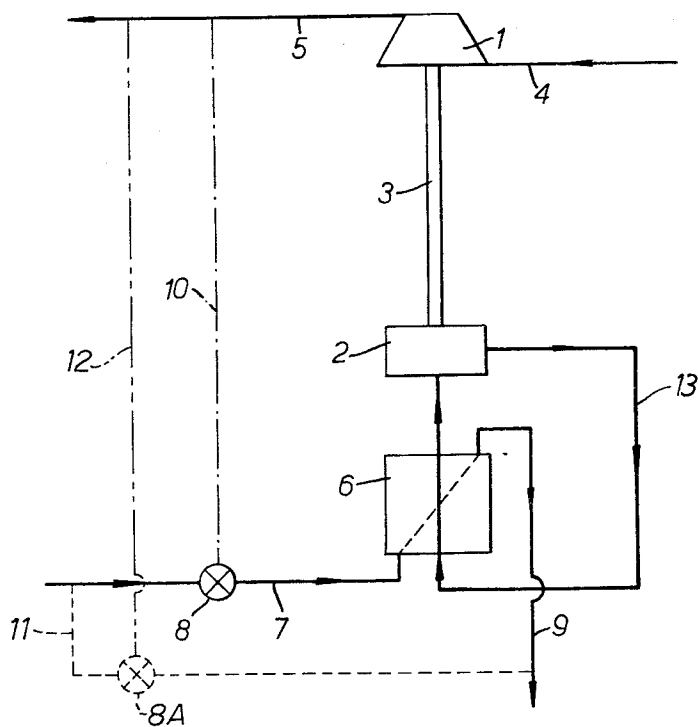


Oct. 5, 1965

M. E. GARRETT
COOLING SYSTEMS FOR GASES
Filed Dec. 14, 1964

3,209,552



INVENTOR
MICHAEL ERNEST GARRETT
By

Shoemaker and Mattare
ATTORNEYS

1

3,209,552

COOLING SYSTEMS FOR GASES

Michael Ernest Garrett, Streatham, London, England,
assignor to The British Oxygen Company Limited,
London, England

Filed Dec. 14, 1964, Ser. No. 417,943

10 Claims. (Cl. 62-172)

This invention relates to cooling systems for gases of the type employing an expansion turbine for expanding and cooling the gas and a compressor driven by the turbine.

Such combined turbine-compressor units for cooling gases are well known and it is known that the speed of the turbine can be controlled by throttling at the output side of the compressor.

It has previously been proposed to provide a turbine-compressor unit of this type in which the compressor lies in a closed gas cycle which does not include the turbine but includes a cooler for the gas in the closed gas cycle and a throttling member in series therewith.

It is an object of the present invention to provide a cooling system for a gas of the type referred to incorporating novel means for controlling the speed of the turbine.

According to the present invention, in a cooling system for a gas of the type employing an expansion turbine for expanding and cooling the gas and a compressor driven by the turbine, and in which the compressor lies in a closed gas cycle which does not include the turbine but includes a heat exchanger in series with the compressor for cooling gas in the closed gas cycle by heat exchange with a coolant fluid, a throttling member is provided for varying the flow of coolant fluid to the heat exchanger.

The throttling member is conveniently a control valve and may be located either in the coolant fluid line leading to the heat exchanger, or in a line for the passage of the coolant fluid which by-passes the heat exchanger, to give either full or partial control of the flow of coolant fluid to the heat exchanger respectively.

By varying the flow of coolant fluid to the heat exchanger by operation of the throttle member, the temperature of the gas in the closed gas cycle can be varied. Since the braking load exerted by the compressor cycle on the turbine is greater, the lower the temperature (and therefore the higher the gas density), in the closed gas cycle and vice versa, by appropriate variation of the flow of coolant fluid to the heat exchanger, the speed of the turbine can be controlled.

The throttling member can be adjusted manually to produce a desired turbine speed, or if desired, it can be operated automatically in accordance with a characteristic of the cooling system, for example, the turbine speed, or the temperature or pressure of the turbine exhaust, to maintain that characteristic constant at a desired value. For example, the throttling member may be adjusted in accordance with the chosen characteristics through a pneumatic, mechanical or electronic linkage.

The gas used in the closed gas cycle may be the same as or different from that passing through the turbine, but it will be appreciated that the cooling cycle including the turbine is in all cases separate from the closed gas cycle including the compressor. Similarly, any available fluid may be used as the coolant fluid, provided, of course, that it is at a lower temperature than the gas in the closed gas cycle.

One form of cooling system according to the invention is illustrated diagrammatically in the accompanying drawing.

The system includes a turbine 1 and a compressor 2

2

mounted on a common shaft 3. Gas which is to be expanded and cooled in the turbine 1 enters it through an input line 4 and the cooled and expanded gas leaves the turbine through an exhaust line 5.

The compressor 2 operates in a closed gas cycle 13 including a heat exchanger 6 in which the gas leaving the compressor is cooled by heat exchange with a coolant fluid which enters the heat exchanger through a line 7 controlled by a flow-control valve 8, and leaves it through a line 9.

The valve 8 is automatically adjustable in dependence upon the pressure or temperature in the turbine exhaust line 5 through a suitable linkage indicated by the chain-line 10.

In operation, the valve 8 controlling the flow of coolant fluid through the heat exchanger 6 is automatically adjusted through the linkage 10 in accordance with variations in the pressure in the turbine exhaust line 5 from a predetermined value. Should this exhaust pressure vary from the predetermined value, such variation will be transmitted through the linkage 10 and will cause the setting of the valve 8 and thus the flow of coolant fluid through the heat exchanger 6 to alter, and consequently to alter the temperature of the gas in the compressor cycle and hence the speed of the turbine in such a manner that the pressure in the exhaust line 5 is brought back to its predetermined value alternatively, as shown in chain lines in the drawing, the valve 8 may be placed by valve 8a located in a bypass line 11 connecting lines 7 and 9, the valve 8a similarly being automatically adjustable in dependence upon the pressure or temperature in the turbine exhaust line 5 by suitable linkage indicated at 12.

What I claim as my invention and desire to secure by Letters Patent of the United States is:

1. Cooling system for a gas comprising an expansion turbine for expanding and cooling the gas, a compressor driven by said turbine, a heat exchanger, a closed gas cycle including said compressor and one phase of said heat exchanger but not said turbine, a supply line for supplying a coolant fluid to the other phase of said heat exchanger, an outlet line for withdrawing coolant fluid from the other phase of said heat exchanger and a throttling member controlling the flow of coolant fluid through said other phase of said heat exchanger.

2. A cooling system according to claim 1, wherein said throttling member is a flow control valve.

3. A cooling system according to claim 2, wherein said flow control valve is located in said coolant fluid supply line to said heat exchanger.

4. A cooling system according to claim 2, wherein said flow control valve is located in a by-pass line connecting said coolant fluid supply line and said coolant fluid outlet line and by-passing said heat exchanger.

5. A cooling system according to claim 1 wherein said throttling member is adjusted to control the flow of coolant fluid through said other phase of said heat exchanger in dependence upon a characteristic of the turbine cycle to maintain said characteristic substantially constant.

6. A cooling system according to claim 5, wherein said characteristic is the temperature of the turbine exhaust.

7. A cooling system according to claim 5 wherein said characteristic is the pressure of the turbine exhaust.

8. A cooling system according to claim 5 wherein said characteristic is the turbine speed.

9. In a cooling system for a gas comprising an expansion turbine for expanding and cooling the gas, means for controlling the speed of said turbine comprising a compressor driven by said turbine, a heat exchanger, a closed gas cycle including said compressor and heat exchanger, a

3

supply line for supplying a coolant fluid to said heat exchanger and a throttling member for varying the flow of coolant fluid to the heat exchanger thereby varying the temperature of the gas in the closed gas cycle and thereby varying the braking load exerted by the compressor 5 cycle on the turbine.

10. The invention as defined in claim 9, wherein said throttling member is controlled by the temperature of the turbine exhaust.

4

References Cited by the Examiner

UNITED STATES PATENTS

2,503,250	4/50	Eckert	62—172
2,618,125	11/52	Fischer	62—172
2,851,863	9/58	Theed	62—172
2,923,222	2/60	Manning	62—172

WILLIAM J. WYE, *Primary Examiner.*