

April 21, 1942.

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2,280,585

EXPANSION TURBINE FOR LOW TEMPERATURE PLANTS

Filed Nov. 3, 1938

2 Sheets-Sheet 1

Fig.1.

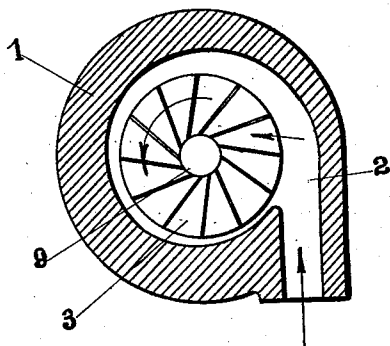


Fig.2.

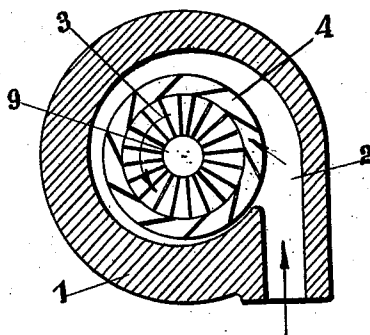


Fig.3.

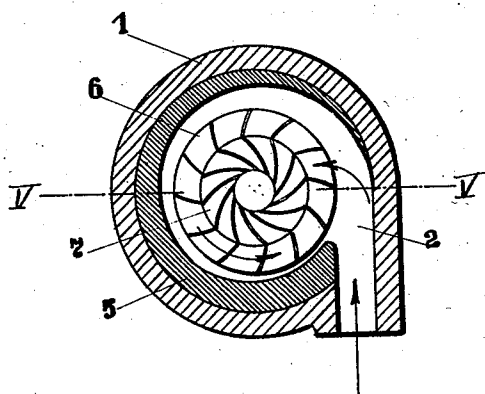
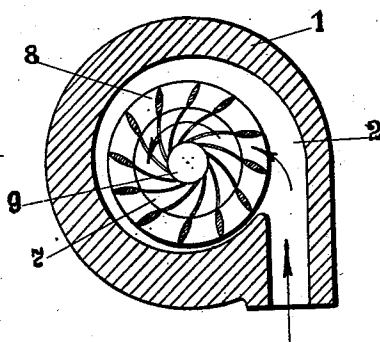


Fig.4.



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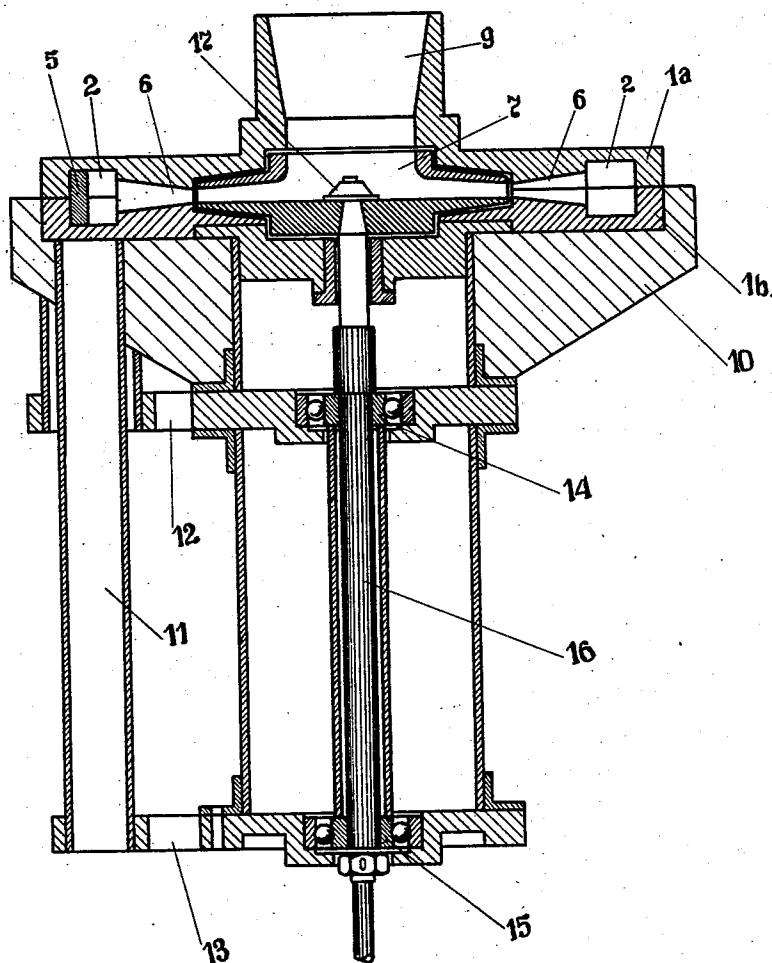
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2 Sheets-Sheet 2.

Fig. 5



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UNITED STATES PATENT OFFICE

2,280,585

EXPANSION TURBINE FOR LOW TEMPERATURE PLANTS

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Application November 3, 1938, Serial No. 238,699.
In the Union of Soviet Socialist Republics September 16, 1938

3 Claims. (Cl. 62-123)

The present invention relates to expansion turbines for cooling gaseous mediums to low temperatures.

Up to the present time it has not been possible to use an expansion turbine for the cooling to very low temperatures large quantities of gas as the construction of an ordinary expansion turbine gave such a small pressure drop that the adiabatic process was not sufficient to cool the gas down to the required temperature.

The expansion turbine has always been used in conjunction with high pressure compressors. These turbines are usually constructed according to the steam turbine principle of impulse axial flow turbines.

Contrary to this, the present invention provides means for the cooling of gases adiabatically by the use of an expansion turbine alone making the use of the high pressure apparatus unnecessary. Other and further features and objects of the invention will be more apparent to those skilled in the art upon a consideration of the accompanying drawings and the following description wherein several exemplary embodiments of the invention are disclosed.

In the drawings:

Fig. 1 is a sectional view of the turbine casing showing one type of rotor blade.

Fig. 2 is a similar view illustrating another type of rotor blade.

Fig. 3 is a sectional view of a modified turbine casing showing a third type of rotor.

Fig. 4 is a view similar to Fig. 1 illustrating a fourth type of rotor.

Fig. 5 is a sectional view of the turbine taken on the line V—V of Fig. 3.

It has been established that at the low temperature achieved by an expansion turbine adiabatically by feeding it with air cooled, say, to about -160°C ., the working medium has such a density that the turbine can be constructed on the principle of steam or gas turbines making use of the expansion of the gas and the principle of the turbines working in the dense medium such as the hydraulic turbine where one makes use of centrifugal force. The combining of these two principles makes the pressure drop 2 or 3 times greater and it follows that the temperature limits are much larger in the expanding cycles, which leads to increased thermodynamic efficiency and so to the efficiency of the whole expansion turbine.

For example, it has been found that when the air let into the turbine at 4 atmospheres, after being cooled in heat exchangers to -165°C ., it

can be expanded to 1 atmosphere, and on leaving the turbine reaches the temperature of -196°C . It was found from experiments that the efficiency of the expansion turbine is about 85% in practice or even higher. To achieve this result, the turbine, as can be seen from the annexed drawings, is like a radial flow turbine in which the working medium is not directed from the centre to the periphery as is usual, but from the periphery to the centre. In this way the expansion turbine is constructed in much the same way as an inverted turbo-compressor. As can be seen from the drawings, 1 is the turbine casing, 2 the spiral channel of the air feeding means, and 3 the rotor. The arrows show the direction of the flow of the inlet air and the direction of the rotation of the rotor. The incoming air enters the whole circumference of the wheel.

A modification is shown in Fig. 2 wherein the spiral channel 2 has a guiding mechanism consisting of the guide blades 4 and all the blades of the rotor 3 and of the directing mechanism 4 are shown to be rectilinear.

Fig. 3 illustrates another possible construction in which the spiral channel 2 is formed by an inserted piece 5 so that the casing 1 can be made concentric to the rotor and the guiding passages.

The blades 6 and 7 of both are curved as shown in the drawings.

Fig. 4 shows still another form in which the blades 8 of the guiding passages are so constructed that the channel between them has the same shape as Laval's expanding nozzle. In all these different designs the guiding passages can be distributed all round the rotor.

Fig. 5 shows that the casing 1 is made of two halves 1a and 1b fixed together and forming the spiral air feeding channel 2 by their conjunction with the inserted blade.

The air compressed to a few atmospheres and suitably cooled is let into the feed channel 2 through a pipe which is not shown in Fig. 5 and passes through the guiding passages 6 to the rotor blades 7 from where it goes out through the central opening 9 after expanding and giving up its energy and passes on to the next apparatus at a temperature of about -196°C . and a pressure of 1 atmosphere.

The casing 1a and 1b is rigidly fixed to the table 10 which is supported by three columns 11. On these columns two holders 12 and 13 are fixed with ball bearings 14 and 15 to the vertical shaft 16 of the turbine wheel 17. Owing to the device and also to the high density of the gas

at the low pressure at which it enters the passage between the blades a centrifugal force is produced whose action is directed towards the blades to increase the pressure on them.

In this way the pressure drop of 1:3 used in the expansion turbines up to this time may be increased to 1:8 or even higher.

Beside this it is possible to combine a series of two or more expansion turbines and obtain a still greater increase of the pressure drop and the consequent lowering of the temperature in the system at the expense of the adiabatic expansion. In this way there is provided a low temperature plant without high pressure and all the consequent difficulties attached to the use of high pressure compressors giving a much more simple and economical plant.

The power of the shaft 16 of the expansion turbine can be utilised in some already known way or have its energy absorbed by the use of some device which will convert its mechanical energy into heat.

I claim:

1. An expansion turbine for low temperature refrigerating plants having a working medium entering said turbine at a low temperature and having considerable density at the temperatures and pressures existing in the turbine rotor comprising, a shaft, a rotor attached to the shaft, means for utilizing the work done by the expansion of the working medium and by the centrifugal forces in the working medium comprising radially disposed single action blades directing the working medium from the periphery to the center of the rotor, means for feeding the working medium to the periphery of the rotor com-

prising a spiral-formed channel, and means circumferentially spaced around the periphery of the rotor for guiding the working medium between said blades.

2. An expansion turbine for low temperature refrigerating plants with a working medium entering said turbine at a low temperature and having considerable density at the temperatures and pressures existing in the turbine rotor comprising a vertically disposed shaft, a rotor attached to the shaft, means for utilizing the work done by the expansion of the working medium and by the centrifugal forces in the working medium comprising radially disposed single-action blades directing the working medium from the periphery to the center of the rotor, and means for feeding the working medium to the periphery of the rotor comprising a spiral-formed channel having a ring-shaped group of director vanes.

3. An expansion turbine for low-temperature refrigerating plants with a working medium entering the turbine at a low temperature and having considerable density at the temperatures and pressures existing in the turbine rotor comprising, a vertically disposed shaft, a rotor attached to the shaft, means for utilizing the work done by the expansion of the working medium and by the centrifugal forces in the working medium, comprising radially disposed blades directing the working medium from the periphery to the center of the rotor, and means for feeding the working medium to the periphery of the rotor comprising a spiral-formed channel having a ring-shaped group of director vanes forming expansion channels.

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