Nov. 25, 1952 F. SCHAER 2,619,279

AXIAL FLOW COMPRESSOR

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Fig. 1

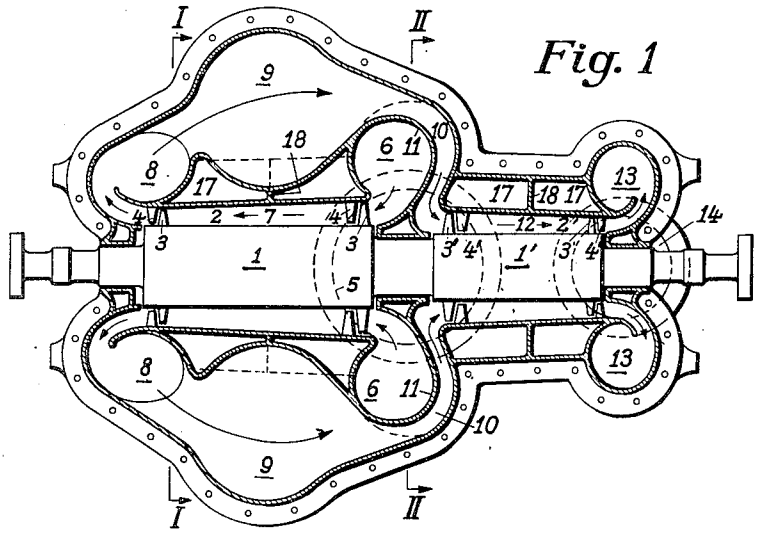


Fig. 2

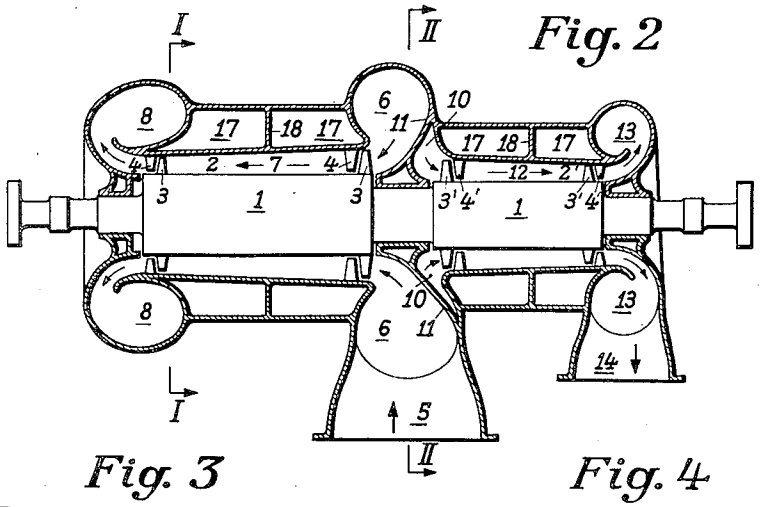


Fig. 3

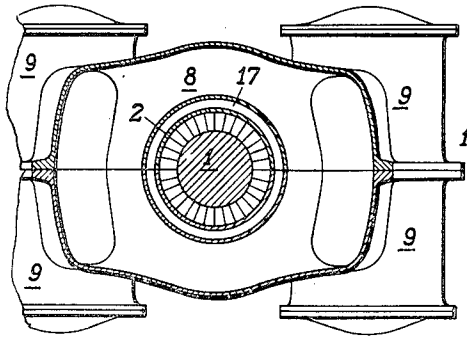
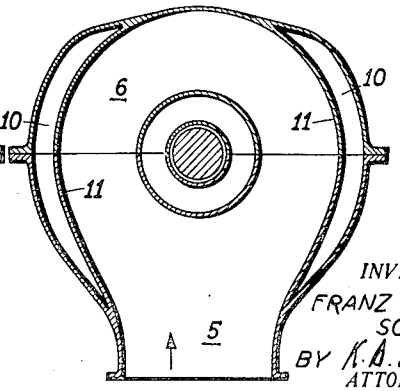


Fig. 4



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Fig. 5

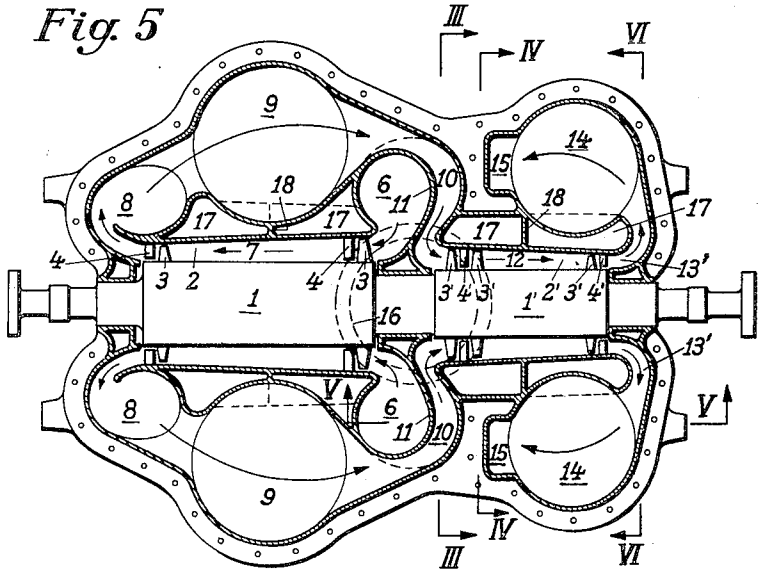
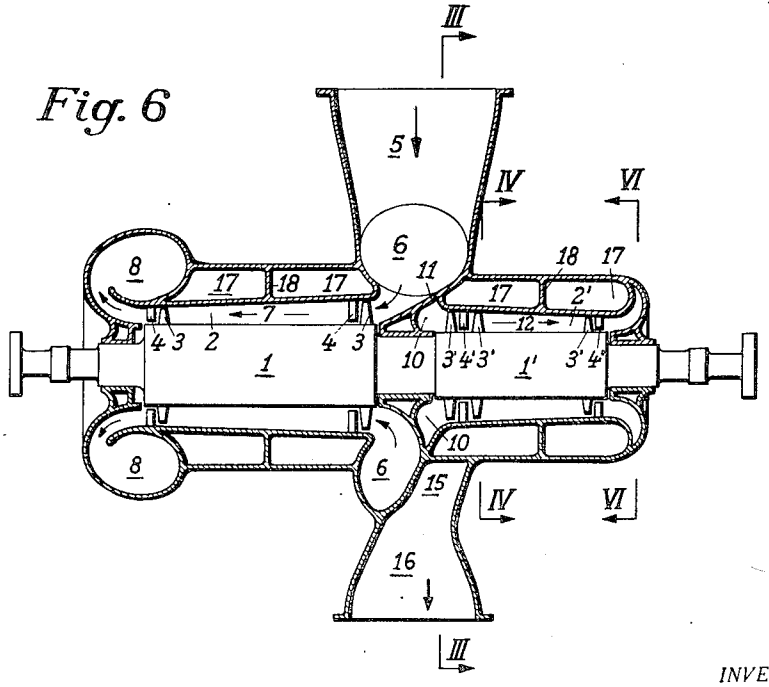


Fig. 6



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Fig. 7

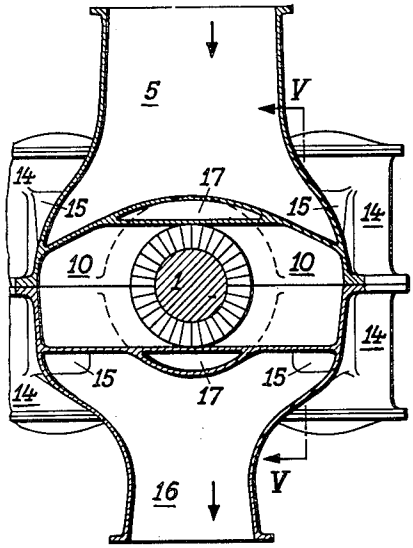


Fig. 8

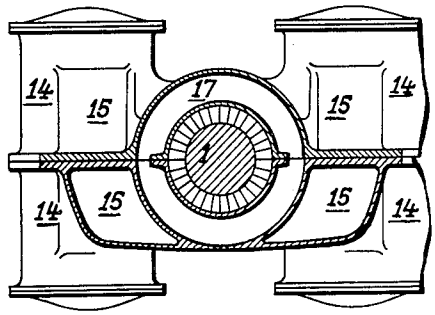


Fig. 10

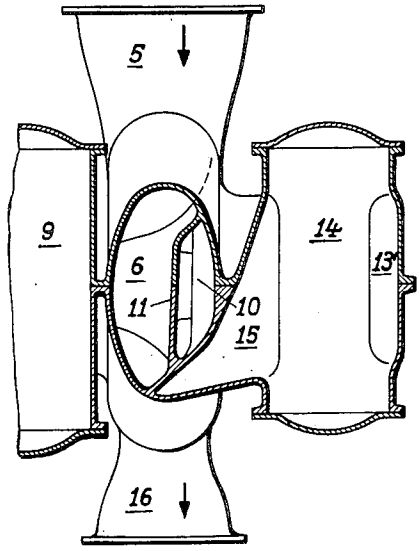
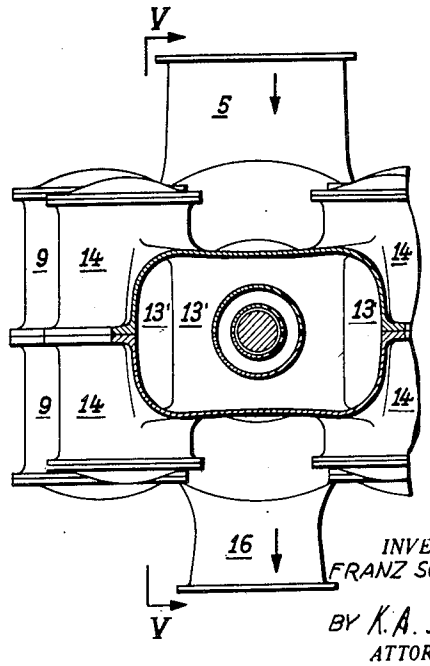


Fig. 9



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UNITED STATES PATENT OFFICE

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AXIAL FLOW COMPRESSOR

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Application June 22, 1949, Serial No. 100,700
In Switzerland July 16, 1948

4 Claims. (Cl. 230—122)

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The present invention relates to multistage axial flow compressors having at least one cooler for the compressed medium.

It is an object of the invention to arrange in the casing of an axial flow compressor a cooler for the compressed medium in such a manner that the temperature of the outer portions of the casing is approximately the same as that of the inner portions whereby heat stresses and deformations are avoided, and that the inlet and outlet channels of one group of compressor stages can be arranged adjacent to one another without undue heat exchange through the wall portions of the casing separating said channels.

An object of the present invention resides in the combination of the casing of an axial flow compressor with an intercooler in such a manner that the medium flowing in axial direction through a group of compressor stages passes the intercooler in axial direction substantially opposite to the direction in which the medium has passed through the compressor and that the compressed and cooled medium flows in pressure conduits which are adjacent to the suction conduits of said group of stages of the compressor.

A further object of the invention resides in the provision of a compressor having two axially arranged groups of stages in one casing, the medium flowing in opposite directions through said groups and the inlet conduit or conduits of one group being adjacent to its outlet conduits and the latter forming the inlet conduit or conduits of the other group of stages. In this way the axial thrusts of the rotors of the two groups balance one another without necessitating complicated flow and conduits for the medium. A further beneficial result of the arrangement according to the invention is the elimination of heat expansion of the casing in the middle of the compressor unit and the fact that the unit may be supported rigidly thereat, i. e. at its center of gravity, and its inlet can be rigidly connected with the medium supply conduit without special provisions for expansion.

A further object of the invention is the provision of a compressor having two axially arranged groups of stages and a cooler for the compressed medium provided for each group, the medium flowing through each cooler in a direction opposite to that in which it flows through the group of compressor stages to which the cooler belongs; the suction conduit of the first group of stages being in the neighborhood of the outlet of the cooler of the second group, which is the outlet of the whole compressor unit. Since

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the highly compressed medium is cooled in the second cooler and the outlet thereof is in the neighborhood of the inlet of the compressor unit, not only the inlet but also the outlet of the unit can be rigidly fitted to the connecting ducts without special provisions for taking care of expansion. In the described arrangement, temperature expansion in the middle of the unit where its center of gravity is located, is avoided and the unit may be rigidly supported at its center portion and connected with the suction and pressure ducts, whereas the hot end portions of the unit which may be slidingly supported or be not supported at all, can expand freely.

Further and other objects of the present invention will be hereinafter set forth in the accompanying specification and claims and shown in the drawings, which by way of illustration show what I now consider to be preferred embodiments of the invention.

In the drawings:

Fig. 1 is a horizontal longitudinal sectional view of a compressor according to the invention;

Fig. 2 is a vertical sectional view of the compressor illustrated in Fig. 1;

Fig. 3 is a cross-sectional view of the compressor shown in Figs. 1 and 2, and taken along lines I—I of said figures;

Fig. 4 is a cross-sectional view of the compressor shown in Figs. 1 and 2, and taken along lines II—II of said figures;

Fig. 5 is a horizontal longitudinal sectional view of a modified compressor according to the invention;

Fig. 6 is a vertical longitudinal sectional view of the compressor illustrated in Fig. 5;

Fig. 7 is a cross-sectional view of the compressor shown in Figs. 5 and 6, and taken along lines III—III of said figures;

Fig. 8 is a cross-sectional view of the compressor shown in Figs. 5 and 6, and taken along lines IV—IV of said figures;

Fig. 9 is a cross-sectional view of the compressor shown in Figs. 5 and 6, and taken along lines VI—VI of said figures;

Figure 10 is a longitudinal vertical sectional view of a part of the modified compressor according to the invention, the section being taken along lines V—V in Figs. 5, 7, and 9.

Like parts are designated by like numerals in all figures of the drawings.

Referring more particularly to Figs. 1 to 4 of the drawings, numerals 1 and 1' designate the two aligned rotors of the compressor unit hav-

ing blades 3 and 3', respectively, and numerals 2, 2' the associated stators having buckets 4 and 4', respectively, only the blades and buckets at the ends of the two groups of compressor stages being shown to avoid overloading of the drawing.

The first group of stages receives medium to be compressed from the inlet conduit 5 through the suction channel 6 and compresses it in the direction indicated by arrow 7. The compressed and thereby heated medium is discharged into the annular channel 8 wherein its flow direction is reversed, and flows through a cooler 9 in a direction opposite to that of arrow 7. The cooler is built into the casing and comprises a cooling coil or other heat transfer means which are not shown as they do not form part of the present invention. The cooled medium is conducted through the pressure conduits 10 to the second group of compressor stages. The medium in channels 10 has approximately the same temperature as the medium flowing through suction conduits 6 and no heat transfer occurs through the separating walls 11, which would reduce the efficiency of the machine. The compressed medium is available in about the same radial plane, for withdrawal or for further compression, in which it was introduced into the compressor whereby the construction of the unit is considerably simplified. A further advantage is that the medium whose temperature increased from the inlet 6 in the direction of arrow 7, is cooled to approximately its original temperature while passing through 8, 9 and 10 in about the same sequence. The temperatures near the diametrical center of the unit are therefore approximately equal to those on the periphery whereby tension in radial direction and deformations due to heat are avoided.

Compressed and cooled medium may be withdrawn from the channels 10 preferably at the radial plane in which the suction conduit 5 is located. The rest of the medium or, in the embodiments illustrated, all of it is further compressed in a second group of compressor stages which is arranged coaxially with the first group and which receives the pre-compressed medium from the channels 10 which are disposed adjacent to the suction channels 6. The medium flows through stages 2' in the direction of arrow 12 which is opposite to that in which the medium flows through stages 2. The medium compressed and thereby heated in the second group of compressor stages passes therefrom into the annular chamber 13 from which it is conducted to the compressor outlet 14.

An arrangement according to Figs. 1 to 4 is used if heating of the medium in the second part of the compressor is not objectionable or is desired.

If the compressed medium is required at a low temperature, for example if it must be further compressed, the arrangement according to the invention may be modified as shown in Figs. 5 to 10. In this case the direction of flow of the medium leaving the second part of the compressor is reversed in the annular conduit 13', directed through a cooler 14 in a direction opposite to that of arrow 12, enters the pressure channels 15 in cooled condition, and leaves the compressor through outlet 16. The temperature of the medium in conduits 6, 10 and 15 is approximately the same and these conduits can be arranged closely to one another without reducing the efficiency of the unit. For the same reason, the outlet 16 can be in the same radial plane of the compressor as the inlet 5.

Chambers 17 of the compressor casing which are not used for conducting the medium to be compressed, may be provided with separating walls 18 for preventing generation of convection currents in the chambers.

While I believe the above described embodiments of my invention to be preferred embodiments, I wish it to be understood that I do not desire to be limited to the exact details of method, design and construction shown and described, for obvious modifications will occur to a person skilled in the art.

I claim:

1. An axial flow compressor comprising a casing, a longitudinal rotor disposed in said casing, blades extending substantially radially from said rotor, buckets extending substantially radially from said casing and between said blades; a suction conduit in said casing for conducting the medium to be compressed to one end of said rotor; a cooler disposed in said casing and around said rotor between its ends; a medium flow reversing outlet conduit in said casing at the other end of said rotor, reversing the direction of flow of the medium and being connected with said cooler for conducting the medium thereinto and therethrough in a direction substantially opposite to that in which it flows through the rotor; and an outlet conduit in said casing connected with said cooler for receiving the compressed and cooled medium from said cooler, said pressure conduit being adjacent to said suction conduit.

2. An axial flow compressor comprising a casing, a longitudinal rotor disposed in said casing, blades extending substantially radially from said rotor, buckets extending substantially radially from said casing and between said blades; a suction conduit in said casing for conducting the medium to be compressed to one end of said rotor; a cooler disposed in said casing and around said rotor between its ends; a medium flow reversing outlet conduit in said casing at the other end of said rotor, reversing the direction of flow of the medium and being connected with said cooler; a pressure conduit in said casing receiving the compressed and cooled medium from said cooler, said pressure conduit neighboring said suction conduit; a second longitudinal rotor disposed in said casing coaxially with and having an end proximal to the first rotor, blades on said second rotor, buckets connected with said casing and extending between the blades of said second rotor, an intake at the proximal end of said second rotor and connected with said pressure conduit for receiving precompressed and cooled medium from the cooler and conducting it into the second rotor to flow therethrough in a direction opposite to that in which it flows through the first rotor, and a medium discharge conduit in said casing at the end of the second rotor which is distal to the first rotor.

3. An axial flow compressor as defined in claim 2, having a second cooler disposed in said casing around said second rotor, the discharge conduit of the second rotor being connected with said second cooler and so shaped as to reverse the flow of the medium and to direct it into and through the second cooler in a direction substantially opposite to that in which it flows through the second rotor, and a second pressure conduit in said casing connecting with and receiving the medium from said second cooler and disposed in the neighborhood of said suction conduit.

4. An axial flow compressor as defined in claim

3 having inlet means connected with said suction conduit and outlet means connected with said second pressure conduit, said inlet and outlet means being disposed substantially in the same radial plane in the middle of the compressor.

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