

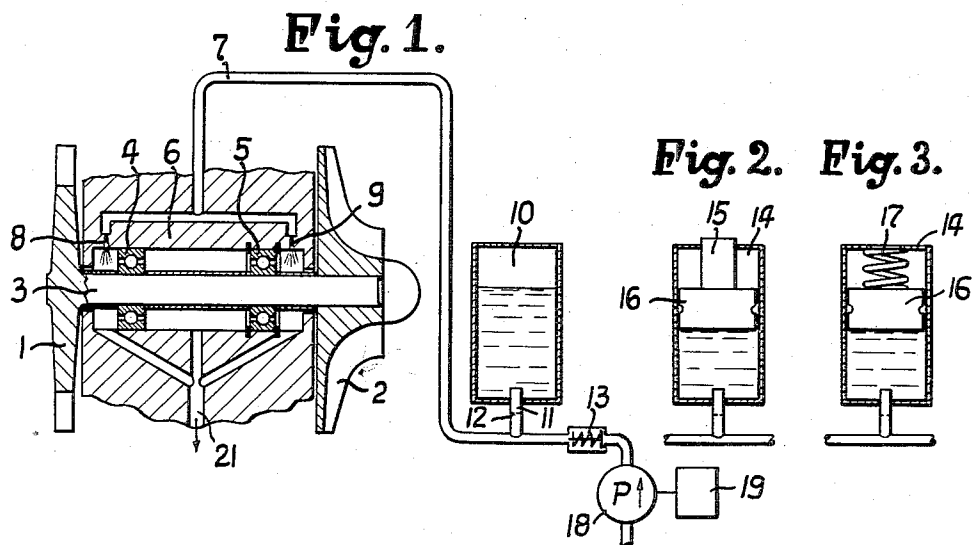
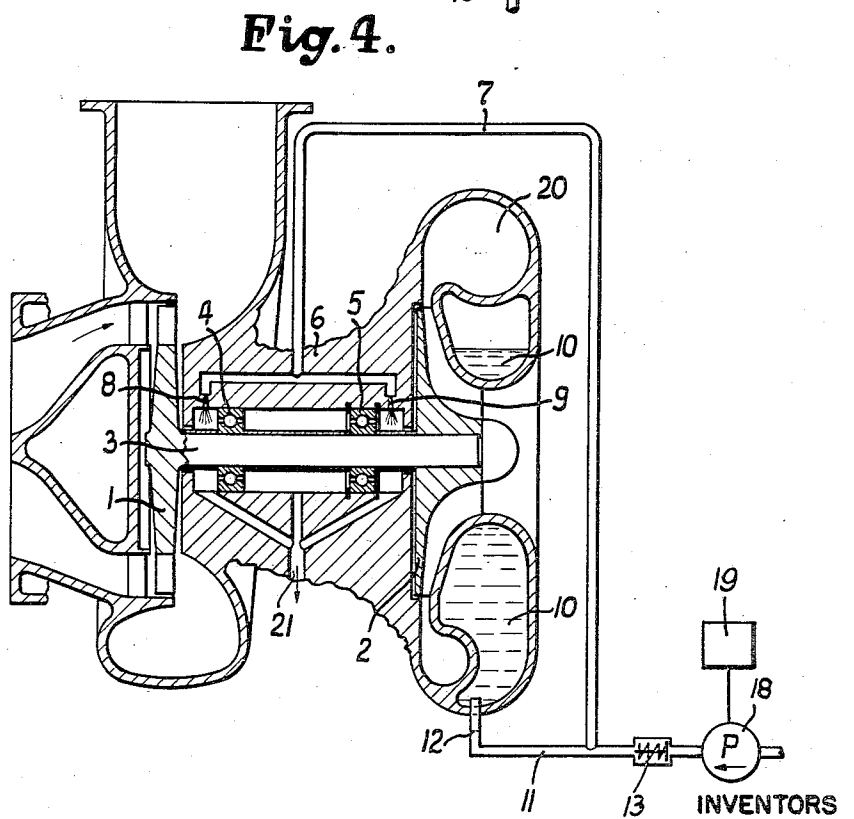
Sept. 30, 1958

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2,854,296

GAS TURBINE WITH AUTOMATIC COOLING MEANS

Filed May 6, 1955



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1

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GAS TURBINE WITH AUTOMATIC COOLING MEANS

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Application May 6, 1955, Serial No. 506,558

Claims priority, application Germany May 20, 1954

12 Claims. (Cl. 308—76)

This invention relates to gas turbines and, more particularly, to mechanism for cooling the shaft and bearings of a high temperature gas turbine after the turbine has come to a stop.

In high temperature gas turbines there is a large heat transfer from the turbine, subjected to the hot driving gas, to the shaft of the turbine and its associated bearings, and such heat transfer in operation may be great enough to warrant cooling of the turbine shaft and bearings. If it is attempted to provide such cooling action by spraying a coolant such as oil onto the turbine shaft, satisfactory results are obtained while the turbine is running. Upon stopping of the turbine, however, if the coolant pump driven by the turbine also stops, the cooling effect ceases. After prolonged operation at up to 500° or 600° C., however, there is still a great amount of residual heat transferred from the turbine to its shaft after the turbine is stopped and before the whole machine has cooled to room temperature. Therefore, stopping the flow of coolant at the same time as the turbine stops may not provide sufficient cooling protection for the shaft against the temperature to which it is subjected, at least for a short while, immediately after the turbine has stopped running but before all the residual heat has been dissipated.

According to this invention, however, means have been provided in the coolant supply arrangement for a gas turbine whereby a reserve supply of coolant is built up in a reservoir by the coolant pump during operation of the turbine, and automatic pressure means in the reservoir continue to supply coolant to the turbine shaft after the turbine and the coolant pump have stopped at least during the period immediately after stopping the turbine when heat damage to the shaft might result if coolant supply were suddenly cut off before the entire machine has cooled appreciably.

It is accordingly an object of this invention to provide a device for supplying coolant under pressure to the shaft of a gas turbine during operation thereof, and for continuing said supply of coolant under pressure to said shaft for a predetermined time after the turbine has stopped but without additional mechanical motive power input from the turbine.

Another object of this invention is to provide mechanism in the coolant supply system of a gas turbine to retain a portion of the coolant under pressure during operation of the turbine and to supply this retained supply of coolant at a controlled rate to the turbine shaft for a limited time after the turbine has come to rest and until it has cooled sufficiently to prevent heat damage to the shaft.

Still another object of this invention is to provide in a gas turbine of the character described a pump for supplying coolant under pressure to the shaft of the turbine and a reservoir to retain an excess supply of coolant stored therein under pressure during operation of said turbine so that the retained supply of coolant is delivered

2

under pressure to the turbine shaft after both the turbine and the pump have stopped.

Other objects and advantages of this invention will become apparent from the following description, the accompanying drawings, and the appended claims.

In the drawing,

Fig. 1 is a fragmentary somewhat diagrammatic section showing an exhaust gas turbo blower embodying this invention;

Figs. 2 and 3 illustrate diagrammatically two modifications of the reservoir of this invention; and

Fig. 4 is a fragmentary somewhat diagrammatic section of a turbo blower embodying this invention.

Referring to the drawing, in which like reference characters designate like parts throughout the several views thereof, an exhaust gas turbo blower of the type utilized for supercharging diesel engines is indicated in Fig. 1 as having a turbine 1 to be driven by the hot engine exhaust gases and a compressor or blower element 2 for compressing, for example, supercharging air for the engine. Turbine 1 and compressor 2 are mounted on turbine shaft 3 rotatably supported in bearings 4 and 5 in a housing 6. During continued operation of the machine, with the turbine 1 subjected to temperatures of several hundred degrees C. or higher, heat conducted through turbine 1 to shaft 3 and bearings 4 and 5 raises the temperature of shaft 3 and bearings 4 and 5 to an undesirable extent.

Accordingly, means are provided for supplying a coolant to shaft 3 during operation of the turbine. In the illustrated embodiment, such means include a coolant such as lubricating oil supplied from a source (not shown), which may be the main lubricating oil reservoir of the engine, by pump 18 through conduit 7 to be sprayed on shaft 3 through nozzles 8 and 9. Oil so sprayed onto shaft 3, thus, not only has a coolant effect for shaft 3 and bearings 4 and 5, but also provides proper lubrication for the bearings as it flows off shaft 3 and out of housing 6 through outlet 21 back to the main oil reservoir. Pump 18 is provided with suitable drive means indicated at 19 which may be the main engine when the invention is applied to an exhaust gas supercharging turbine, or the drive 19 may be actuated directly from the turbine itself.

If the turbine is brought to a stop, however, the flow of coolant under pressure from pump 18 also ceases as pump 18 stops. The heat transfer from turbine 1 to shaft 3, however, continues at least until the residual heat has been dissipated to the surrounding atmosphere. Especially after prolonged operation at high temperature, the cutting off of coolant supply upon stopping the turbine permits such heat transfer suddenly to raise the temperature of shaft 3 and bearings 4 and 5 to an undesirable extent and even so much that actual heat damage to the shaft or bearings may occur before all the residual heat in the machine is dissipated as the machine cools down.

To avoid this situation, a reservoir 10 is provided and coupled through conduit 11 with the coolant conduit 7. Reservoir 10 is a substantially air tight container being filled with air at atmospheric pressure before the turbine is started. During operation of the turbine, while pump 18 is supplying coolant through conduit 7 under pressure, a supply of coolant is forced into reservoir 10 by pump 18 against the action of the atmospheric pressure therein. As pump 18 continues to operate, the air in reservoir 10 is compressed to a greater and greater extent by the oil pressure prevailing in conduit 7. When the turbine is stopped, then, and pump 18 ceases to operate, the air above the level of oil in reservoir 10 is sufficiently compressed to force the retained oil out of

3

reservoir 10, through conduits 11 and 7 and nozzles 8 and 9 to be sprayed on shaft 3 and bearings 4 and 5 even after the turbine is standing still.

The rate at which the coolant is expelled from reservoir 10 by the pressure therein is controlled by a circular valve or control orifice 12 in conduit 11, and the size and capacity of reservoir 10 are correlated with the flow characteristics of orifice 12 as well as the usual operating temperature of turbine 1 to provide for delivery of coolant to shafts 3 and bearings 4 and 5 for a sufficient time after the turbine has come to rest to allow the machine to cool sufficiently through the danger zone where heat damage to the shaft or bearings might result. Also the size and capacity of pump 18, as will be understood, are sufficient to deliver the desired quantity of coolant into reservoir 10 against the pressure therein and the back pressure of the restrictions of nozzles 8 and 9, while also delivering coolant at the desired rate under pressure to shaft 3 through nozzles 8 and 9. A check valve is provided in conduit 7 between the pump 18 and conduit 11 leading to reservoir 10 to prevent back flow of coolant from reservoir 10 to pump 18.

Instead of utilizing the air pressure compressed above the level of coolant in reservoir 10, modifications such as illustrated in Figs. 2 and 3 are provided. Thus, Fig. 2 illustrates a reservoir 14 having a piston 16 slidable therein and actuated by a weight 15. During operation of the turbine and pump 18, a supply of oil under pressure is introduced into the bottom of reservoir 14 by pump 18 and raises piston 16 against the action of weight 15. Upon stopping of the turbine and pump 18, then, weight 15 provides the pressure through piston 16 to force the coolant out of reservoir 14 for continued cooling application to shaft 3 and bearings 4 and 5 during cooling of the machine. As indicated in Fig. 3, a further modification includes a reservoir 14 and a piston 16 slidable therein and actuated by a spring 17 to force out of reservoir 14 under pressure coolant supplied thereto during operation of the turbine by pump 18.

It will be noted that the pressure means for feeding coolant from reservoirs 10 or 14 are self-contained and automatic in operation upon stopping of the turbine 1 and pump 18. Particularly the self-contained feature presents an advantage in construction with regard to space requirements for a reservoir of adequate capacity. The utilization of compressed air as with reservoir 10 is particularly advantageous in that the reservoir can be arranged in or on the machine as space is available and disposed or oriented independently of such external considerations as gravity, etc. For example, considering Fig. 4, one arrangement of the reservoir 10 is indicated as being of generally circular or toroidal configuration and arranged concentrically in the turbine housing around the spiral compressor output channel 20, thereby requiring little extra space and presenting a compact and economic arrangement.

It will accordingly be seen that a simple device is provided according to the invention for continuing the supply of coolant for a limited time after the turbine and its associated coolant supply mechanisms have ceased to operate. Furthermore this is accomplished according to the invention in a manner simple of construction and economical of space and susceptible of location and disposition in many different forms and places as may be appropriate in the overall design, yet in a way in which an adequately large excess supply of coolant is retained with automatic and self-contained means for delivering the coolant at a controlled rate to shaft 3 and bearings 4 and 5 after the turbine and coolant pump have come to a stop and throughout the critical period of cooling to prevent heat damage to the stationary shaft and bearings such as might occur if the supply of coolant were suddenly interrupted upon stopping of the turbine and before the residual heat therein can be dissipated.

While the forms of apparatus herein described con-

4

stitute preferred embodiments of the invention, it is to be understood that the invention is not limited to these precise forms of apparatus, and that changes may be made therein without departing from the scope of the invention which is defined in the appended claims.

What is claimed is:

1. In a gas turbine having a shaft and bearings subjected to high temperature in operation, a device for cooling said shaft and bearings after the turbine has come to a stop comprising in combination pump means for supplying coolant to said shaft during operation of said turbine, an auxiliary coolant reservoir, conduit means from said pump means to said reservoir for delivering thereto during operation of said turbine coolant in excess of that supplied to said shaft, conduit means for conducting coolant from said reservoir to said shaft, and pressure means in said reservoir for forcing said coolant therefrom to said shaft upon stopping of said pump means.

2. In a gas turbine having a shaft and bearings subjected to high temperature in operation, a device for cooling said shaft and bearings after the turbine has come to a stop comprising in combination a coolant reservoir, conduit means for conducting coolant from said reservoir to said shaft, pump means for supplying coolant under pressure to said reservoir during operation of said turbine, pressure means in said reservoir for forcing coolant therefrom to said shaft upon stopping of said pump, and means controlling the rate at which coolant is supplied from said reservoir to said shaft by said pressure means.

3. In a gas turbine having a shaft and bearings subjected to high temperature in operation, a device for cooling said shaft and bearings after the turbine has come to a stop comprising in combination a coolant reservoir, conduit means for conducting coolant from said reservoir to said shaft, pump means for supplying coolant under pressure to said reservoir during operation of said turbine, pressure means in said reservoir for forcing coolant therefrom to said shaft upon stopping of said pump, and means for interrupting reverse flow of coolant from said reservoir to said pump upon stopping of said pump.

4. In a gas turbine having a shaft and bearings subjected to high temperature in operation, a device for cooling said shaft and bearings after the turbine has come to a stop comprising in combination a coolant reservoir, pressure means in said reservoir for supplying coolant therefrom to said shaft under pressure, pump means for supplying coolant to said reservoir and maintaining said coolant therein against the action of said pressure means during operation of said turbine, means for interrupting reverse flow of said coolant from said reservoir to said pump upon stopping of said pump, and means for controlling the rate at which coolant is supplied to said shaft from said reservoir by said pressure means therein upon stopping of said turbine.

5. A device for cooling the shaft of a gas turbine after the turbine has come to a stop comprising in combination a source of coolant for said shaft, pump means for supplying said coolant under pressure during operation of said turbine, conduit means for conducting said coolant from said pump to said shaft, a coolant reservoir interposed in the line of flow of said conduit means between said pump and said shaft, and pressure means for forcing said coolant from said reservoir to said shaft upon stopping of said pump, the capacity of said pump being sufficient during operation thereof to overcome said pressure means in said reservoir for maintaining a substantial supply of coolant therein in excess of that being supplied to said shaft by said pump.

6. A device for cooling the shaft of a gas turbine after the turbine has come to a stop comprising in combination a source of coolant for said shaft, pump means for supplying said coolant under pressure during operation of said turbine, conduit means for conducting said coolant from said pump to said shaft, a coolant reservoir inter-

5

posed in the line of flow of said conduit means between said pump and said shaft, pressure means for forcing said coolant from said reservoir to said shaft upon stopping of said pump, the capacity of said pump being sufficient during operation thereof to overcome said pressure means in said reservoir for maintaining a substantial supply of coolant therein in excess of that being supplied to said shaft by said pump, and check valve means between said reservoir and said pump interrupting reverse flow of coolant from said reservoir to said pump.

7. In a gas turbine having a shaft subjected to high temperatures after stopping of said turbine and a pump operable only during operation of said turbine for supplying coolant to said shaft, the combination which comprises a coolant reservoir, conduit means interconnecting said reservoir with said pump for supplying a quantity of coolant to said reservoir during operation of said pump in excess of the coolant supplied to said shaft by said pump, pressure means for expelling coolant from said reservoir upon stopping said pump, and conduit means from said reservoir to said shaft for delivering coolant so expelled from said reservoir.

8. In a gas turbine having a shaft subjected to high temperatures after stopping of said turbine and a pump operable only during operation of said turbine for supplying coolant to said shaft, the combination which comprises a coolant reservoir, conduit means interconnecting said reservoir with said pump for supplying a quantity of coolant to said reservoir during operation of said pump in excess of the coolant supplied to said shaft by said pump, air pressure means for expelling coolant from said reservoir upon stopping said pump, and conduit means from said reservoir to said shaft for delivering coolant so expelled from said reservoir.

9. In a gas turbine having a shaft subjected to high temperatures after stopping of said turbine and a pump operable only during operation of said turbine for supplying coolant to said shaft, the combination which comprises a coolant reservoir, conduit means interconnecting said reservoir with said pump for supplying a quantity of coolant to said reservoir during operation of said pump in excess of the coolant supplied to said shaft by said pump, mechanical pressure means for expelling coolant from said reservoir upon stopping said pump, and conduit means from said reservoir to said shaft for delivering coolant so expelled from said reservoir.

6

10. In a gas turbine having a shaft subjected to high temperatures after stopping of said turbine, generally circular housing, and a pump means operable only during operation of said turbine for delivering coolant to said shaft, the combination which comprises a toroidal reservoir substantially concentrically arranged in said housing, means for supplying coolant to said reservoir from said pump means in excess of the coolant delivered by said pump means to said shaft during operation of said turbine, and pressure means for feeding coolant from said reservoir to said shaft upon stopping of said turbine and said pump.

11. In a gas turbine having a shaft subjected to high temperatures after stopping of said turbine, generally circular housing, and a pump means operable only during operation of said turbine for delivering coolant to said shaft, the combination which comprises a toroidal reservoir substantially concentrically arranged in said housing, means for supplying coolant to said reservoir from said pump means in excess of the coolant delivered by said pump means to said shaft during operation of said turbine, pressure means for feeding coolant from said reservoir to said shaft upon stopping of said turbine and said pump, and means for controlling the rate at which said coolant is supplied from said reservoir to said shaft.

12. In a gas turbine having a shaft subjected to high temperatures after stopping of said turbine, generally circular housing, and a pump means operable only during operation of said turbine for delivering coolant to said shaft, the combination which comprises a toroidal reservoir substantially concentrically arranged in said housing, means for supplying coolant to said reservoir from said pump means in excess of the coolant delivered by said pump means to said shaft during operation of said turbine, pressure means for feeding coolant from said reservoir to said shaft upon stopping of said turbine and said pump, and means for interrupting reverse flow of coolant from said reservoir to said pump means.

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