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(56) Documents Cited
GB 2282643 A **GB 2277129 A** **GB 2268228 A**
GB 2170866 A **GB 1510070 A** **EP 0174867 A2**
US 4817387 A **US 4517803 A**

(58) Field of Search
UK CL (Edition O) **F1G GPC GPG GPX**
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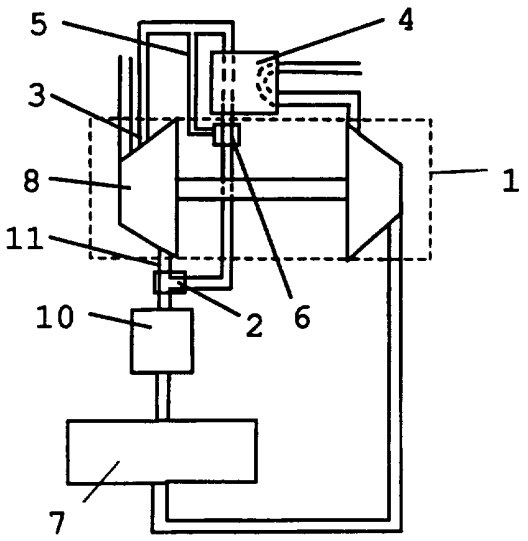
ONLINE WPI

(54) **Reducing turbocharger lag**

(57) For reducing turbocharger lag when increased power is required from a so-equipped engine 7, operating at part load, its compressor 8, is provided with nozzles or directing devices 3, designed to increase the speed of the rotor (9)(figures 1 and 2) or to rotate the charge entering the compressor. The devices 3, are supplied by recirculating compressed charged, via a distributor valve 2. A heat source such as a heat exchanger 4, (with a shunt 5, controlled by a distributor valve 6) using waste heat from exhaust gases, can heat the recirculating charge, thereby increasing the energy of the recirculated charge to further increase the rotational speed of the rotor or charge. Compressed air supplied to the engine 7, may pass through a cooler 10. The tendency of the turbocharger to surge may also be reduced.

figure 3



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The claims were filed later than the filing date within the period prescribed by Rule 25(1) of the Patents Rules 1995

figure 1

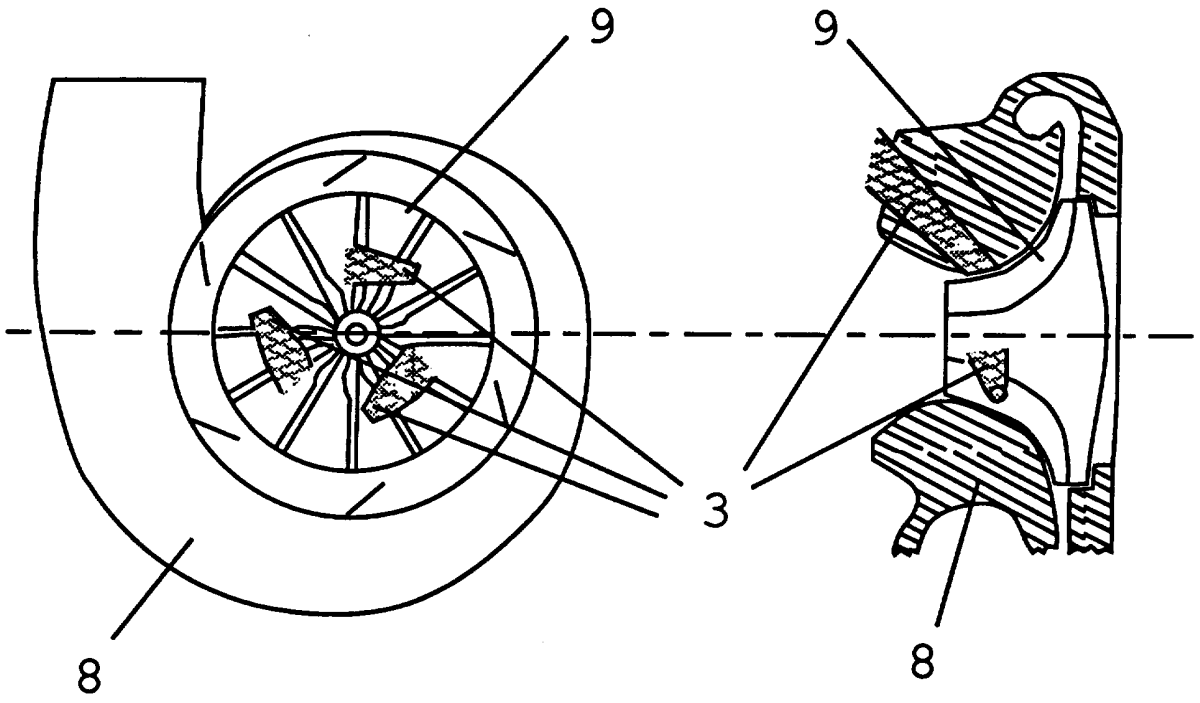
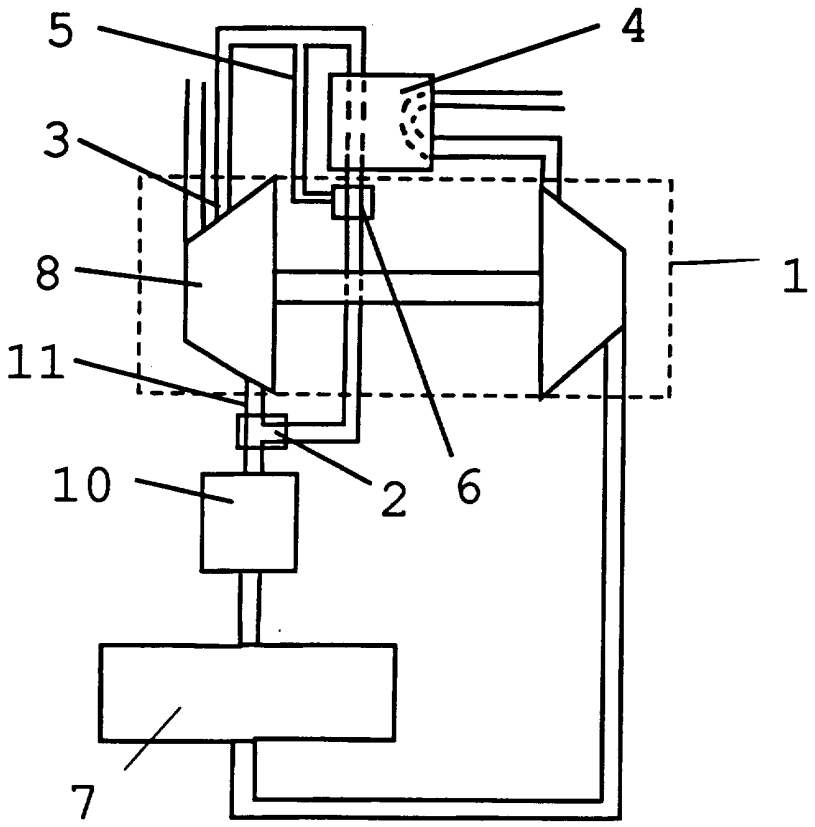


figure 2

figure 3



DEVICE FOR IMPROVING TURBOCHARGER DYNAMIC CHARACTERISTICS

This invention relates to a turbocharger system for an internal combustion engine.

The problems with the use of the turbocharger with the internal combustion engine are well documented. One is known as "throttle lag" and is caused by the low speed of the turbocharger rotor when the engine is operated at part load, combined with the energy required to overcome its inertia and accelerate the rotor to a speed where sufficient boost is created when increased power is required. If the rotor can be made to rotate at a greater speed at engine part load requirement by a reduction in compressor work and/or some additional work input, this problem could be alleviated very substantially.

Other benefits can accrue from this course of action, including a reduced tendency to turbocharger surge, and reduction of losses to throttling in the spark ignition engine.

According to the present invention the induction system of an internal combustion engine is provided with valve means to recirculate some portion of the compressed charge to the low pressure side of the compressor with some recovery of the energy expended in its compression by means of one or more nozzles or directing devices arranged so that the stream of this charge should impinge on the blades of the impellor so as to impart energy on them in their direction of rotation or cause the charge entering the compressor to rotate in the aforementioned direction.

This devised approach will have the effect of increasing the rotational speed of the rotor. A heat source, possibly a heat exchanger using waste heat from exhaust gases, can be provided to heat the recirculating charge between the two pressure regimes, the increase in the energy of this recirculated charge causing a further increase in the rotational speed of the rotor.

There will also be an additional effect due to the heating of the charge being delivered to the compressor and engine with further advantages accruing. Heated air, though requiring greater energy per unit mass for compression through a given ratio, has a lower energy requirement per unit volume for a similar compression, due to its lower density. It logically follows from this that for a given charge air density requirement at the engine, operating at some part of its rating, less throttling of the charge is required, reducing pumping losses at the engine and increasing turbocharger rotor speed.

With use with engines using variable valve timing as a load control means, the deficiency in charge temperature prior to ignition, which can have adverse effects on ignition and combustion, can be reduced.

Occurence of surge in the compressor can be reduced, due to the increase in mass flowrate through the compressor when this type of charge recirculation is operated, and a reduction in turbocharger pressure ratio is also anticipated within embodiments of the invention.

By means of a shunt and distributor valve to bypass the heat source of the recirculatory system and/or a shunt and distributor valve to bypass any chargecooler, the optimum temperature and density of charge reaching the cylinders can be provided.

A circumferentially split volute with more than one chamber where one chamber is arranged to be able to cause the charge to be compressed to a

greater pressure - to be recirculated in any of the manners described in the above paragraphs - could be used within the context of this invention to achieve greater efficiency of operation.

Valve means can be provided to allow inflow of charge from the substantially atmospheric side of the induction system to the nozzle(s) or directing device(s) to increase the flow capacity of the compressor and decrease the incidence of compressor choke. The valve means shall be arranged to prevent compressed charge from venting through the recirculatory system to the substantially atmospheric side of the induction system.

One embodiment of the turbocharger system according to the invention is shown in figures 1, 2 and 3. Figure 1 shows a section of a turbocharger compressor 8 with impellor 9 and nozzles 3. Figure 2 shows another section through a similarly equiped compressor. Figure 3 shows the turbocharger system diagrammatically with reference numeral 1 indicating a turbocharger and 7 an internal combustion engine. The engine feed charge passes into the centrifugal compressor 8 from which it passes into inlet manifold 11. From here it passes to distributor valve 2 where some portion can be diverted to the charge recycling apparatus at engine part load. The remainder of the charge passes to the engine. The charge in the recycling apparatus then encounters distributor valve 6 where it can be directed in variable proportions to exhaust gas heat exchanger 4 and shunt 5. The charge then passes to nozzles 3 where it re-enters compressor 8, impingeing on the blades of the impellor, causing the impellor to rotate at greater speed. Numeral 10 indicates a chargecooler.

CLAIMS

1) A turbocharger provided with valve means to recirculate some portion of the compressed charge to the low pressure side of the compressor with some recovery of the energy expended in its compression by means of one or more nozzles or directing devices arranged so that the stream of this charge should impinge on the blades of the impellor so as to impart energy upon them in their direction of rotation or cause the charge entering the compressor to rotate in this direction.

2) A turbocharger as claimed in claim 1) characterised in that a heat source, possibly a heat exchanger using waste heat from exhaust gases, is provided to heat the recirculating charge between the two pressure regimes.

3) A turbocharger as claimed in claim 2) characterised in that a shunt and distributor valve are provided to bypass the heat source of the recirculatory system.

4) A turbocharger as claimed in claim 1), claim 2) or claim 3) characterised in that a circumferentially split volute with more than one chamber is used, where one chamber is arranged to be able to cause the charge to be compressed to a greater pressure for subsequent recirculation.

5) A turbocharger as claimed in claim 1), claim 2), claim 3) or claim 4) characterised in that valve means are provided to allow inflow of charge from the substantially atmospheric side of the induction system to the nozzles or directing devices. The valve means shall be arranged to prevent compressed charge from venting through the recirculatory system to the substantially atmospheric side of the induction system.

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Application No:	GB 9511830.3	**Examiner:**	C B VOSPER
Claims searched:	1-5	**Date of search:**	29 January 1997

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): F1G(GPC,GPG,GPX)

Int Cl (Ed.6): F02B 37/00,37/02,37/04,37/10,37/11,37/12,37/14,37/16; F02C 6/00,6/04,6/10,6/12

Other: ONLINE WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
Y	GB2282643A	ABB (whole document; shows arrangement for directing compressed air into turbocharger compressor to impart supplementary energy)(Equivalent - US5461860)	1
Y	GB2277129A	MERCEDES- (figs. 1 and 4; page 4 line 24 to page 5 line 10; shows recirculation of gas to LP side of compressor)(Equivalent - US5406796)	1
Y	GB2268228A	ROVER (page 3, third paragraph; shows recirculation of gas to LP side of compressor)	1
Y	GB2170866A	M A N (figs. 4, 5-10; page 3, lines 42-70; page 4, lines 5-40; shows valve control of air to LP side of compressor to impart drive to compressor impeller.)(Equivalent - US4689960)	1
A	GB1510070	BBC (whole document - show HP output of one turbocharger compressor passing to LP inlet of another)	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

The Patent Office

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Application No: GB 9511830.3 **Examiner:** C B VOSPER
Claims searched: 1-5 **Date of search:** 29 January 1997

Category	Identity of document and relevant passage		Relevant to claims
A	EP0174867A2	GARRETT (whole document - shows hydraulic solution to throttle lag)	
Y	US4817387	LASHBROOK (whole document - shows valve controlled recirculation of gas to LP side of compressor)	1
Y	US4517803	JAMISON (whole document - shows valve controlled recirculation of gas to LP side of compressor)	1

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.