

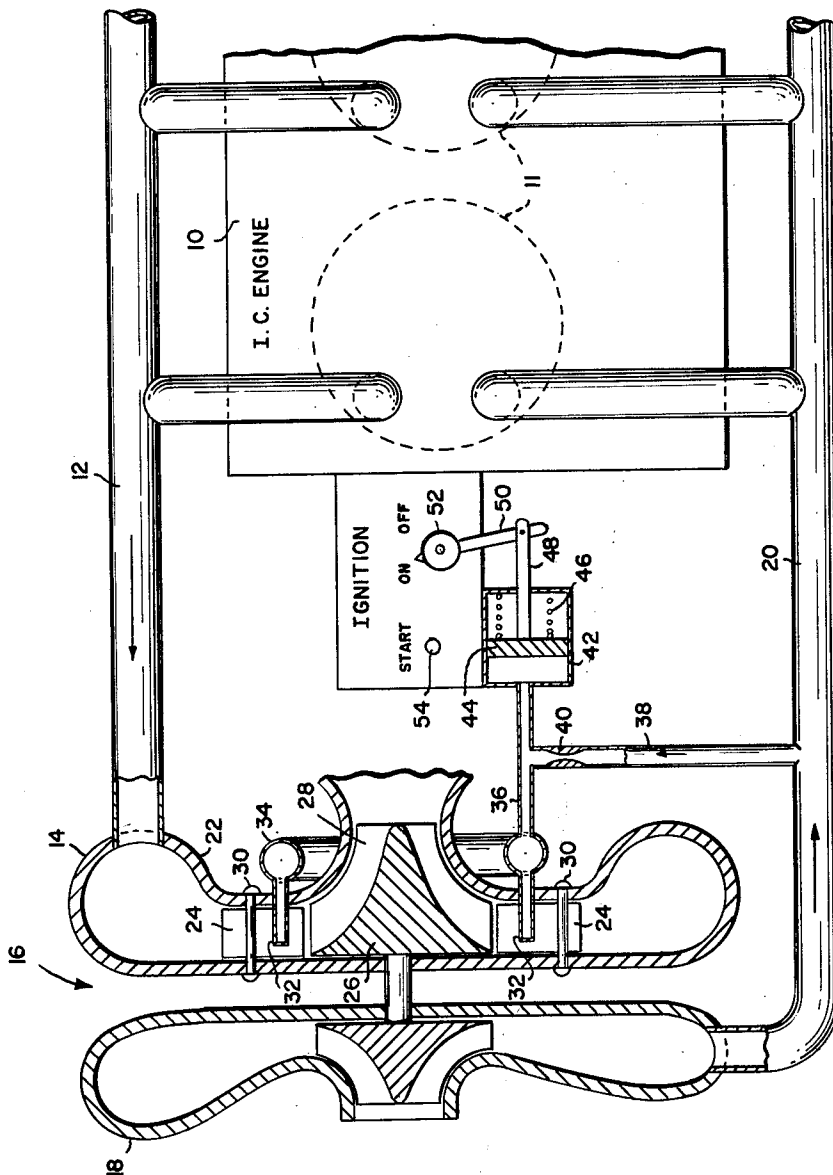
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PROTECTION SYSTEM FOR TURBOCHARGERS

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PROTECTION SYSTEM FOR TURBOCHARGERS
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This invention relates to turbochargers driven by the exhaust gases from internal combustion engines and, more particularly, to a system for substantially reducing the destruction of the turbine wheel caused by the entry of foreign particles into the turbine blading.

Although every effort is made to prevent the occurrence of foreign particles in a turbocharger system, it sometimes happens that nuts, bolts or washers are misplaced during the assembly of the system so that these loose particles are capable of being projected along with the exhaust gases into the turbine blading. Even if no loose particles are initially present, operation of the system sometimes results in the production of loose particles such as welding beads which break away from welded joints or fragments of such engine components as exhaust valves which sometimes fracture due to fatigue after long periods of operation.

Of course, the above mentioned events do not occur with great frequency, however, whenever they do occur, the damage therefrom is usually so extensive as to completely destroy both the turbine rotor and guide blading. This extensive damage is due to the fact that, once a foreign particle has passed through the guide blades and enters the rotor blading, the high rotational speed of the latter is imparted to the particle so that centrifugal force projects the particle radially outwardly thereby striking the guide blading at high velocity and bouncing back into the rotor blading. Thus, a single particle is capable of initially breaking several blades, whereupon, the blade fragments constitute additional particles which, in turn, destroy other blades thereby producing a type of chain reaction which ultimately results in the total destruction of the turbine. In addition, it has been known that broken fragments of the rotor blading have pierced the stationary casing and caused additional damage to the surrounding equipment as well as constituting a severe safety hazard to personnel in the vicinity.

From the foregoing discussion it will be apparent that the occurrence of such foreign particles, although infrequent, presents a most serious problem and various solutions have been proposed with a view toward preventing the foreign particles from entering the turbine. For example, it has been proposed to employ such devices as screens or centrifugal traps upstream of the turbine so as to restrain the particles and prevent their passage into the blading. However, these attempts have been only partially successful in that some particles have been known to pierce the screens and to escape the traps. In addition, both of the above mentioned devices present a serious drawback in that their presence in the exhaust flow path creates a pressure drop therein which reduces the energy available to drive the turbine.

It is therefore a principal object of the present invention to provide a protective system which automatically detects the entry of a foreign particle into the turbine blading and results in stopping the turbine so as to prevent the occurrence of a chain reaction and thereby limit the damage to a repairable degree.

This object as well as others relating more particularly to the details of construction and operation will become more fully apparent from the following description taken with the accompanying drawing which is a schematic diagram illustrating one possible embodiment of the invention.

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Referring now to the drawing, numeral 10 indicates an internal combustion engine having a plurality of cylinders 11 each of which exhausts through manifold 12 to the turbine section 14 of turbocharger 16 which further includes a compressor section 18 the outlet of which is connected through manifold 20 to the intake side of the engine cylinders.

Turbine 14 includes a casing 22 which surrounds an annular set of inlet guide vanes 24 through which the exhaust gas is directed radially inwardly to the turbine wheel 26 carrying rotor blades 28.

Each of inlet vanes 24 is pivotally secured in place by means of a pin or bolt 30 extending axially therethrough and it is to be understood that a slight amount of clearance is provided between the blade edges and the casing 22.

In order to secure each of the vanes in its normal position so as to tangentially direct the exhaust gas into the turbine, each vane receives the closed end of a hollow, frangible pin 32 the other end of which passes through the casing 22. Thus, during normal operation of the turbine, each guide vane is fixed in position and prevented from pivoting about pin 30.

Each of hollow pins 32 is in fluid communication with an annular conduit 34, which in turn, is in communication with compressor outlet manifold 20 by means of branch conduits 36 and 38. Conduit 38 is provided with a flow restrictor 40, whereas, conduit 34 is in unrestricted communication with a cylinder 42 by means of conduit 36.

Cylinder 42 contains a movable piston 44 which is biased to the left by means of a compression spring 46. Piston 44 includes a rigid stem 48 which is pivotally connected to lever 50 which actuates an "on-off" switch 52 forming a portion of the engine ignition system. It will also be noted that the ignition system includes a separate "start" button 54 which closes a switch to energize the ignition system regardless of the condition of switch 52.

The operation of the system is as follows. Engine 10 is started by depressing button 54 and maintaining this button depressed until the exhaust gases from the engine bring the turbine up to operating speed during which time the discharge pressure of the compressor builds up and equalizes in all portions of the closed system composed of pins 32, cylinder 42 and conduits 20, 36 and 38. Thus, piston 44 is moved to the right to the position illustrated wherein switch 52 is in the "on" position and start button 54 may be released.

So long as the system continues to operate in the normal manner, each of pins 32 remains intact and the discharge pressure of the compressor is maintained in cylinder 42 so as to maintain handle 50 in the operating position. However, if a foreign particle is projected into the rotor blading 28, the particle is subjected to an extremely high degree of centrifugal force and strikes one of inlet vanes 24 thereby shearing the associated pin 32. This places conduit 34 in communication with the high velocity, low pressure vane passages whereby the flow rate through the broken pin 32 is greater than that through flow restrictor 40. Thus, the pressure immediately drops in cylinder 42 and piston 44 moves to the left under the biasing force of spring 46. Movement of the piston actuates handle 50 so that the ignition system is deenergized and the engine is consequently shut off. Since exhaust gases are no longer supplied to the turbine, the latter immediately slows down and thereby prevents a destructive chain reaction from occurring. Thus, after the foreign particle has been removed from the turbine, the operation thereof may be easily resumed merely by replacing the fractured pin 32

and initiating the operating cycle as described hereinabove.

From the foregoing description it will be apparent that numerous alternative modes of operation are possible for terminating the operation of the turbine in response to the fracturing of a pin 32. For example, piston 44 may be connected to a valve positioned in conduit 12 so as to vent the exhaust gas to atmosphere or, alternatively, the piston may be connected to control the throttle of the engine so as to shut off the flow of fuel thereto. Therefore, it is to be understood that the foregoing description is intended to be merely illustrative of one possible embodiment of the invention and that the latter is not to be limited other than as specifically set forth in the following claims.

What is claimed is:

1. In combination, a turbine having inlet guide vanes, means mounting each of said vanes for pivotal movement, frangible means normally securing each of said vanes against pivotal movement, said frangible means being adapted to rupture upon impact of the associated vane by a foreign particle, means supplying motive power fluid to said turbine, and means responsive to the rupturing of any one of said frangible means for terminating the supply of motive fluid to said turbine.

2. In combination, a turbine having inlet guide vanes, means mounting each of said vanes for pivotal movement, a hollow, frangible pin securing each of said vanes against pivotal movement, said frangible pins being adapted to rupture upon impact of the vane associated therewith by a foreign particle, a fluid system connected to each of said pins so that the pressure in said system varies upon rupture of any one of said pins, means supplying motive power fluid to said turbine, and means responsive to the occurrence of said pressure variation in said system for terminating the supply of motive fluid to said turbine.

3. A turbocharging system for an internal combustion engine comprising a turbine receiving at its intake exhaust gases from said engine and being driven thereby, a compressor operable by said turbine and having its outlet arranged to deliver air under pressure to the intake of said engine, said turbine having inlet guide vanes, means mounting said vanes for movement upon impact by a foreign particle, frangible means for containing gas under pressure disposed in the path of movement of said vanes, and pressure responsive switching means responsive to the pressure of the gas within said frangible means, said switching means shutting off said engine when said frangible means is broken by one of said vanes.

4. A turbocharging system for an internal combustion engine comprising a turbine receiving at its intake exhaust gases from said engine and being driven thereby, a compressor operable by said turbine and having its outlet arranged to deliver air under pressure to the intake of said engine, said turbine having inlet guide vanes, means mounting said vanes for movement upon impact by a foreign particle, frangible means for containing air under pressure disposed in the path of movement of said vanes, and pressure responsive switching means responsive to the pressure of the air within said frangible means, said switching means shutting off said engine when said frangible means is broken by one of said vanes and said frangible means being pressurized by said compressor.

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