mixed fuel consisting of solid material of pulverized coal and fuel oil in itself to a fuel injection pump, because of occurrence of seizure of a plunger.

SUMMARY OF THE INVENTION:

It is therefore one object of the present invention to provide a system and a method for feeding fuel to a fine-particle-mixed fuel burning diesel engine, which obviate the above-described shortcoming of those in the prior art that seizure of a pump plunger would occur, and which can achieve good operations even if mixed fuel consisting of fine particles of solid fuel and fuel oil is employed.

According to one feature of the present invention, there is provided a fuel feed system for a fine-particle-mixed fuel burning diesel engine, in which fuel oil containing fine particles of solid fuel is employed for a diesel engine to be burnt, which

comprises an injection valve (9) including a needle valve (11) for opening and closing a path between an oil reservoir (12) and a nozzle hole (10), a fuel feed pipe (15) between the oil reservoir (12) of the injection valve and a fuel tank (19) for fuel containing fine particles, a control valve (16) for controlling the amount of fuel flowing through the fuel feed pipe (15) a check valve (13) provided within the injection valve (9) to allow only the flow of fuel flowing from the control valve (16) towards the oil reservoir (12), a high-pressure pump (3) for pressurizing oil within an oil tank (1) and feeding it to the injection valve (9), a pressure wave propagation pipe (8) connecting between a delivery port of the high-pressure pump (3) and the oil reservoir (12) in the injection valve (9), a circulation valve (21) for opening and closing the pressure wave propagation pipe (8), and a control device (20) for controlling opening and closing of the circulation valve and the control valve (16).

According to another feature of the present invention, there is provided the above-feature fuel feed system for a fine-particle-mixed fuel burning diesel engine, which comprises a control rack detector (23) for detecting a position of a control rack (24) which controls a delivery amount of the high-pressure pump (3) and for inputting a detection signal to the control device (20).

According to yet another feature of the present invention, there is provided a method for feeding fuel to a fine-particle-mixed fuel burning diesel engine, in which fuel oil containing fine particles of solid fuel is employed for a diesel engine to be burnt, which comprises steps of feeding fuel containing fine particles of solid fuel within a fuel tank (19) to an oil reservoir (12) within an injection valve from the side of a needle valve seat of the injection valve through a check valve (13) by means of a pump (18), pressurizing the fuel within the oil reservoir by high-pressure oil which has been pressurized by a high-pressure pump (3) and which has passed through a pressure wave propagation pipe (8), and injecting the fuel through a nozzle hole (10) of the injection valve.

According to still another feature of the present invention, there is provided the last-featured method for feeding fuel to a fine-particle-mixed fuel burning diesel engine, which comprises the steps of inputting a signal issued from a control rack detector (23) provided to detect a position of a control rack (24) for controlling a delivery amount of the high-pressure pump (3) to a control device (20), controlling a sending amount of fuel containing fine particles of solid fuel sent out from the pump (18) so as to meet with the delivery amount of the high-pressure pump (3) by controlling a control valve (16) by means of the control device (20), and sending the fuel containing particles of

solid fuel into the oil reservoir (12) within the injection valve through the check valve (13).

According to the present invention provided with the above-described features, fuel containing fine particles of the amount controlled by the control valve which is in turn controlled by the control device, is sent from the fuel tank through the fuel feed pipe to the oil reservoir in the fuel injection valve. On the other hand, the oil within the oil tank is pressurized by the high-pressure pump, and a pressure wave of the oil is transmitted to the above-mentioned oil reservoir through the pressure wave propagation pipe, and the above-mentioned fuel containing fine particles which is present within the oil reservoir is injected through the nozzle hole of the injection valve. When this injection has finished, the oil sent to the injection valve through the circulation valve controlled by the control device is returned to the oil tank, and so, deterioration of the oil can be precluded. In this way, fuel containing fine particles is never fed to the high-pressure pump, hence seizure of the plunger of the same pump does not occur, and also, only the fuel containing fine particles is injected through the nozzle hole of the injection valve.

In addition, according to the present invention, owing to the additional feature that a detection signal issued from the control rack detector for detecting a position of the control rack which controls a delivery amount of the high-pressure pump is input to the control device, and the amount of fuel containing fine particles to be fed to the oil reservoir is controlled on the basis of the amount of oil delivered from the high-pressure pump by the control device, only the same fuel containing fine particles is surely injected through the nozzle hole of the injection valve, and the oil propagating the pressure wave can be prevented from being injected through the nozzle hole.

The above-mentioned and other objects, features and advantages of the present invention will become more apparent by reference to the following description of preferred embodiments of the invention taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS:

In the accompanying drawings:

Fig. 1 is a schematic view showing one preferred embodiment of the present invention; and Fig. 2 is a schematic view showing one example of a fuel injection system for a diesel engine in the prior art.

DESCRIPTION OF THE PREFERRED EMBODIMENT:

Now one preferred embodiment of the present invention will be described with reference to Fig. 1. In this figure, reference numeral 1 designates an oil tank which accommodates oil for propagating a pressure wave to a fuel valve, numeral 2 designates an oil feed pump, numeral 3 designates a high-pressure injection pump, numeral 4 designates a plunger, numeral 5 designates a barrel, numeral 6 designates a delivery valve, numeral 7 designates a pressure-regulating check valve, numeral 8 designates a pressure wave propagation pipe, numeral 9 designates a fuel injection valve, numeral 10 designates a nozzle hole, numeral 11 designates a needle valve, numeral 12 designates an oil reservoir section, numeral 13 designates a check valve, numeral 14 designates a spring, numeral 15 designates a feed pipe, numeral 16 designates a control valve, numeral 17 designates a fuel feed pipe, numeral 18 designates a fuel feed pipe, numeral 19 designates a fuel tank for fuel containing fine particles of coal, numeral 20 designates a control device, numeral 21 designates a circulation valve, numeral 21' designates a drive motor controlled by the control device 20, numeral 22 designates a circulation pipe, and numeral 23 designates a control rack detector for detecting a position of a control rack 24 which controls a delivery amount of the high-pressure injection pump.

Fuel containing fine particles of coal is fed by the fuel feed pump 18 from the fuel tank 19 through the fuel feed pipe 17 and enters the control valve 16, and during a pause period of fuel injection and after circulation of the oil in the pressure propagation pipe 8 has finished, a predetermined amount of fuel containing fine particles of coal is sent into the fuel injection valve 9 through the feed pipe 15. At this time, representing a valve-opening pressure of the pressure-regulating check valve 7 in the high-pressure injection pump 3 by P_R , a valve-opening pressure of the check valve 13 by P_P and a valve-opening pressure of the needle valve 11 by P_N , and if these values are preset so as to fulfil the relations of $P_N > P_P > P_R$, the fuel fed from the fuel tank 19 would pass through the check valve 13 and would flow into the oil reservoir section 12 in the fuel injection valve 9. Consequently, the oil for use in propagation of a pressure which was present in this oil reservoir section, is pushed back towards the high-pressure injection pump 3 through the pressure wave propagation pipe 8, and flows inversely into the barrel (plunger chamber) 5 by forcibly opening the pressure-regulating check valve 7.

In addition, by detecting a position of the control rack 24 for controlling a delivery amount of high-pressure oil by means of the control rack detector 23 and inputting the detection signal to the control device 20 for controlling an opening/closing timing period of the control valve 16, an appropriate amount of fuel containing fine particles of coal is filled in the oil reservoir section 12.

Under the above-mentioned condition, when the plunger 4 in the high-pressure fuel pump 3 rises to push up the delivery valve 6 and oil feed starts, the oil for propagating a pressure wave is sent through the pressure, wave propagation pipe 8 to the side of the fuel injection valve 9, the pressure in the oil reservoir section 12 rises higher than the pressure P_N , hence the needle valve 11 opens against the resilient biasing force of the spring 14, and injection through the nozzle hole 10 commences.

At this time, fuel of the amount corresponding to the position of the control rack of the high-pressure injection pump has been preliminarily fed into the oil reservoir section, the oil for use in pressure wave propagation is not injected. Also, since the check valve 13 is closed, even if a high pressure is applied the fuel does not flow inversely towards the fuel tank.

After finishment of the fuel injection, the circulation valve 21 is opened via the drive motor 21' as controlled by the control device 20, thereby the oil for use in pressure wave propagation is circulated via the circulation pipe 22 to the oil tank 1, and so, deterioration of the oil can be prevented.

As will be apparent from the description of the preferred embodiment above, according to the present invention, owing to the above-mentioned structural feature, fuel containing fine particles of solid fuel can be injected at a high pressure from an injection valve into a combustion chamber without introducing such fine-particle-mixed fuel into a barrel (plunger chamber) in a high-pressure pump.

Accordingly, seizure of a high-pressure pump plunger caused by fine particles of solid fuel having a high hardness can be precluded, and in addition, since provision is made such that the oil for propagating a pressure wave from a high-pressure pump is also circulated, the fault in propagation of a hydraulic pressure due to deterioration of oil can be also eliminated.

While a principle of the present invention has been described above in connection to one preferred embodiment of the invention, it is intended that all matter contained in the above description and illustrated in the accompanying drawings shall be interpreted to be illustrative and not as a limitation to the scope of the present invention.

Claims

1. A fuel feed system for a fine-particle-mixed fuel burning diesel engine, in which fuel oil containing fine particles of solid fuel is employed for a diesel engine to be burnt; characterized in that said system comprises an injection valve (9) including a needle valve (11) for opening and closing a path between an oil reservoir (12) and a nozzle hole (10), a fuel feed pipe (15) between the oil reservoir (12) of said injection valve and a fuel tank (19) for fuel containing fine particles, a control valve (16) for controlling the amount of fuel flowing through said fuel feed pipe (15), a check valve (13) provided within said injection valve (9) to allow only the flow of fuel flowing from the control valve (16) towards the oil reservoir (12), a high-pressure pump (3) for pressurizing oil within an oil tank (1) and feeding it to the injection valve (9), a pressure wave propagation pipe (8) connecting between a delivery port of said high-pressure pump (3) and the oil reservoir (12) in the injection valve (9), a circulation valve (21) for opening and closing said pressure wave propagation pipe (8), and a control device (20) for controlling opening and closing of said circulation valve (21) and said control valve (16).
2. A fuel feed system for a fine-particle-mixed fuel burning diesel engine as claimed in Claim 1; characterized in that said system comprises a control rack detector (23) for detecting a position of a control rack (24) which Controls a delivery amount of said high-pressure pump (3) and for inputting a detection signal to said control device (20).
3. A method for feeding fuel to a fine-particle-mixed fuel burning diesel engine, in which fuel oil containing fine particles of solid fuel is employed for a diesel engine to be burnt; characterized by steps of feeding fuel containing fine particles of solid fuel within a fuel tank (19) to an oil reservoir (12) within an injection valve from the side of a needle valve seat of said injection valve through a check valve (13) by means of a pump (18), pressurizing the fuel within said oil reservoir by high-pressure oil which has been pressurized by a high-pressure pump (3) and which has passed through, a pressure wave propagation pipe (8), and injecting the fuel through a nozzle hole (10) of the injection valve.
4. A method for feeding fuel to a fine-particle-mixed fuel burning diesel engine as claimed in

Claim 3; characterized by steps of inputting a signal issued from a control rack detector (23) provided to detect a position of a control rack (24) for controlling a delivery amount of the high-pressure pump (3) to a control device (20), controlling a sending amount of fuel containing fine particles of solid fuel sent out from said pump (18) so as to meet with the delivery amount of said high-pressure pump (3) by controlling a control valve (16) by means of said control device (20), and sending said fuel containing fine particles of solid fuel into the oil reservoir (12) within the injection valve through the check valve (13).

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Fig. 1

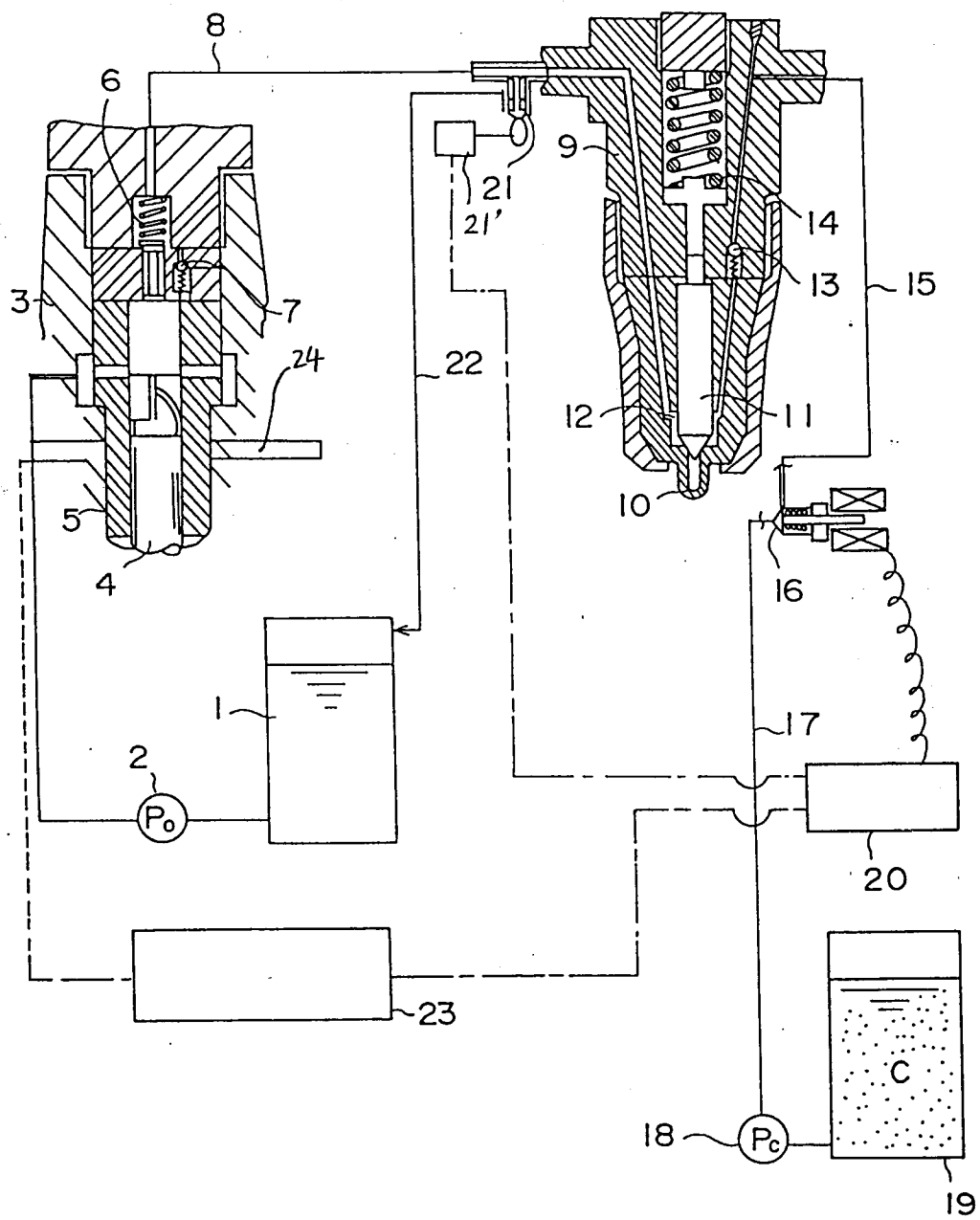
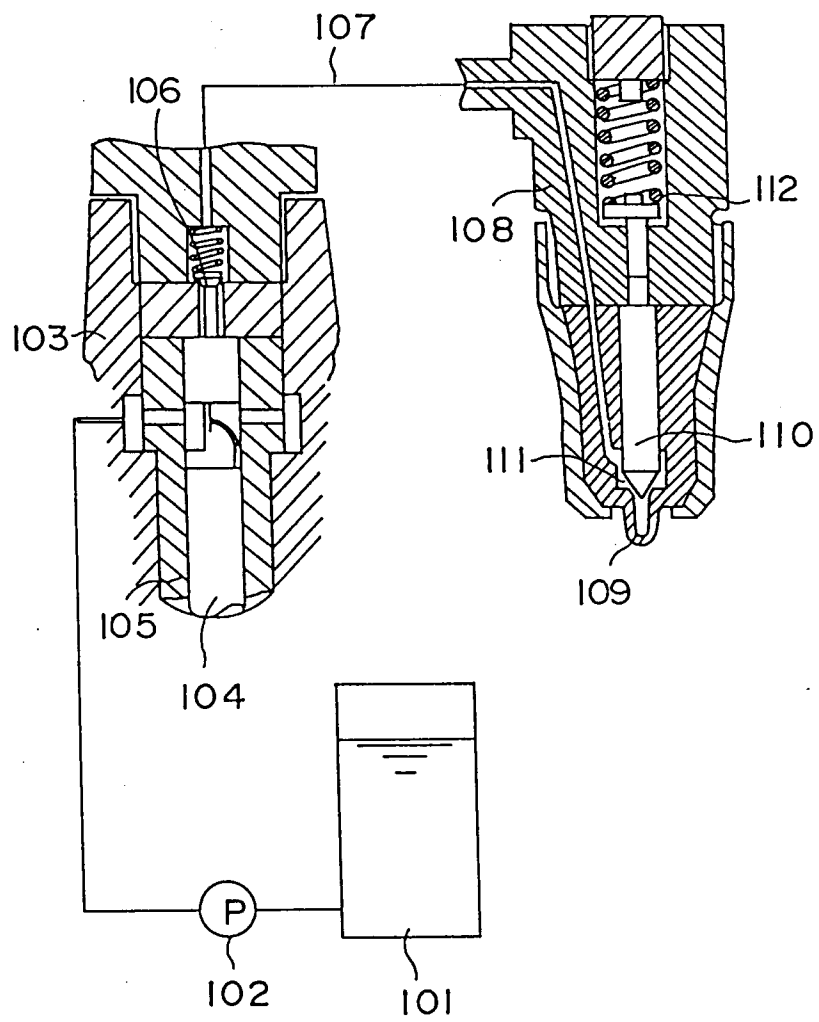


Fig. 2 (Prior Art)





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EUROPEAN SEARCH REPORT

Application Number

EP 92 11 1211

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)
Y	EP-A-0 282 819 (MITSUBISHI) * the whole document * ---	1-4	F02M43/00 F02D19/08 F02M37/08
Y	EP-A-0 104 368 (BARANESCU) * page 3, line 32 - line 34; figures 1,2 * ---	1-4	
A	US-A-4 699 103 (KENJI TSUKAHARA ET AL.) * the whole document * ---	1,3	
A	PATENT ABSTRACTS OF JAPAN vol. 10, no. 163 (M-487)(2219) 11 June 1986 & JP-A-61 014 465 (ISUZU) 22 January 1986 * abstract * ---	1,3	
A	DE-A-2 924 128 (MOTOREN-WERKE MANNHEIM) * claims 1-3; figures 1,5 * ---	1,3	
A	EP-A-0 418 601 (BOSCH) * claims 1,2; figure 1 * -----	1,3	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			F02M F02D
The present search report has been drawn up for all claims			
Place of search BERLIN		Date of completion of the search 23 NOVEMBER 1992	Examiner THOMAS C.
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			