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(54) **Egr control system and apparatus in the supply system of boosted internal combustion engines**

(57) The invention concerns a system and a control and adjustment apparatus of exhaust gas recirculation (EGR) in a supply plant of an internal combustion engine (MCI), boosted in terms of temperature and flow rate of the recirculation gases, both in stationary and in transient conditions. According to the invention, the main flow rate of burnt gases is sent to a turbine (4), for the actuation thereof, while a share of exhaust gas, drawn upstream of the turbine, flows through an adjustor valve (6) and is channelled through a heat exchanger (7) ("EGR cooler"), dedicated to gas cooling. This share of cooled exhaust gas is led to a flow deflector (8), wherefrom - depending on the instant operation conditions of the engine (MCI), it is sent

- to a Venturi assembly (10), arranged downstream of the compressor (5), to be mixed there with the air coming from the compressor (5) and then conveyed to an intercooler (9), where the gases are further cooled and then sent to a throttle valve (3), which adjusts the supply thereof to the combustion chamber of the engine (MCI), or
- directly downstream of the throttle valve (3), where mixing with the air coming from the intercooler device (9) occurs. The EGR control is actuated, through electric actuations of the adjustor valve (6), of the gas deflection means (8) and of the cooling fluid circulation device (13 or 14), of an electronic control system which uses a ded-

icated microprocessor, independent but cooperating with the electronic system (ECU) for the general control of the engine supply (MCI).

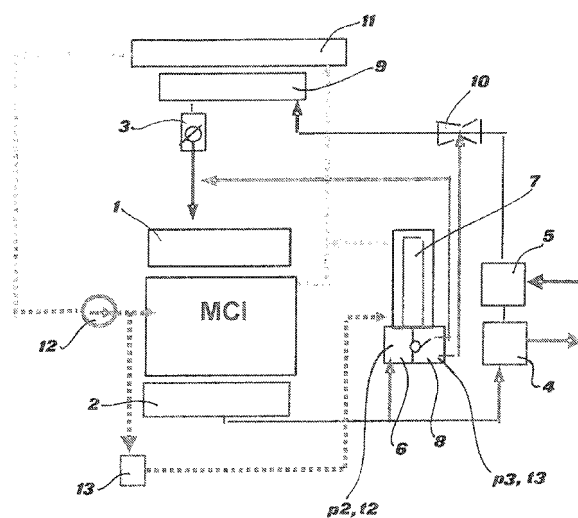


Fig.1

Description

FIELD OF THE INVENTION

[0001] The invention concerns a system which allows to implement the controlled recirculation of exhaust gases in an internal combustion engine with controlled ignition and a control system of this device.

[0002] More precisely, the technical fields to which the invention refers are those of the use of EGR (acronym of "Exhaust gas recirculation"), both in stationary and in transient conditions (acceleration or deceleration phase), so as to mitigate detonation phenomena and the overheating of some engine parts; this in particular in controlled-ignition engines supplied with petrol or with liquid or gaseous alternative fuels.

[0003] Detonation is the main limit to performance improvement of controlled-ignition engines. The onset of the detonation phenomenon is emphasized by design choices, which imply the achievement of high actual, average pressure values in the presence of high compression ratios. Such choices, ordinarily aimed at improving the efficiency and specific power of propellers, may determine critical conditions for detonation whenever it is not possible to exploit the cooling action of the excess of vaporised liquid fuel, as occurs in natural gas engines.

[0004] Experience has shown that the use of cooled EGR gases allows to achieve a remarkable increase of detonation resistance. As a matter of fact, the recirculation of cooled exhaust gases causes a drop of combustion cycle temperatures, as well as the reduction of the speed of the oxidation reactions responsible for the self-ignition of the portion of air-fuel mixture present downstream of the flame front (also called "end gas").

[0005] The use of EGR systems may further allow to limit the temperature of heads, the power being equal or, viceversa, to increase the deliverable power values to detonation limits, the head temperature being equal.

[0006] As a matter of fact, detonation is a phenomenon which sets in especially at high loads and in transient conditions and may be heightened - rather than limited - if the quota of EGR gases introduced into the intake collector has not been suitably cooled.

[0007] The effectiveness of EGR for detonation limitation is hence linked to the opportunity of controlling - also at high loads - both EGR temperature and contents, within close preset limits, and this both in stationary and in transient conditions.

[0008] The present invention proposes innovations: to the system for actuating controlled recirculation; to the measuring procedures of the EGR flow rate; to EGR cooling procedures.

STATE OF THE BACKGROUND ART

[0009] Special embodiments of EGR valves which allow to implement the technique of controlled recirculation of exhaust gases are already known; they are described

for example in Italian patent applications no. MI2005A-000407, MI2005A-000408, and MI2008A-000450, all filed in the name of the same Applicant.

[0010] More specifically, as far as the present invention is concerned, during the examination of the state of the art, special care will be devoted to the following aspects:

- the application system of the EGR circuit,
- the measurement of the EGR gas flow rate or contents,
- the cooling procedures of the EGR exchanger

[0011] Concerning the system of the EGR circuit applied to controlled-ignition engines supplied with liquid or gaseous fuel, in general the various manufacturers of components propose recirculation approaches which variously exploit diesel-derived "short route & long route" technologies.

[0012] Short route applications are illustrated in patents US-5,617,726, US-5,611,204 in the name of Cummins. The cited devices - conceived to be applied to diesel engines - provide a drawing of recirculation gas upstream of the turbine, refrigeration of recirculation gases through an EGR cooler (with possible by-pass) and mixing of the gases with the air downstream of an intercooler. A conceptually similar approach is illustrated also in patent US-6,408,833 in the name of Caterpillar.

[0013] However, it must be noted that an EGR obtained according to the technique called "Short route" has the drawback that, although effectively cooled, it may cause significant increases of the temperatures of the engine-drawn mixture. As an example, assuming a temperature of 140°C of the cooled EGR gas and a recirculation proportion of 20%, as well as an air temperature at the exit of the intercooler of 50°C, a temperature increase of the air-EGR gas mixture by little less than 20°C compared to air temperature is determined. Such increase is of course in contrast with the aim of achieving greater detonation resistance.

[0014] Documents US-2005/0235644 and US-2007/0256413 illustrate so-called "Long-Route" systems, wherein the gases to be recirculated are drawn downstream of the turbine and are delivered for engine intake. Long-route systems benefit from the intercooler effect to curb intake temperatures.

[0015] However, tests carried out so far show that such systems are little effective in transient conditions. Moreover, the entry of warmer gases in the engine intake implies an increase of the compression work by the turbo compressor, with a resulting deterioration of the overall yield.

[0016] The measurement of the EGR flow rate is carried out with highly varied methods. The most widespread one uses load losses in bottlenecks, often called "measuring orifices": in such respect US-6,182,644 and US-6,321,732 are cited. As an alternative to simple measuring orifices, Venturi tube meters have also been proposed, such as in US-6,810,725 for example.

[0017] An alternative to the use of measuring orifices or of Venturi tubes for measuring the EGR flow rate is to exploit the measurement of the pressure drop through the heat exchanger, as proposed in US-7,278,411. Such system, in addition to a differential pressure meter, provides one or two temperature sensors, upstream and downstream of the exchanger. The signal coming from the pressure meter, with the possible addition of those derived from the temperature meters, is processed in a dedicated processor for the calculation of the EGR flow rate.

[0018] The problem of the controlled recirculation of exhaust gases in an internal combustion engine is addressed also in US2007/0246028; here a high-pressure EGR line and a low-pressure EGR line as well as a suitable control electronic system are shown. In such system the conventional configuration is observed by which low-pressure EGR gas can be drawn downstream of the catalytic converter and, after having been cooled, it can be delivered upstream of the compressor; moreover, it is possible to draw high-pressure EGR gas upstream of the turbine. Control problems of an internal combustion engine and in particular of calculation and investigation of the conditions of exhaust gases are addressed in various documents, among which US2008/0120962; in such document the control method is based on the use of oxygen sensors.

[0019] As far as the gas cooling circuit in the EGR cooler is concerned, some solutions provide cooling circuits with multiple radiators, such as for example in US-6,244,256, US-7,380,544. Today the most widespread solutions on the market provide the use of a single radiator which uses the same engine fluid or auxiliary fluids.

PROBLEM AND SOLUTION

[0020] The problem at the base of the invention is to propose an EGR system which overcomes the drawbacks or limits of the known art, in the use of the technique of controlled recirculation of exhaust gases, in terms of temperature and flow rate of the recirculation gases, and this both in stationary and in transient conditions.

[0021] A second problem is that of providing a control system which does not overload the work of the electronic central unit for the management of the combustion engine and of the entire vehicle which uses said engine.

[0022] These objects are achieved through the features mentioned in independent claims 1 and 10. The dependent claims describe preferential features of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] Further features and advantages of the invention are in any case more evident from the following detailed description of some preferred embodiments, given purely as a non-limiting example and shown in the attached drawings, wherein:

fig. 1 shows the functional diagram of an EGR system according to a first embodiment of the present invention;

fig. 2 shows a functional diagram similar to that of fig. 1, concerning a second embodiment;

fig. 3 shows a possible concrete embodiment of the mushroom valve device and of the deflector valve according to the invention, in section according to the valve axis;

fig. 4 shows a comparison plot in which it can be noticed that the expected values and the measured ones of the EGR flow rate which flows through the heat exchanger gather along a same straight line.

15 DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0024] As already stated, the invention hence proposes the use of the controlled EGR technique, both in stationary and in transient conditions (i.e. in an acceleration or deceleration phase), so as to mitigate detonation phenomena and the overheating of some engine parts, in particular in controlled-ignition engines supplied with petrol or with alternative liquid or gaseous fuels.

[0025] As reported in the functional diagram of fig. 1, the EGR system according to the present invention applies to a boosted internal combustion engine (MCI), which comprises an intake collector 1 and an exhaust collector 2. Through a throttle valve 3 the supply of air is controlled, delivered through a turbocompressor consisting of turbine 4 and compressor 5.

[0026] The invention provides that the main flow rate of burnt gases, drawn immediately downstream of exhaust collector 2, is sent to turbine 4, for the actuation thereof. A further quota of exhaust gas flows through an electrically-actuated adjuster valve 6. Exhaust gases, after having flowed through valve 6, flow through heat exchanger 7 other EGR system, also called "EGR Cooler".

[0027] Downstream of exchanger 7 a deflector 8 is located which allows to convey the cooled EGR gases either directly downstream of the throttle valve 3, where they mix with the air coming from an intercooler device 9, or alternatively into a simple or double Venturi tube 10, arranged downstream of compressor 5 and before intercooler 9.

[0028] It is to be understood that the assembly consisting of mushroom valve 6 and deflector valve 8 forms a subsystem capable of operating the adjustment of the flow of recirculated gases both in terms of flow rate and of selective channelling of the gas upstream of the intercooler or rather downstream of the throttle valve, according to the diagrams reported in fig. 1 and fig. 2.

[0029] Fig. 3 shows, more concretely, a possible embodiment of this assembly of mushroom valve 6 and deflector valve 8.

[0030] Valve body 6 comprises a mushroom valve 6a, pushed against its seat 6b by a compression spring 6c, and an electric moving system - known per se and there-

fore represented through sole housing 6d containing the various constitutive elements - which controls the opening thereof according to a precise control strategy, actuated by means of a dedicated electronic control system, as better detailed in the following.

[0031] With valve body 6 there is further associated a conduit 6e for the entry of recirculation gas coming from the engine exhaust system 2, the flow rate of which is adjusted precisely through the greater or smaller opening of mushroom valve 6a; this flow rate is conveyed from output conduit 6f to exchanger 7, while the remaining part of burnt gases is separately sent to the entry of turbine 4.

[0032] The gases which flow through exchanger 7 are cooled - as better detailed also in the following - by the cooling liquid of the MCI engine; this liquid is conveyed to the exchanger through adjustment valve 13, according to a first embodiment of the invention, the diagram of which is shown in fig. 1, or through auxiliary electric pump 14, as provided by a second embodiment of the invention, the diagram of which is shown in fig. 2.

[0033] The flow rate of this liquid, which becomes necessary for the cooling of the EGR gases, is delivered to exchanger 7 through a conduit 7a and comes out thereof through a conduit 7b, to return to the radiator 11 of the MCI engine.

[0034] The body 8 of the deflector valve joins downstream of exchanger 7, said valve essentially consisting of a deflector 8a which moves between two extreme positions so as to close a delivery conduit 8b, which leads directly downstream of throttle valve 3, or so as to close a supply conduit 8c, respectively, which leads to Venturi tube 10, as better described in the following.

[0035] The arrangement according to fig. 3 is of course one of the possible arrangements which the person skilled in the field will be able to adopt. However, it is clear that the assembly consisting of adjuster valve 6 and deflector valve 8 can be thought to be manufactured also by other means or systems, i.e. with a first adjuster valve actually present upstream of the heat exchanger and a second valve for selective channelling downstream of the exchanger; or rather with a single system, arranged downstream of the EGR cooler, capable of performing both functions, for example of the type of the one subject of the already cited patent application MI2008A-000450 in the name of the same Applicant.

[0036] Venturi device 10 and the exhaust gas delivery system are designed to work in a subsonic regime, with very modest load losses. Venturi device 10 absolves the task of increasing the pressure difference between the one upstream of turbine 4 and the one downstream of compressor 5 and hence of increasing the reaction speed of the system.

[0037] Upstream of EGR cooler 7 there are arranged a pressure meter and a temperature meter, referred to as p2 and t2, respectively (associated with valve assembly 6, even though not shown in detail). Downstream of EGR cooler 7 a pressure meter p3 is arranged (possibly

associated with a temperature meter t3, both associated with the deflector assembly 8, but not shown).

[0038] The pressure and temperature measurements p2, t2, p3 are acquired and used by a processor for the calculation of the EGR flow rate and temperature.

[0039] According to an important feature of the present invention, this is a local, closed-circle processor, dedicated exclusively to the control of the EGR function, but which integrates with the general electronic system (ECU) for the control of the supply of the engine (MCI).

[0040] This dedicated microprocessor governs at least the following elements: said means (6) for the actuation of the EGR valve, said means (8) for gas deflection, and the means - adjustment valve 13 or circulation pump (14) - for cooling fluid control.

[0041] Such microprocessor, together with the other elements of the measurement-control chain, allows an effective real-time control - both in stationary and in transient conditions - of the flow rates and the temperatures of the incoming mixture to the engine. It collects the requests of the main ECU and performs a "model based" control to chase the desired EGR temperature and flow rate profiles.

[0042] This arrangement is particularly advantageous, on the one hand, due to the fact that it allows to free the main ECU of the entire engine supply system from the task of controlling the EGR function and, on the other hand, due to the fact that it is possible to use a microprocessor dedicated to the sole control of this function, achieving faster reaction times.

[0043] As already stated, the exhaust gases are cooled, within heat exchanger 7, by means of the engine cooling fluid. A quota of the cooling fluid coming from engine radiator 11 is taken downstream of the relative circulation pump 12, before entering the engine. This quota of cooling fluid flows through valve 13, which adjusts the flow rate thereof, which goes through exchanger 7. At the exit of exchanger 7 the cooling fluid mixes with that coming out from the engine and goes back into engine radiator 11.

[0044] The flow rate of the cooling fluid may be adjusted in a closed cycle, using as reference the temperature sensor t3 arranged at the exit of exchanger 7.

[0045] Another possible embodiment of the invention is shown in the diagram of fig. 2; it differs from that of fig. 1 in terms of the cooling circuit of EGR exchanger 7.

[0046] As a matter of fact, the cooling fluid coming from radiator 11 is taken upstream of the fluid circulation pump 12 in the engine, before entering the engine. The drawn fluid flows through auxiliary electric pump 14, which adjusts the flow rate thereof, which goes through exchanger 7. At the exit from exchanger 7 the cooling fluid then mixes with that coming out from the engine and goes back into engine radiator 11, as shown in fig. 1.

[0047] In this case too the flow rate of the cooling fluid may be adjusted in a closed cycle, using as reference temperature sensor t3, arranged at the exit of exchanger 7.

[0048] The recirculation diagram according to the invention hence provides the EGR gases delivery immediately downstream of compressor 5 and upstream of intercooler device 9 or, alternatively, downstream of throttle 3. The assessment of which of the two paths must be used, on each occasion and instant by instant, is actuated by means of the cited dedicated microprocessor, depending on the instant conditions of engine operation (MCI).

[0049] The diagram described in figures 1 and 2 is different both from traditional "Short Route" devices and from "Long Route" devices. In fact, unlike in the known art, according to the EGR system proposed by the present invention, recirculation gas delivery occurs upstream of the Intercooler, in the high-pressure area (downstream of the compressor).

[0050] The essential advantage of this arrangement according to the invention is given by the fact that it makes reply faster in transient conditions.

[0051] Another advantage is that precisely the delivery of the EGR upstream of the intercooler device and downstream of the compressor allows a precise control of the gas mixture temperature taken in by the engine, with a cooling effect comparable to the one obtainable by using a traditional Long Route diagram, but controllable in a much more precise manner.

[0052] A further advantage is given by the presence of a Venturi tube downstream of the compressor, in the delivery area of recirculated gases; it allows an increase of the EGR transit speed, with a dramatic improvement of the control in transient conditions. By adopting a double Venturi device it would furthermore be possible to achieve further advantages in terms of system functionality.

[0053] Still another advantage is achieved in the control of the flow rate of recirculation gases. As seen, it is based on the opportunity of measuring in a suitably accurate manner the instant EGR flow rate which, according to the invention and in both embodiments - which differ only by a detail of the cooling circuit of the EGR exchanger - is performed, on the one hand, using the pressure signals p2 and temperature signals t2, taken upstream of the exchanger, after the EGR gas has crossed adjustment valve V and, on the other hand, using pressure signal p3 taken downstream of the heat exchanger, before the EGR gas is sent from deflector valve D into the Venturi, or into the throttle valve (figs. 1 and 2). For the calculation of said flow rate said dedicated microprocessor uses a correlation formula which exploits functional groups obtained from the combination of the measured parameters p2, p3, t2.

[0054] According to an important aspect of the present invention, the operation control of both one and the other of the two proposed embodiments (figs. 1 and 2) is performed by means of a dedicated processor. Thereby it is understood that the control of: EGR valve 6, gas deviation system 8 with electric pump 12 and valve 13 for the adjustment of the circulation of the cooling fluid, as well

as auxiliary pump 14, are actuated by means of a microprocessor which is distinct from the microprocessor of the main engine management ECU. It actuates a "model based" control to chase the desired EGR temperature and flow rate profile.

[0055] In actual fact, as already stated, in US-7,278,411 the measurement of the pressure difference between upstream and downstream of the exchanger and the measurement of the temperatures upstream and downstream of the EGR cooler are used for calculating the flow rate of recirculated gases. However, according to the present invention, a different and more effective calculation method of the EGR flow rate is proposed. In particular, the EGR assessment is operated using a combination of parameters measured upstream of the EGR exchanger, i.e. pressure (p2) and temperature (t2), as well as pressure (p3) downstream of the EGR exchanger. Using suitable functional groups, among which: $((p2-p3) * p3 / t2)^n$, it is possible to achieve a remarkable level of measurement accuracy. In addition thereto it is possible, for example, to use a variable m2, significant of the flow rate of the gas at the exchanger entry, as a dependent variable, while the main independent variables continue to be temperature t3 and pressures p2 and p3 combined in the algorithm $((p2-p3) * p3 / t2)^n$.

[0056] A confirmation of the effectiveness of this system is given in figure 4, where a comparison between the expected values (straight, oblique line) and the measured ones (points along said line) of the EGR flow rate crossing the exchanger is reported.

[0057] As far as the cooling method of the EGR exchanger is concerned, the invention provides that the cooling fluid consists of engine coolant. Said coolant is taken at the exit of radiator 11 and caused to circulate in the EGR exchanger by means of a variable-speed electric pump (14). The system is controlled by said dedicated processor, which governs the electric circulation pump of the cooling fluid.

[0058] Therefore, the described cooling circuits (fig. 1 and fig. 2) have the feature of using the same cooling fluid and the same engine radiator. Such choice allows to contain manufacturing costs with the overall operation effectiveness remaining equal. Moreover, the proposed systems allow to use variable flow rates of the cooling fluid.

[0059] However, it is understood that the invention must not be considered limited to the special arrangement illustrated above, which represents only an exemplifying embodiment thereof, but that a number of variants are possible, all within the reach of a person skilled in the field, without departing from the scope of protection of the invention, as defined by the following claims.

REFERENCE LIST OF FEATURES

[0060]

1) intake collector

- 2) exhaust collector
- 3) throttle valve
- 4) turbine
- 5) compressor
- 6) adjustor valve, with:
 - 6a) mushroom valve
 - 6b) valve seat
 - 6c) pressure spring
 - 6d) electronic central unit box
 - 6e) exhaust gas inlet pipe
 - 6f) exhaust gas outlet pipe

- 7) heat exchanger, with:

- 7a) cooling liquid entry

- 8) deflector, with:

- 8a) deflector
 - 8b) supply pipe
 - 8c) supply pipe

- 9) intercooler device
- 10) Venturi tube
- 11) engine radiator
- 12) circulation pump
- 13) adjustment valve
- 14) auxiliary electric pump
- p2) pressure meter
- t2) temperature meter
- p3) pressure meter
- t3) temperature meter

Claims

1. Control and adjustment system for exhaust gas recirculation (EGR) in a supply plant of a boosted internal combustion engine (MCI), in terms of recirculation gas temperature and flow rate, both in a stationary and in a transient condition, **characterised in that:**

- the main flow rate of burnt gases is sent to a turbine (4), for the operation thereof;
- a quota of exhaust gases, drawn upstream of the turbine, flows through an adjustment valve (6) and is channelled through a heat exchanger (7) ("EGR cooler"), dedicated to the cooling of the gas
- this quota of cooled exhaust gas is led to a flow deflector (8), wherefrom it is sent

- to a Venturi assembly (10), arranged downstream of the compressor (5), to be mixed there with the air coming from the compressor (5) and then channelled to an

intercooler (9), where the gases are further cooled and then sent to a throttle valve (3), which adjusts the supply thereof to the combustion chamber of the engine (MCI), or
 - directly downstream of the throttle valve (3), where mixing with the air coming from the intercooler device (9) occurs, respectively,

depending on the instant conditions of operation of the engine (MCI).

2. Exhaust gas recirculation system as claimed in claim 1), **characterised in that** said adjustment valve (6) is actuated by an electric movement system, according to a precise control strategy implemented through an electronic control system dedicated to the adjustment function of the EGR flow.

3. Exhaust gas recirculation system as claimed in claim 1) or 2), **characterised in that** the EGR flow rate controlled by said adjusting valve (6) is calculated by a microprocessor through an algorithm $[(p2-p3) * p3 / t2]^n$ which uses a combination of pressure parameters (p2) and of temperature parameters (t2), measured upstream of the exchanger (7), as well as of pressure parameters (p3) and of temperature parameters (t3), measured downstream of the exchanger (7).

4. Exhaust gas recirculation (EGR) system as claimed in claim 3), **characterised in that** said dedicated, local microprocessor picks up the requests of the electronic system (ECU) for the general control of the supply to the engine (MCI) and performs a "model-based" check to chase the desired temperature and EGR flow rate profiles.

5. Exhaust gas recirculation system as claimed in any one of claims 1) to 4), **characterised in that** the cooling fluid of the exhaust gases which circulates inside the heat exchanger (7), is drawn downstream of the circulation pump of the cooling fluid of the engine (MCI), before entering the engine, and the flow rate thereof through the exchanger (7) is adjusted by means of a control valve (13).

6. Exhaust gas recirculation system as claimed in any one of claims 1) to 4), **characterised in that** the exhaust gas cooling fluid which circulates inside the heat exchanger (7) is drawn upstream of the circulation pump of the cooling fluid of the engine (MCI) and caused to flow through an auxiliary electric pump (14), which adjusts the flow rate thereof through the heat exchanger (7).

7. Exhaust gas recirculation system as claimed in any one of claims 1) to 6), **characterised in that** the flow

rate of the cooling fluid is adjusted in a closed cycle, using as reference the temperature (t_3) at the exit of the EGR exchanger.

8. Exhaust gas recirculation system as claimed in any one of claims 1) to 4), **characterised in that** recirculation gas control is performed considering as dependent variable the gas flow rate (m_2) at the exchanger entrance. 5
9. Exhaust gas recirculation system as claimed in any one of claims 1) to 4) and 8), **characterised in that** recirculation gas control is performed considering as dependent variable said flow rate (m_2), defined by a calculation algorithm based on independent temperature variable (t_3) and on the combination of independent variables, pressures (p_2 - p_3) and temperature (t_2), in the main functional group $((p_2-p_3)*p_3/t_2)^n$. 10
10. Control and adjustment apparatus of the exhaust gas recirculation (EGR) in a supply plant of a boosted internal combustion engine (MCI), both in a stationary and in a transient condition, of the type comprising, in combination, a turbine (4), driven by the burnt gases of the engine exhaust gases and a compressor (5) driven by said turbine (4), for sending air to the supply of the engine (MCI), as well as means for mixing with said supply air a quota of said exhaust gases, controlled in terms of temperature and flow rate, 20
characterised in that it comprises:
 - an actuated adjuster valve (6), arranged upstream of said turbine (4), which determines said quota of exhaust gas to be recirculated, 25
 - a heat exchanger (7) ("EGR cooler"), arranged immediately downstream of said adjuster valve (6), and dedicated to the cooling of said quota of exhaust gas to be recirculated, and 30
 - a flow deflector (8), arranged downstream of said heat exchanger (7), for sending said cooled exhaust gas quota 35
 - to a first path, comprising a Venturi assembly (10), arranged downstream of the compressor (5) and, in succession, an intercooler (9), where the gases are further cooled, and a throttle valve (3) for the adjustment of the supply to the combustion chamber of the engine (MCI) or, alternatively, 40
 - to a second path, which leads directly downstream of said throttle valve (3), where mixing with the air coming from the intercooler device (9) occurs. 45
11. Control and adjustment apparatus of the exhaust gas recirculation as claimed in claim 10), **characterised** 50

in that said adjuster valve (6) is driven by an electric control.

12. Control and adjustment apparatus of the exhaust gas recirculation (EGR) as claimed in claim 10), **characterised in that** said Venturi assembly (10) of said first path is a double Venturi. 5
13. Control and adjustment apparatus of the exhaust gas recirculation (EGR) as claimed in claim 10), **characterised in that** it comprises a local microprocessor, dedicated to the sole control and adjustment functions of the exhaust gas recirculation. 10
14. Control and adjustment apparatus of the exhaust gas recirculation (EGR) as claimed in claim 13), **characterised in that** said local, dedicated microprocessor cooperates with the electronic system (ECU) for the overall supply control of the engine (MCI). 15
15. Control and adjustment apparatus of the exhaust gas recirculation (EGR) as claimed in one of claims 13) or 14), **characterised in that** said local, dedicated microprocessor governs at least the following elements: said driving means (6) of the EGR valve, said gas deflection means (8), and an electric pump (14) for the circulation of the cooling fluid. 20
16. Control and adjustment apparatus of the exhaust gas recirculation (EGR) as claimed in one of claims 1) to 15), **characterised in that** said local, dedicated microprocessor presides over the reckoning of the EGR flow rate based on the signals coming from pressure sensors (p_2 , p_3) and temperature sensors (t_2 , t_3) arranged upstream and downstream of said heat exchanger (7) dedicated to the cooling of the EGR gas. 25

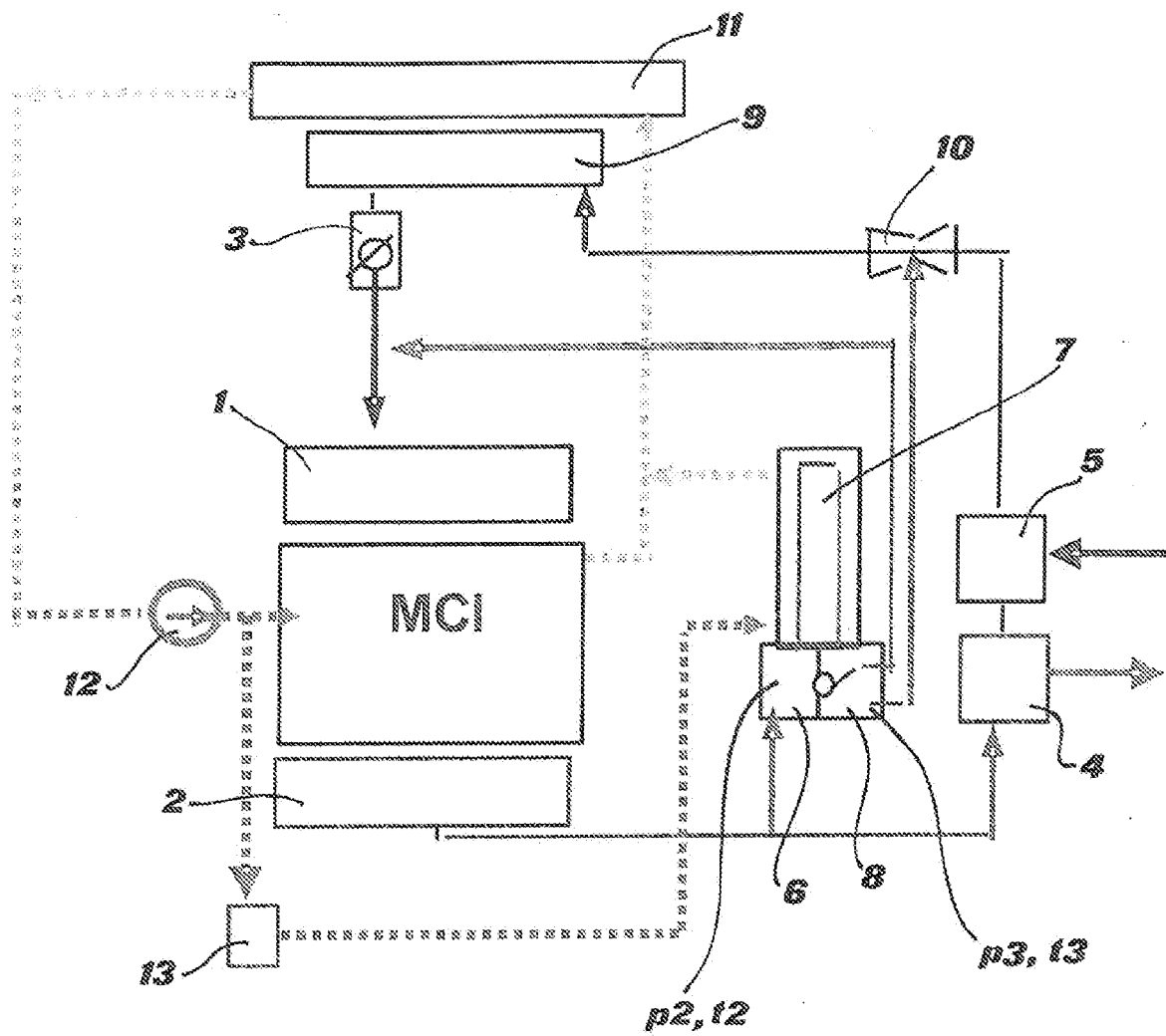


Fig.1

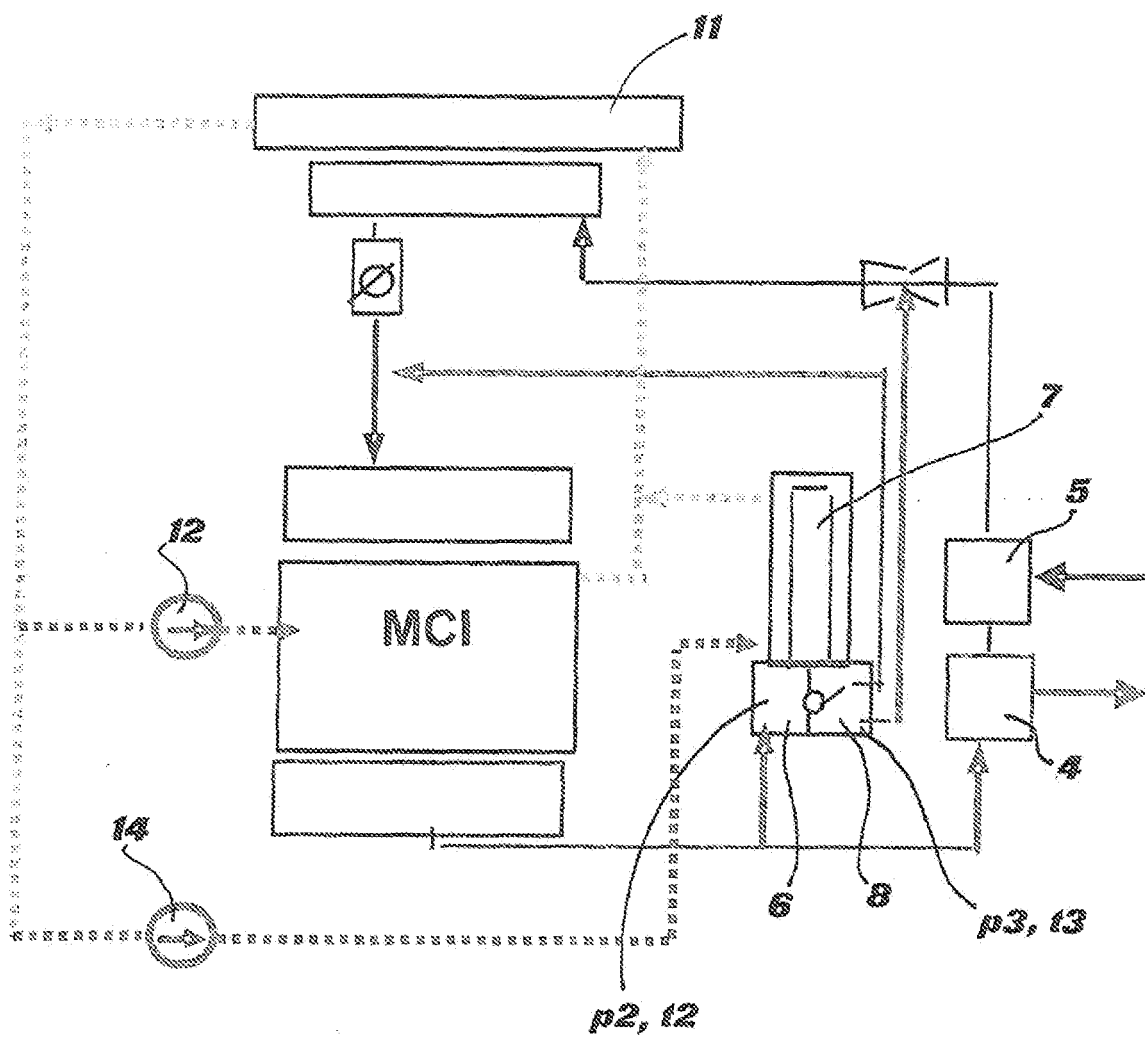


Fig.2

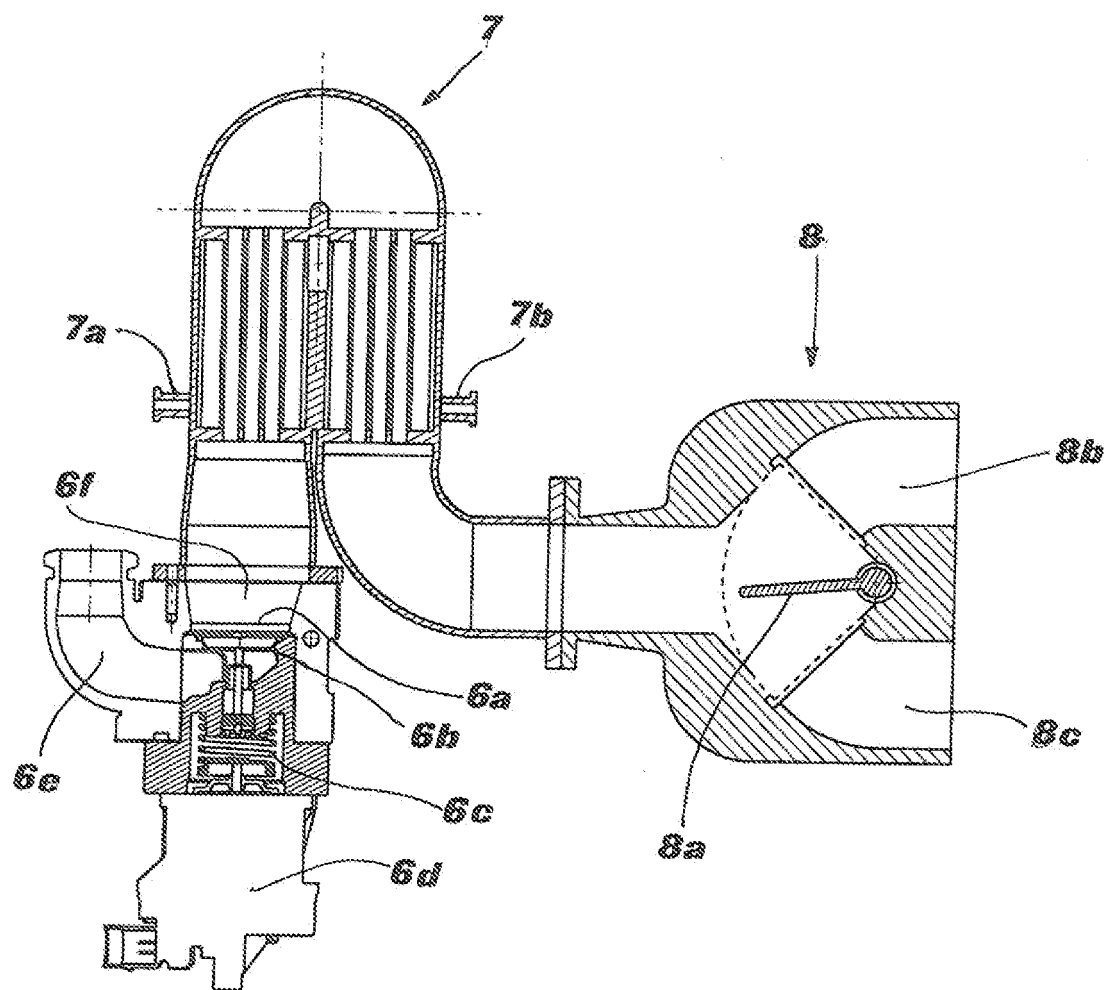


Fig.3

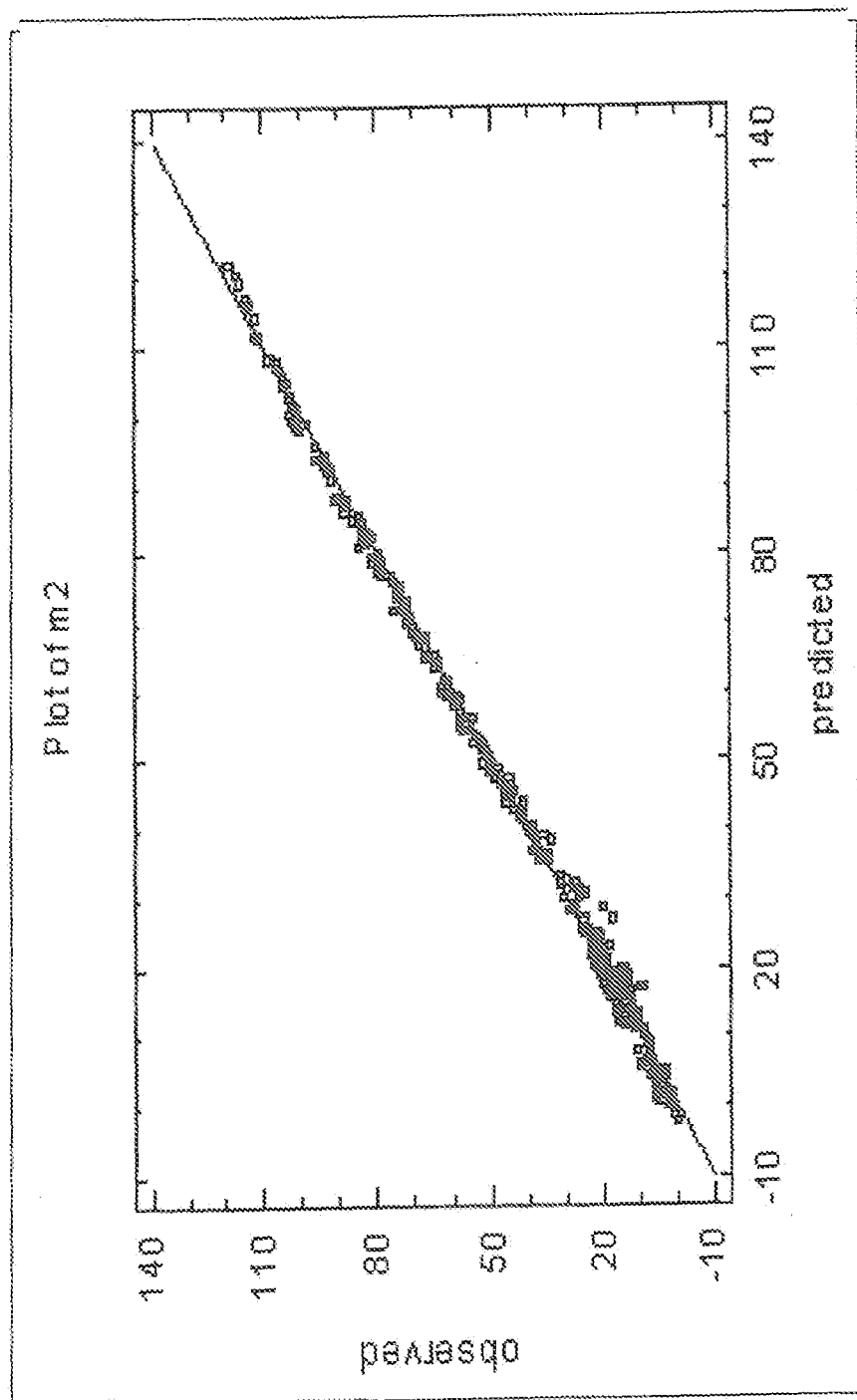


Fig.4



EUROPEAN SEARCH REPORT

Application Number
EP 10 16 6351

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Place of search Munich		Date of completion of the search 5 August 2010	Examiner Vedoato, Luca
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