(12) UK Patent Application (19) GB (11) 2 121 474 A

(21) Application No **8308287**
(22) Date of filing **25 Mar 1983**
(30) Priority data
(31) **57/041917**
(32) **26 Mar 1982**
(33) **Japan (JP)**
(43) Application published **21 Dec 1983**
(51) **INT CL³ F02B 37/04**
(52) Domestic classification **F1B** 2N13 2N14A 2N16A 2N16B
(56) Documents cited
GB 1504544
GB 1140877
GB 0804124
GB 0620376
GB 0575502
GB 0537483
(58) Field of search **F1B**
(71) Applicant
Kabushiki Kaisha Komatsu Seisakusho, (Japan), 3—6 Akasaka 2-chome, Minato-ku, Tokyo, Japan
(72) Inventors
Tamotsu Kasuya, Hiroshi Sugito
(74) Agent and/or address for service
Lloyd Wise, Tregear and Co., Norman House, 105—109 Strand, London, WC2R 0AE

(54) Two-stage I. C. engine turbocharging

(57) Compressed air from a tank 17, charged by an engine driven compressor 15 or by the compressor 5 (Figure 7) is fed into the exhaust gas upstream of the turbine 4 in response to predetermined accelerator pedal depression.

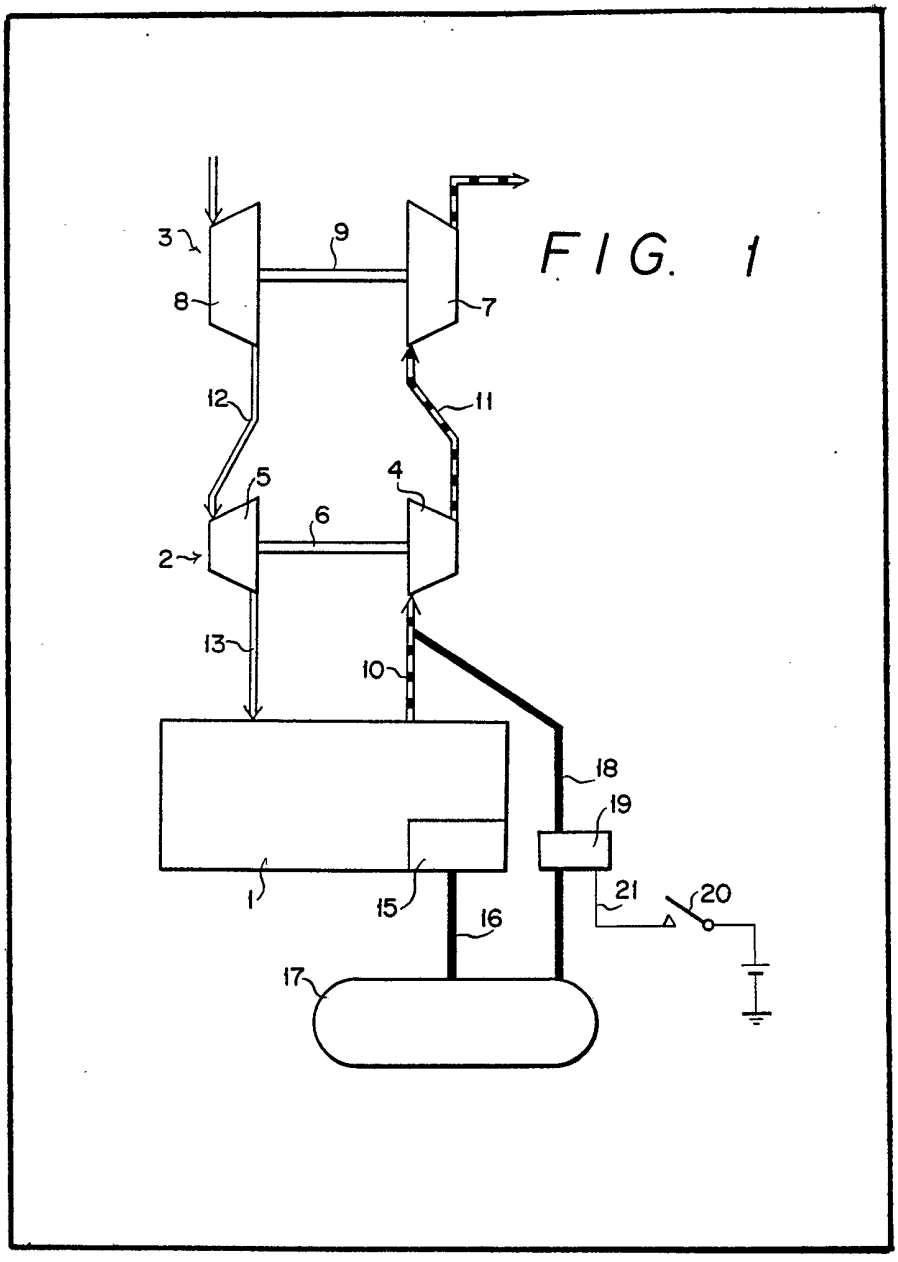


FIG. 1

GB 2 121 474 A

2121474

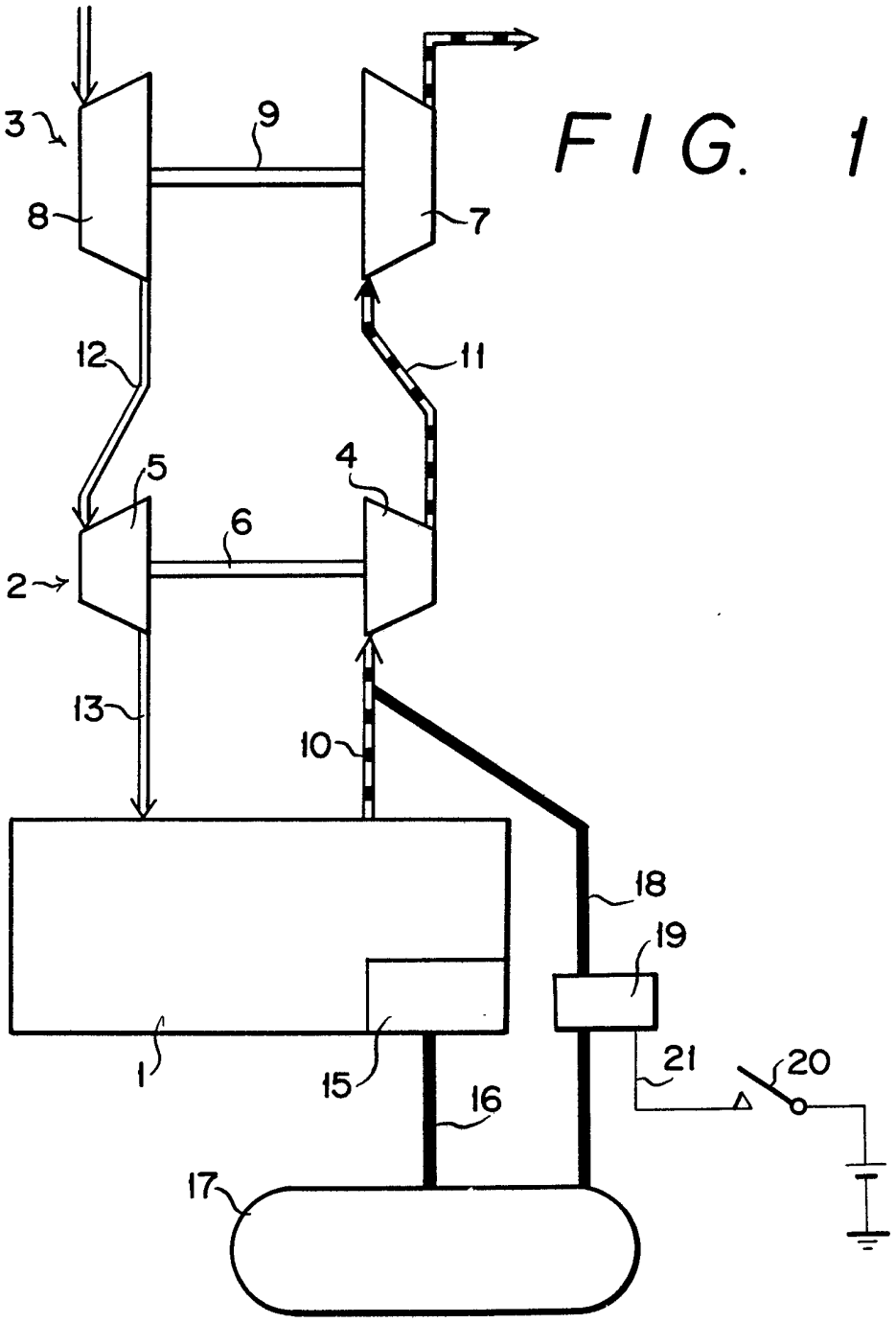


FIG. 1

2121474

FIG. 2

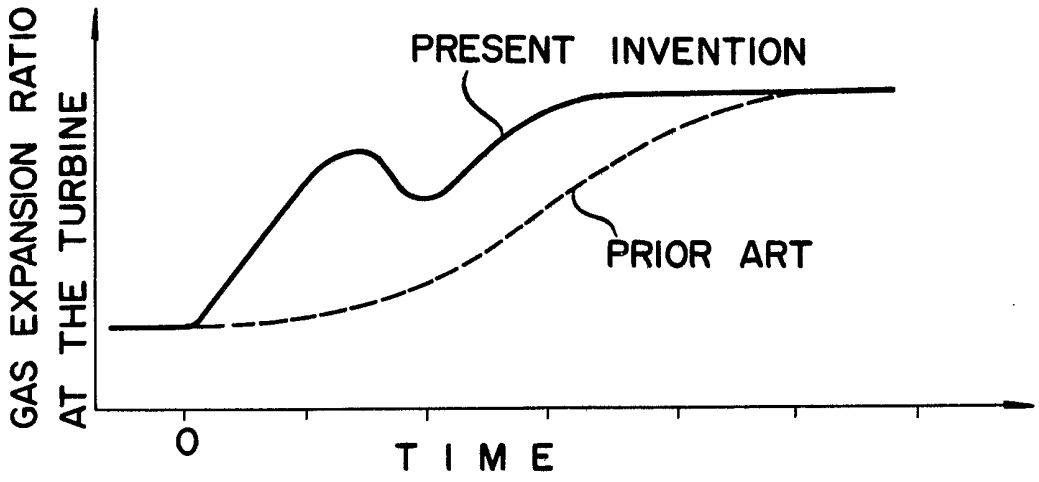


FIG. 3

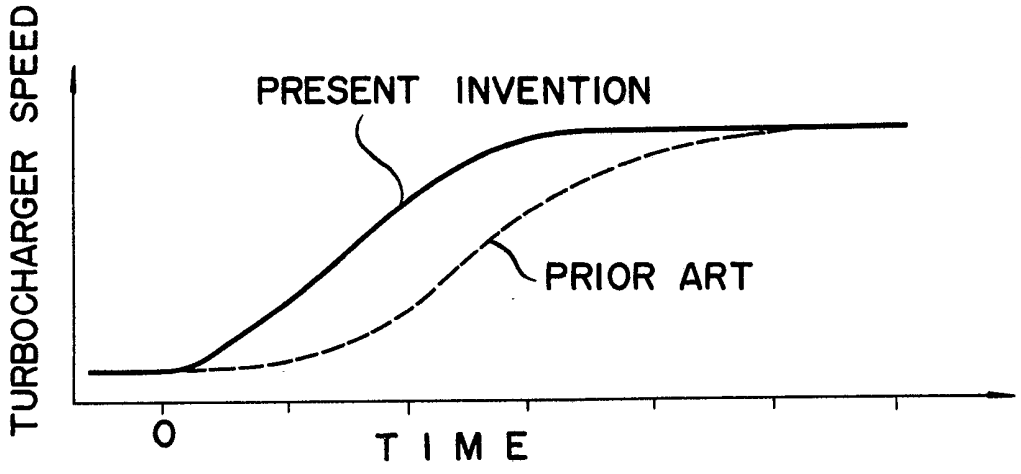


FIG. 4

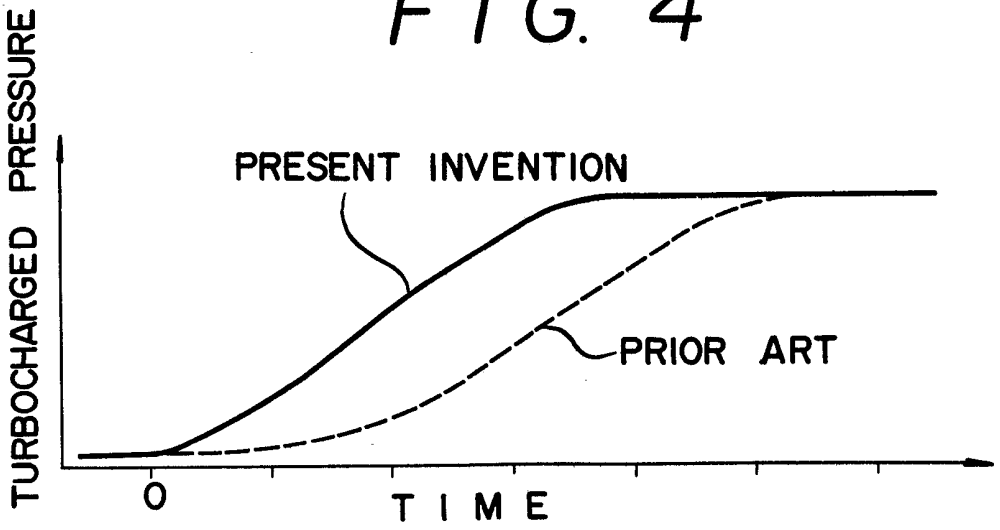


FIG. 5

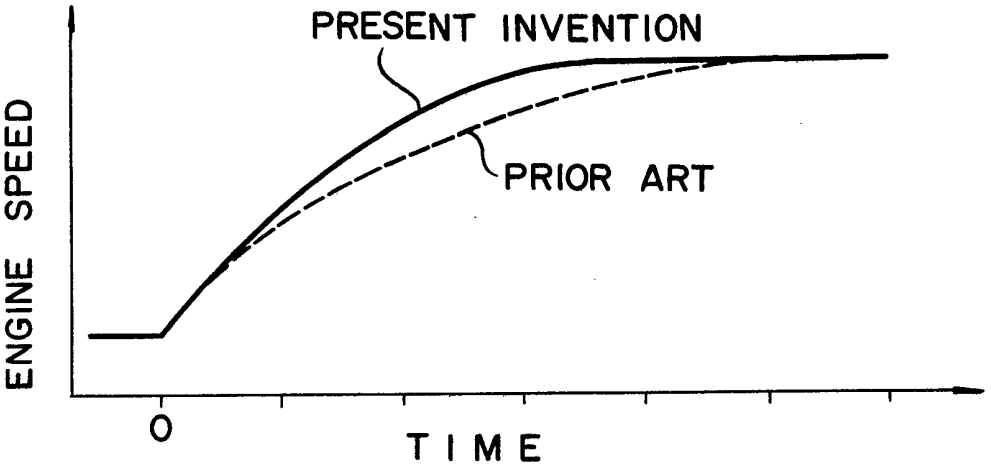
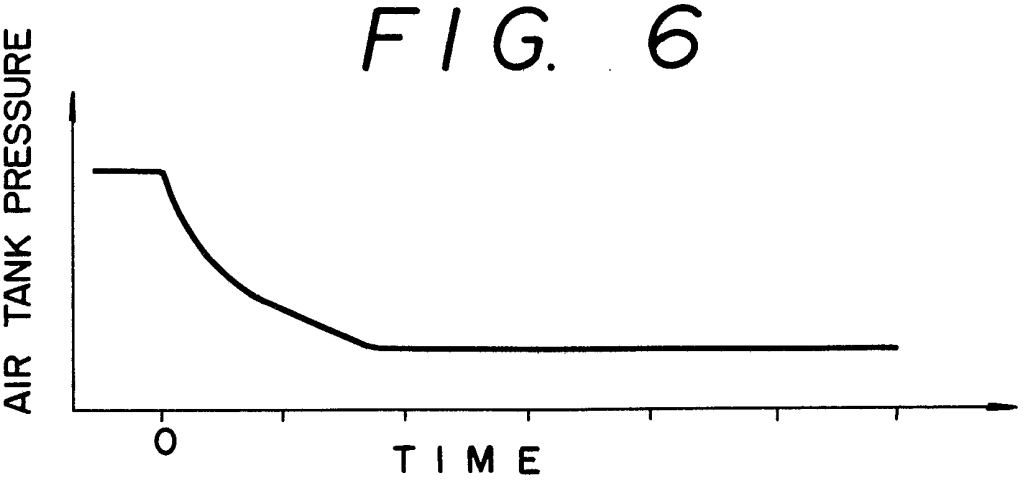


FIG. 6



2121474

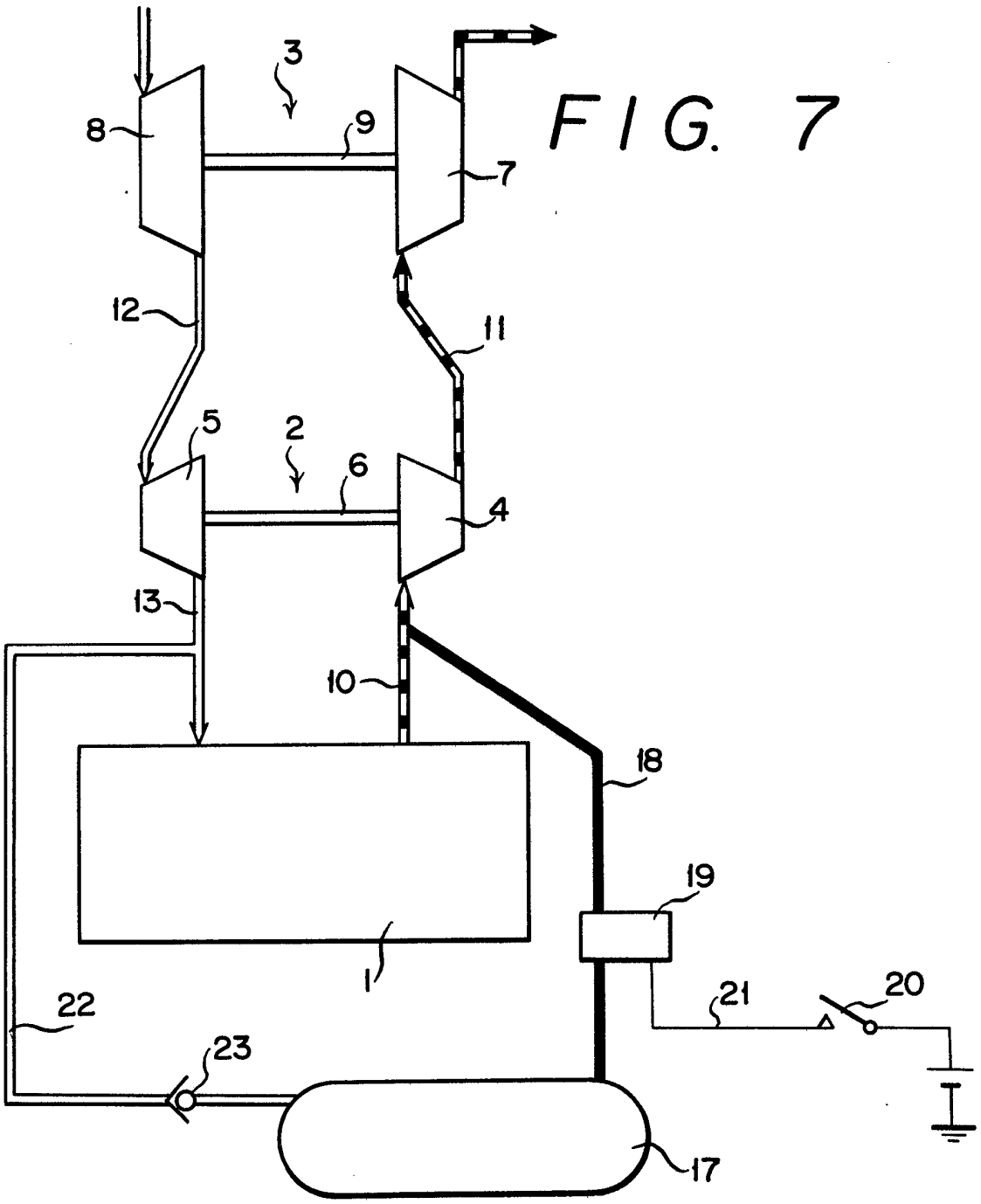


FIG. 7

SPECIFICATION

Turbocharging

This invention relates to the turbocharging of internal combustion engines.

It has previously been suggested to employ two-stage turbocharging for increasing the engine power of internal combustion engines. However, we have found that the response of turbochargers in two-stage turbocharging to the acceleration of the engine is not good. This is especially so during low engine speeds. Previous attempts to solve this problem have not in our view been satisfactory.

In accordance with a first aspect of the present invention, there is provided a two-stage turbocharging system for an internal combustion engine, comprising: a first turbocharger having a first turbine and a first compressor, said first turbine being arranged for connection on its input side with said engine and said first compressor being arranged for connection on its output side with said engine; a second turbocharger having a second turbine and a second compressor, said second turbine being connected on its input side with the output side of said first turbine and said second compressor being connected on its output side with the input side of said first compressor; and an air tank containing compressed air therein connected on its output side with the input side of said first turbine.

In a second and alternative aspect of this invention, we provide a turbocharged internal combustin engine, provided with a first turbocharger having a first turbine and a first compressor, said first turbine being connected on its input side with said engine and said first compressor being connected on its output side with said engine; a second turbocharger having a second turbine and a second compressor, said second turbine being connected on its input side with the output side of said first turbine and said second compressor being connected on its output side with the input side of said first compressor; and an air tank containing compressed air therein connected on its output side with the input side of said first turbine.

In one arrangement described below, the air tank is connected with a third compressor driven directly by the engine. In another arrangement, also described below, instead of providing a third compressor, the air tank is connected with the output side of the first compressor.

In the accompanying drawings:—

Fig. 1 is a schematic illustration of a two-stage turbocharging system according to the present invention;

Fig. 2 is a graph plotting gas expansion ratio at a turbine against time elapsed wherein solid line represents the turbocharging system of the present invention and dotted line denotes a typical prior art system;

Fig. 3 is a graph plotting number of revolutions of a turbocharger against time elapsed;

Fig. 4 is a graph plotting turbocharged pressure against time elapsed;

Fig. 5 is a graph plotting number of revolutions of the engine against time elapsed;

Fig. 6 is a graph plotting pressure in the air tank against time elapsed; and

Fig. 7 is similar to Fig. 1 but showing another embodiment of the present invention.

The present invention will now be described in detail below with reference to the accompanying drawings.

Reference numeral 1 denotes an engine, 2 a first turbocharger, 3 a second turbocharger for turbocharging the engine. The first turbocharger 2 comprises a high pressure turbine 4 and a compressor 5 both mounted on a common shaft 6. The second turbocharger 3 comprises a low pressure turbine 7 and a compressor 8 both mounted on common shaft 9. Exhaust gas from the engine 1 is introduced through a first exhaust pipe 10 into the input side of the high pressure turbine 4 thereby rotating the latter. After driving the high pressure turbine 4, pressure reduced exhaust gas is expelled from the high pressure turbine 4 and is introduced into the input side of the low pressure turbine 7 through a second exhaust pipe 11 thereby rotating the low pressure turbine 7. The output side of the low pressure turbine is open to the atmosphere.

As the compressor 8 is driven by the low pressure turbine 7, fresh air introduced from the atmosphere is compressed thereby and the compressed air is introduced through a first induction pipe 12 into the compressor 5 where the air is further compressed and is supplied through a second induction pipe 13 to the induction side of the engine 1.

Mounted adjacent to the engine 1 is another compressor 15 which is connected to and driven by a crankshaft of the engine. The output side of the compressor 15 is connected through a conduit 16 with an air tank 17. The output side of the air tank 17 is connected through a conduit 18 with the input side of the high pressure turbine 4, such as the first exhaust pipe 10 as shown or a turbine casing of the turbine 4. Disposed in the conduit 18 is a solenoid-operated valve 19 which is normally closed and is opened when its solenoid is energized. A switch 20 is disposed in an electric circuit 21 of the solenoid-operated valve 19. The switch 20 is adapted to be closed when an acceleration pedal is depressed to a predetermined extent.

In operation, compressed air supplied from the compressor 15 is stored in the air tank 17 and is introduced or injected into the input side of the high pressure turbine 4 only when the acceleration pedal is depressed to a predetermined extent. As a result, performance curves of the two-stage turbocharging system of the present invention are improved as shown in solid lines in Figs. 2 to 5 as compared with a typical two-stage turbocharging of a prior art system shown in dotted lines. It will be appreciated when observing Fig. 6 that air

pressure assist is especially large at the beginning of the acceleration where response lag of the turbochargers is particularly large. Therefore, with air pressure assist from the air tank 17, acceleration performance of the engine is improved remarkably.

Referring to Fig. 7 showing another embodiment of the present invention, a branch conduit 22 is arranged for interconnecting the second induction pipe 13 and the air tank 17 and a check valve 23 is disposed in the conduit 22 for allowing air flow only from the compressor 5 to the air tank 17. Therefore in this embodiment, compressed air is supplied from the compressor 5 to the air tank 17 without additionally providing the compressor 15 of the embodiment of Fig. 1. Other constructions of this embodiment are the same as those of Fig. 1

Claims

1. A two-stage turbocharging system for an internal combustion engine, comprising: a first turbocharger having a first turbine and a first compressor, said first turbine being arranged for connection on its input side with said engine and said first compressor being arranged for connection on its output side with said engine; a second turbocharger having a second turbine and a second compressor, said second turbine being connected on its input side with the output side of said first turbine and said second compressor being connected on its output side with the input side of said first compressor; and an air tank containing compressed air therein connected on its output side with the input side of said first turbine.

2. A two-stage turbocharging system according to Claim 1, further comprising a third compressor adapted to be driven directly by said engine and wherein said tank is connected on its input side with said third compressor.

3. A two-stage turbocharging system according to Claim 1, further comprising first conduit means for connecting the output side of said first compressor with said air tank, and check valve means disposed in said first conduit means for allowing air flow only from said first compressor to said air tank.

4. A two-stage turbocharging system for an internal combustion engine according to Claims 2 or 3 further comprising conduit means for connecting the output side of said air tank with the input side of said first turbine, valve means disposed in said conduit means for opening and closing the same, and means adapted to be actuated by the depression of an acceleration pedal for opening said valve means.

5. For an internal combustion engine, a two-stage turbocharging system substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

6. A turbocharged internal combustion engine, provided with a first turbocharger having a first turbine and a first compressor, said first turbine being connected on its input side with said engine and said first compressor being connected on its output side with said engine; a second turbocharger having a second turbine and a second compressor, said second turbine being connected on its input side with the output side of said first turbine and said second compressor being connected on its output side with the input side of said first compressor; and an air tank containing compressed air therein connected on its output side with the input side of said first turbine.

7. A turbocharged internal combustion engine substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

Printed for Her Majesty's Stationery Office by the Courier Press, Leamington Spa, 1983. Published by the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.