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(54) A LOW-COMPRESSION PISTON INTERNAL-COMBUSTION ENGINE WITH TURBOSUPERCHARGING AND CONTROL OF THE INTAKE AIR TEMPERATURE

(71) We, MOTOREN - UND - TURBINEN-UNION FRIEDRICHSHAFEN GMBH, a West German Body Corporate, of D—7990 Friedrichshafen 1, Olgastrasse 75, Postfach 289, German Federal Republic 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:—

The invention relates to a low-compression piston-type internal-combustion engine operating with exhaust-driven turbosupercharging, which has a heat exchanger unit comprising a first air-charge/water heat exchanger which, during starting and partial-load operation, transfers the thermal energy of a heating appliance to the air charge and which can be connected to the cooling-water circuit of the internal-combustion engine, and a second air-charge/water heat exchanger which is connected up to cooling-water circuit independent of the engine cooling water-circuit.

Such heat-exchanger units have the purpose of influencing the temperature of the air charge supplied from the compressor to the internal-combustion engine, in such a way that for each operating condition of the internal-combustion engine there are ensured favourable conditions for the ignition and combustion of the change in the cylinders.

In accordance with German PS 14 51 887 it is known to couple a supercharger intercooler to a preheating appliance and to the cooling circuit of the internal-combustion engine. However, the regulation of the air-charge temperature provided in this case is too sluggish for the rapidly occuring load changes in internal-combustion engines, since with each alteration in air-charge temperature controlled by the sensors indicating the load-condition of the internal-combustion engine, temperature or otherwise, it is firstly necessary for the temperature of the water in the supercharger-intercooler circuit to be varied, which necessarily requires a certain amount of time. Moreover, for high-performance internal-combustion engines a more intensive cooling of the air charge is desirable during full-load operation than can be achieved by cooling the cooling water with the ambient air.

It is also known to cool the air charge by way of an independent cooling-water circuit. However, in this case the heating up of the air-charge for starting and partial-load operations presents difficulties, since the cooling water of the independent circuit is mostly available at low temperatures and, moreover, this water cannot be heated up because of the deposits associated therewith.

The invention provides a low-compression piston-type internal-combustion engine operating with exhaust-driven turbocharging, which has a heat exchanger unit comprising a first air-charge/water heat exchanger which, during starting and partial-loading operations of the engine, transfers the thermal energy of a heating appliance to the air charge and which can be connected up to the cooling-water circuit of the internal-combustion engine, and a second air-charge/water heat exchanger which is connected up to a cooling-water circuit independent of the engine cooling water circuit, wherein the two air-charge/water heat exchangers are connected in parallel for flow of the air-charge, and a regulating device is provided for steplessly controlling the air-charge throughout the individual heat exchangers as a function of the temperature of the air-charge upstream of the cylinders and downstream of the heat exchangers and as a function of another operating condition of the internal-combustion engine.

By way of example, one embodiment of

an internal combustion engine according to the invention will now be described with reference to the accompanying drawing.

Exhaust gases from a low-compression piston-type internal-combustion engine 11 are fed via an exhaust manifold 12 to an exhaust-driven turbocharger 13. The compressed air charge passes through a pipe 14 and a regulating device 15 to reach a first air-charge/water heat exchanger 16 and/or a second air-charge/water heat exchanger 17. The air charge then passes into an air-charge manifold 18, and from the manifold 18 to the air charge is fed to individual cylinders of the piston-type internal-combustion engine 11.

Circulation in a cooling-water circuit 19 is maintained by a pump 20 driven by the internal-combustion engine 11. A radiator 21 serves to dissipate into the atmosphere the heat due to energy losses in the internal-combustion engine.

By way of a heating appliance 22, which is powered by electric energy in this embodiment, although it will be appreciated that other energy sources may be used, it is possible to heat up a small amount of water flowing through the air-charge/water heat exchanger 16 and the air-charge can be heated during starting and partial-load operations. The circulation of water is maintained by a pump 23.

The air-charge/water heat exchanger 16 can be connected with the cooling-water circuit 19 via solenoid valves 24 and 25. Depending on the arrangement of the branching place in the cooling-water circuit 19, either a warm-up or a cooling of the charging-air can be realized by means of the charging-air/water heat-exchanger 16. If, for example, the branching is undertaken at the place 29 of the cooling water circuit 19, then the charging-air-water heat-exchanger 16 receives water with an average temperature of the cooling water circuit 19 and the charging air can be heated up. With an arrangement of the branching at the place 30 of the cooling-water circuit 19, the charging-air-water heat-exchanger 16 receives cooled water. As a result thereof, also the charging-air is cooled. The valve 25 may be of suitable, known construction to achieve such alternative operation of the branching places.

During full-load operation, the cooling of the air charge is carried out by the air-charge/water heat exchanger 17 acted upon by cooling water independent of the engine cooling water. The circulation of water is maintained by a pump 26.

Control of the regulating device 15 for the air charge is effected by a control unit 27 and a servomotor 28 as a function of the temperature in the air-charge manifold 18 and of another operating condition of the internal-combustion engine. The control unit 27 can also control the solenoid valves 24 and 25, as well as the pumps 23 and 26 in accordance with the requirements of the internal-combustion engine, so that fully automatic operation of the air-charge regulation is possible.

The advantage of this embodiment of the invention is that a sensitive regulation of the air-charge temperature is provided acting directly as a function of the air temperature in the manifold 18 and the load or any other operating condition of the internal-combustion engine.

With the installation of this embodiment it is possible to preheat the air charge with a small quantity of water, therefore one which can be heated up rapidly, for starting and partial-load operations, and as performance increase to use the waste heat from the internal-combustion engine for the purpose of heating the air charge, or to cool the air charge via the radiator of the internal-combustion engine, and during full-load operation to obtain satisfactory air-charge cooling by the independent cooling-water circuit.

Accordingly, the air-charge temperature can be adapted steplessly and without delay to the requirements for satisfactory combustion of the charge in the cylinders.

WHAT WE CLAIM IS:—

1. A low-compression piston-type internal-combustion engine operating with exhaust-driven turbocharging, which has a heat exchanger unit comprising a first air-charge/water heat exchanger which, during starting and partial-load operations of the engine transfer to the thermal energy of a heating appliance to the air charge and which can be connected up to the cooling-water circuit of the internal-combustion engine, and a second air-charge/water heat exchanger which is connected up to a cooling-water circuit independent of the engine cooling water circuit, wherein the two air-charge/water heat exchangers are connected in parallel for flow of the air-charge, and regulating device is provided for steplessly controlling the air-charge throughout through the individual heat exchangers as a function of the temperature of the air-charge upstream of the cylinders and downstream of the heat exchangers and as a function of another operating condition of the internal-combustion engine.

2. A low-compression piston-type internal-combustion engine substantially as hereinbefore described with reference to and as shown in the accompanying drawing.

MOTOREN-UND-TURBINEN-UNION
FRIEDRICHSHAFEN GMBH
Per: Boult, Wade & Tennant,
34 Cursitor Street,
London, EC4A 1PQ.
Chartered Patent Agents.

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1 SHEET *This drawing is a reproduction of the Original on a reduced scale*