

PATENT SPECIFICATION

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(54) IMPROVEMENTS IN SUPERCHARGED DIESEL ENGINES AND IN METHODS OF STARTING THEM

(71) We, ETAT FRANCAIS REPRESENTÉ PAR LE MINISTRE D'ETAT CHARGE DE LA DEFENSE NATIONALE DELEGATION MINISTERIELLE POUR L'ARMEMENT DIRECTION TECHNIQUE DES ARMEMENTS TERRESTRES ATELIERS DE CONSTRUCTION D'ISSY-LES-MOULINEAUX, a French Government Organization, residing at Caserne Sully, 92-Saint-Cloud, France, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to supercharged diesel engines and to methods of starting such engines. More particularly it relates to supercharged diesel engines having a low compression ratio.

As regards the methods of starting such engines, the expression "starting" denotes the starting proper and the raising of the temperature of such an engine.

These engines are cooled by a closed cooling system traversed by a cooling liquid such as water or a mixture of water and anti-gel.

These engines comprise a supercharging unit constituted by at least one turbine and at least one compressor. The turbine is supplied with exhaust gases from the engine through a combustion chamber ensuring the heating of the exhaust gases. The compressor supplies air to the engine through a cooler mounted in the cooling system of the engine and to the heating combustion chamber.

In these engines self-ignition at the end of the compression stroke is made possible by the prior starting of the supercharging unit whose compressor already delivers compressed and heated air. Now, during the starting of the engine and during its raising in temperature the cooler through which the compressor supplies the engine is at a low temperature since the cooling liquid has not yet reached its normal operating temperature. The cooler then lowers the tem-

perature of the air admitted to a level no longer permitting self-ignition.

It will be understood therefore that recourse must be had to special means which are brought into action during the period of starting and of raising the temperature.

It is an object of the invention to provide simple, efficient and reliable means for enabling easy starting and rapid raising of temperature of engines of the type concerned.

Accordingly, in one aspect, the present invention provides a diesel engine having a closed cooling system traversed by a liquid and having a supercharging unit comprising a turbine, which is supplied with exhaust gases through a combustion chamber, and a compressor, which supplies air to the engine through a cooler mounted in said cooling system and to the said combustion chamber, in which engine a by-pass pipe is arranged in parallel with the cooler and distributing means are provided at the beginning of this by-pass pipe, the distributing means being controlled so that, during the period of starting and rise in temperature of the engine, a part at least of the air delivered by the compressor passes through the by-pass pipe.

In another aspect, the invention provides a method of starting and raising the temperature of a diesel engine having a closed cooling system traversed by a liquid and having a supercharging unit comprising a turbine, which is supplied by exhaust gases through a combustion chamber, and a compressor, which supplies air to the engine through a cooler mounted in said cooling system and to said combustion chamber, which method includes: starting the supercharging unit and bringing it to an autonomous operating condition; starting the engine whilst distributing means is actuated to admit into the engine a part at least of the air delivered by the compressor through a by-pass pipe arranged in parallel with the cooler; and maintaining the actuation of said distributing

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means until the temperature of the liquid of the cooling system reaches a value such that the air can be admitted into the engine through the cooler whilst preserving a sufficiently high temperature for self-ignition to occur at the end of the compression stroke in the one or more cylinders of said engine.

In order that the invention may be readily understood, an embodiment thereof will now be described in more detail, by way of example, with reference to the accompanying drawing.

The single figure of the drawing is a diagrammatic view of one embodiment of an engine according to the invention.

The diesel engine represented in this Figure comprises a closed cooling system 1 traversed by a liquid (such as water or a mixture of water and anti-gel) circulating between the engine unit 2 and a radiator 3 by the action of a circulating pump 4.

This engine is supercharged by a supercharging unit constituted by a turbine 5 and a compressor 6 keyed on the same shaft 7.

The turbine 5 is supplied by exhaust gases through a combustion chamber 8; to this end, a pipe 9 connects this combustion chamber 8 to the exhaust manifold 10 of the engine.

The compressor 6 supplies air to the engine through a cooler 11, mounted, for example in parallel, on the cooling system 1, and also supplies air to the combustion chamber 8; to this end, a pipe 12, dividing into two branches 12a and 12b, connects the compressor 6 to the intake manifold 13 of the engine (branch 12a), and to the combustion chamber 8 (branch 12b).

This being the case and according to the invention, a by-pass pipe 14 is arranged in parallel with the cooler 11 and distributing means 15 are provided at the beginning of this by-pass pipe 14.

These distributing means 15 are controlled so that, during the period of starting and of rise in temperature of the engine, a portion at least of the air delivered by the compressor 6 passes through the by-pass pipe 14.

These distributing means 15 can be arranged so that a portion only of the air delivered by the compressor 6 passes through the by-pass pipe 14, in which case the remaining portion of the air supplies the combustion chamber 8 directly.

These distributing means 15 can also be arranged so that the whole of the air delivered by the compressor 6 passes through the by-pass pipe 14, in which case the portion of this air which is not admitted into the engine supplies the combustion chamber 8 by traversing (in reverse direction) the cooler 11 and the branch 12b, which causes more rapid heating of the liquid of the cooling system 1.

With a view to rendering the operation of the distributing means 15 automatic, the distributing means 15 can advantageously be servo operated in dependence upon the temperature of the liquid of the cooling system 1, so that, as long as this temperature remains below a normal value, the distributing means occupy a position in which a portion at least of the air delivered by the compressor 6 passes through the by-pass pipe 14, and, when this temperature becomes higher than the above-said normal value, the distributing means 15 occupy a position in which the inlet of the by-pass pipe 14 is closed.

The method of starting an engine constructed as has just been described is then as follows:

The starting of the supercharging unit is effected by means of a starter 16 and this unit is brought to an autonomous operating condition by acting on the flow of fuel delivered by an injector 17 supplying the combustion chamber 8 with fuel.

The starting of the engine is effected by means of a starter 18 whilst conjointly the distributing means 15 is actuated (manually, or automatically if the control of these distributing means 15 is servocoupled to the temperature of the liquid of the cooling system 1) so that at least a part of the air delivered by the compressor is admitted to the engine through the by-pass pipe 14.

Finally, the actuation of the distributing means 15 is maintained until the temperature of the liquid of the cooling system 1 reaches its normal operating value.

As a result of which and whatever the embodiment adopted, there is provided a diesel engine which can be easily put into operation and in which the rise in temperature is effected rapidly.

It will be understood that such an engine, mounted on a vehicle, enables this vehicle to be brought into service extremely rapidly.

Moreover, the improvements proposed by the invention are simple, inexpensive to produce, and of very reliable automatic operation.

WHAT WE CLAIM IS:—

1. A diesel engine having a closed cooling system traversed by a liquid and having a supercharging unit comprising a turbine, which is supplied with exhaust gases through a combustion chamber, and a compressor, which supplies air to the engine through a cooler mounted in said cooling system and to the said combustion chamber, in which engine a by-pass pipe is arranged in parallel with the cooler and distributing means are provided at the beginning of this by-pass pipe, the distributing means being con-



means until the temperature of the liquid of the cooling system reaches a value such that the air can be admitted into the engine through the cooler whilst preserving a sufficiently high temperature for self-ignition to occur at the end of the compression stroke in the one or more cylinders of said engine.

In order that the invention may be readily understood, an embodiment thereof will now be described in more detail, by way of example, with reference to the accompanying drawing.

The single figure of the drawing is a diagrammatic view of one embodiment of an engine according to the invention.

The diesel engine represented in this Figure comprises a closed cooling system 1 traversed by a liquid (such as water or a mixture of water and anti-gel) circulating between the engine unit 2 and a radiator 3 by the action of a circulating pump 4.

This engine is supercharged by a supercharging unit constituted by a turbine 5 and a compressor 6 keyed on the same shaft 7.

The turbine 5 is supplied by exhaust gases through a combustion chamber 8; to this end, a pipe 9 connects this combustion chamber 8 to the exhaust manifold 10 of the engine.

The compressor 6 supplies air to the engine through a cooler 11, mounted, for example in parallel, on the cooling system 1, and also supplies air to the combustion chamber 8; to this end, a pipe 12, dividing into two branches 12a and 12b, connects the compressor 6 to the intake manifold 13 of the engine (branch 12a), and to the combustion chamber 8 (branch 12b).

This being the case and according to the invention, a by-pass pipe 14 is arranged in parallel with the cooler 11 and distributing means 15 are provided at the beginning of this by-pass pipe 14.

These distributing means 15 are controlled so that, during the period of starting and of rise in temperature of the engine, a portion at least of the air delivered by the compressor 6 passes through the by-pass pipe 14.

These distributing means 15 can be arranged so that a portion only of the air delivered by the compressor 6 passes through the by-pass pipe 14, in which case the remaining portion of the air supplies the combustion chamber 8 directly.

These distributing means 15 can also be arranged so that the whole of the air delivered by the compressor 6 passes through the by-pass pipe 14, in which case the portion of this air which is not admitted into the engine supplies the combustion chamber 8 by traversing (in reverse direction) the cooler 11 and the branch 12b, which causes more rapid heating of the liquid of the cooling system 1.

With a view to rendering the operation of the distributing means 15 automatic, the distributing means 15 can advantageously be servo operated in dependence upon the temperature of the liquid of the cooling system 1, so that, as long as this temperature remains below a normal value, the distributing means occupy a position in which a portion at least of the air delivered by the compressor 6 passes through the by-pass pipe 14, and, when this temperature becomes higher than the above-said normal value, the distributing means 15 occupy a position in which the inlet of the by-pass pipe 14 is closed.

The method of starting an engine constructed as has just been described is then as follows:

The starting of the supercharging unit is effected by means of a starter 16 and this unit is brought to an autonomous operating condition by acting on the flow of fuel delivered by an injector 17 supplying the combustion chamber 8 with fuel.

The starting of the engine is effected by means of a starter 18 whilst conjointly the distributing means 15 is actuated (manually, or automatically if the control of these distributing means 15 is servocoupled to the temperature of the liquid of the cooling system 1) so that at least a part of the air delivered by the compressor is admitted to the engine through the by-pass pipe 14.

Finally, the actuation of the distributing means 15 is maintained until the temperature of the liquid of the cooling system 1 reaches its normal operating value.

As a result of which and whatever the embodiment adopted, there is provided a diesel engine which can be easily put into operation and in which the rise in temperature is effected rapidly.

It will be understood that such an engine, mounted on a vehicle, enables this vehicle to be brought into service extremely rapidly.

Moreover, the improvements proposed by the invention are simple, inexpensive to produce, and of very reliable automatic operation.

WHAT WE CLAIM IS:—

1. A diesel engine having a closed cooling system traversed by a liquid and having a supercharging unit comprising a turbine, which is supplied with exhaust gases through a combustion chamber, and a compressor, which supplies air to the engine through a cooler mounted in said cooling system and to the said combustion chamber, in which engine a by-pass pipe is arranged in parallel with the cooler and distributing means are provided at the beginning of this by-pass pipe, the distributing means being con-

trolled so that, during the period of starting and rise in temperature of the engine, a part at least of the air delivered by the compressor passes through the by-pass pipe.

5 2. A diesel engine according to claim 1, wherein the distributing means are arranged so that a part only of the air delivered by the compressor passes through the by-pass pipe, the remaining part of the air supplying
10 the combustion chamber directly.

3. A diesel engine according to claim 1, wherein the distributing means are arranged so that the whole of the air delivered by the compressor passes through the by-pass pipe,
15 the part of this air which is not admitted into the engine supplying the combustion chamber by passing through the cooler.

4. A diesel engine according to any preceding claim, wherein the distributing
20 means is servo-operated in dependence upon the temperature of the liquid of the cooling system so that, as long as this temperature remains less than a normal value, the distributing means occupy a position in which a
25 part at least of the air delivered by the compressor passes through the by-pass pipe, and, when this temperature becomes higher than said normal value, the distributing means occupy a position in which the inlet
30 of the by-pass is closed.

5. A method of starting and raising the temperature of a diesel engine having a closed cooling system traversed by a liquid and having a supercharging unit comprising
35 a turbine, which is supplied by exhaust gases

through a combustion chamber, and a compressor, which supplies air to the engine through a cooler mounted in said cooling system and to said combustion chamber, which method includes: starting the super-
40 charging unit and bringing it to an autonomous operating condition; starting the engine whilst distributing means is actuated to admit into the engine a part at least of the air delivered by the compressor through a
45 by-pass pipe arranged in parallel with the cooler; and maintaining the actuation of said distributing means until the temperature of the liquid of the cooling system reaches a value such that the air can be ad-
50 mitted into the engine through the cooler whilst preserving a sufficiently high temperature for self-ignition to occur at the end of the compression stroke in one or more cylinders of said engine.

6. A diesel engine substantially as hereinbefore described with reference to, and as illustrated in the accompanying drawings.

7. A method of starting a diesel engine substantially as hereinbefore described with
60 reference to the accompanying drawings.

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