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J. L. BONNANO ET AL

2,853,638

INDUCTOR GENERATOR

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2 Sheets-Sheet 1

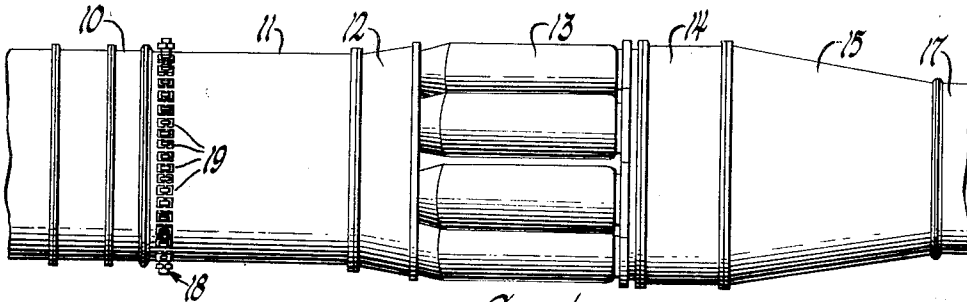


Fig. 1

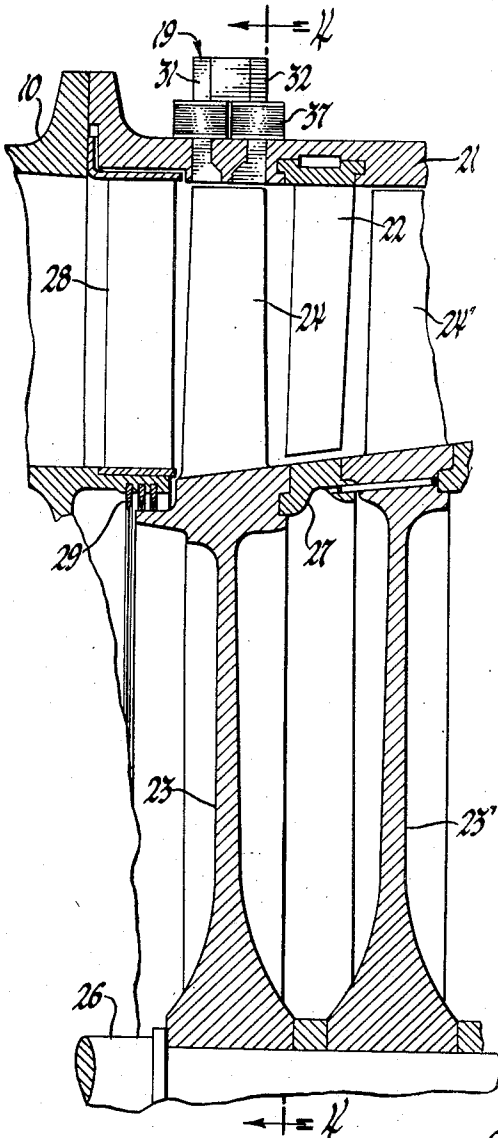


Fig. 2

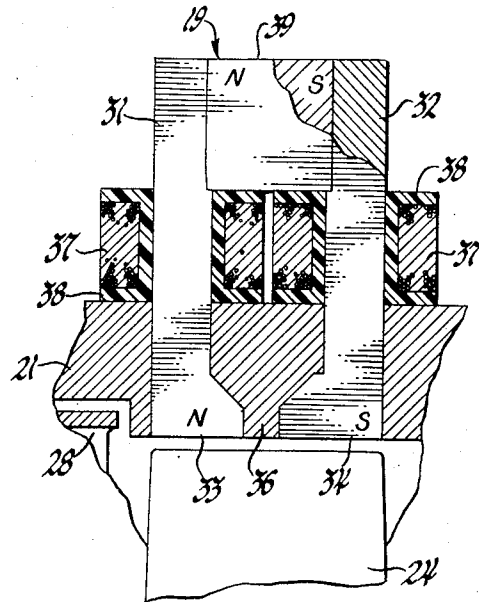


Fig. 3

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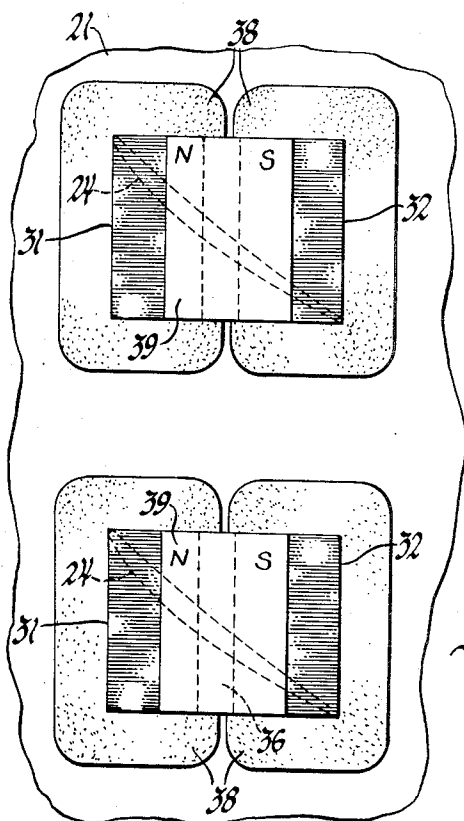
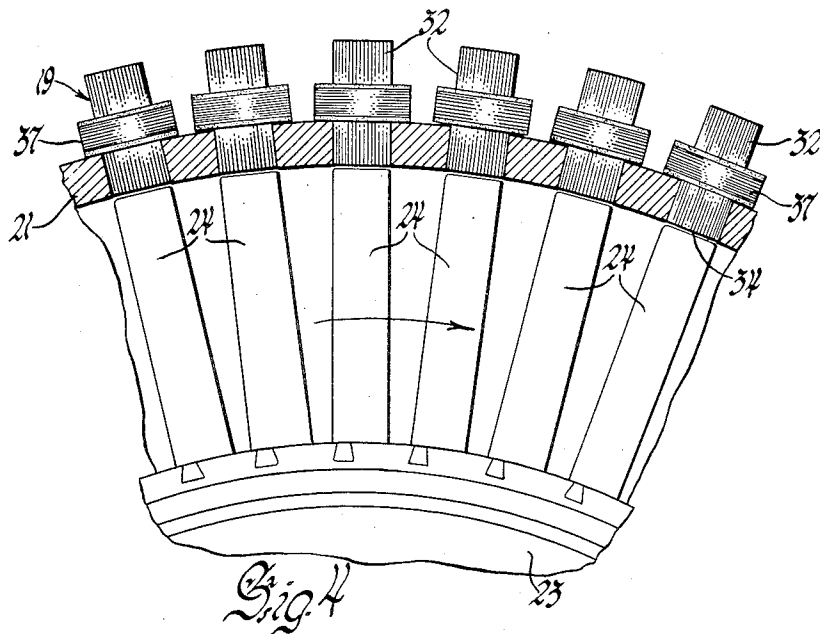
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INDUCTOR GENERATOR

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Application January 11, 1957, Serial No. 633,672

5 Claims. (Cl. 310—154)

This invention relates to the provision of an alternating current generator in a rotating machine such as an axial flow compressor.

An axial flow compressor ordinarily contains a number of stages of which each stage comprises a circumferential row of rotating blades which may be employed as inductor elements in an alternating current generator of the inductor type. By virtue of the invention, minor modifications to the compressor provide a source of alternating current which may be used for any desired purpose, including heating the compressor inlet to prevent ice formation therein.

The principal object of the invention is to provide a simple alternating current generator which may readily be incorporated in axial flow compressors.

The nature of the invention and the advantages thereof will be more clearly apparent from the succeeding detailed description of the preferred embodiment of the invention and the accompanying drawings, in which:

Figure 1 is an elevation view of a turbo jet engine.

Figure 2 is a sectional view of the inlet portion of the compressor thereof taken on a plane containing the axis of the compressor.

Figure 3 is an enlarged view of a portion of Figure 2.

Figure 4 is a cross-sectional view of the compressor taken substantially on the plane indicated by the line 4—4 in Figure 2.

Figure 5 is an enlarged elevation view of a portion of the compressor case showing the generator field elements.

Referring first to Figure 1, there is shown a jet engine of known type comprising an air inlet 10, a compressor 11, a diffuser 12, combustion chambers 13, a turbine 14, and an exhaust cone 15 discharging into an exhaust duct 17. A generator field 18 comprising a number of circumferentially distributed field elements 19 is disposed at the forward or inlet end of the compressor.

The invention is described as incorporated in a compressor of known type which is described in U. S. Patent 2,548,886. The compressor comprises a magnesium case 21 within which are mounted stator vanes 22. The rotor comprises a number of disks 23, 23' on each of which a row of blades 24, 24' are mounted. The wheels are mounted on a shaft 26 and are separated by spacer rings 27. The first row of stationary vanes, the inlet guide vanes 28, are mounted on the air inlet 10. A labyrinth seal 29 is provided between the rotor and stator at the inlet.

The electrical generator comprises the field 18 made up of the ring of field elements 19 and the first stage blades 24 which act as inductors. The blades 24 rotate in the direction indicated by the arrow in Figure 4. The direction of rotation is immaterial to the operation of the generator. Each field element comprises a forward pole 31 and a rearward pole 32. All of the forward poles are of the same polarity, which we may assume to be north. The poles are of laminated silicon steel cast into the magnesium case. Each north pole comprises a tip 33 and each south pole comprises a tip 34, which tips are of

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greater extent axially of the compressor than the remainder of the pole. As will be seen most clearly from Figure 5, the forward edge of the north pole overlies the leading edge of the blades and the rearward edge of the south pole overlies the trailing edge. The south pole tip 34 is slightly larger axially of the compressor than the north pole tip so that the faces of both poles both overlie equal areas of the blade tip. An effective gap 36 is left between the pole tips.

Windings 37 on bobbins 38 are dropped over the portions of the poles extending from the case. The windings are held in place by, and magnetic flux is provided by permanent magnets 39, preferably of Alnico, inserted between the outer ends of the poles and retained in any suitable way.

It will be noted that the length of the poles in the direction circumferentially of the compressor substantially equals the circumferential width, or distance between the leading and trailing edges, of the blade tip as shown clearly in Figure 5.

The alternator operates in known manner. Passage of the blade tips past poles 33, 34 varies the permeance of the magnetic circuit through parts 39, 31, 24 and 32, and thereby varies the magnetic flux. This variation in flux induces alternating E. M. F. in the coils 37, the frequency of which will be equal to the number of blades passing each generator element per second. In a typical compressor, the frequency will be rather high. For example, with 56 blades in a row at 6,000 R. P. M. the frequency will be 5,600 cycles per second. The coils 37 may be connected all in series, all in parallel, or in series parallel depending upon the output voltage and current relationship desired.

The fact that the circumferential width of the pole tips is equal to the full circumferential width of the blade tip provides the maximum possible permeance between the blade tip and the pole faces. Since the axes of the magnets are parallel to the axis of the compressor and the north pole is immediately ahead of the south pole, the rate of change of permeance between the blade tips and the pole faces stays as constant as possible during the period when the blade is entering into and departing from the position of maximum permeance. This reduces the tangential force exerted on the rotor blades by the field poles to a minimum and thus minimizes the amplitude of any vibration induced in the blades by the magnetic forces.

The capacity of the generator is limited primarily by the area of the blade tips which, with the typical thin section compressor blades illustrated, is quite small. An increase in capacity may be realized by utilizing thicker blades or blades with a tip of enlarged cross-section.

The eddy currents reduced in the blade by the magnetic field tend to heat the blades and thus reduce ice formation on them. The high frequency current developed by the generator may be supplied to coils which heat the compressor inlet to prevent ice formation. It may also be used for any other purpose either at the high frequency or after rectification.

Among the advantages of this generator are the fact that it utilizes the existing compressor frame, bearings, and rotating parts, thus requiring no such new parts for the generator, and no drive gearing from the compressor rotor.

The detailed description of the preferred embodiment of the invention for the purposes of explaining the principles thereof should not be considered as limiting the invention, as many modifications may be made by the exercise of skill in the art.

We claim:

1. In combination, a compressor including a case and a rotor having a row of circumferentially spaced blades

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extending therefrom; and means providing an inductor-type alternator comprising a number of generator field elements on the compressor case aligned with the row of blades; each field element comprising first and second poles having faces adjacent the tips of the blades, means between the first and second poles to create a magnetic field through the poles and blade tips, and generator coils coupled to the magnetic field.

2. In combination, a compressor including a case and a rotor having a row of circumferentially spaced blades extending therefrom; and an inductor-type alternator comprising a number of generator field elements on the compressor case aligned with the row of blades, there being one generator field element for each blade of the said row; each field element comprising a first pole having a face adjacent the leading portion of the tips of the blades, a second pole having a face adjacent the trailing edge portion of the tips of the blades, means to create a magnetic field through the poles and blade tips, and generator coils coupled to the magnetic field.

3. In combination, a compressor including a case and a rotor having a row of circumferentially spaced blades extending therefrom; and an inductor-type alternator comprising a number of generator field elements on the compressor case aligned with the row of blades, there being one generator field element for each blade of the said row; each field element comprising a first pole having a face adjacent the leading portion of the tips of the blades, a second pole having a face adjacent the trailing edge portion of the tips of the blades, a permanent magnet mounted between the first and second poles to create a magnetic field through the poles and blade tips, and generator coils coupled to the magnetic field.

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4. In combination, a compressor including a case and a rotor having a row of circumferentially spaced blades extending therefrom; and an inductor-type alternator comprising a number of generator field elements on the compressor case aligned with the row of blades, there being one generator field element for each blade of the said row; each field element comprising a first pole having a face adjacent the leading portion of the tips of the blades, a second pole having a face adjacent the trailing edge portion of the tips of the blades, means to create a magnetic field through the poles and blade tips, and generator coils coupled to the magnetic field, the blade tips being skewed relative to the axis of the case, and the poles of each element being aligned axially of the case.

5. In combination, a compressor including a case and a rotor having a row of circumferentially spaced blades extending therefrom; and an inductor-type alternator comprising a number of generator field elements on the compressor case aligned with the row of blades, there being one generator field element for each blade of the said row; each field element comprising a first pole having a face adjacent the leading portion of the tips of the blades, a second pole having a face adjacent the trailing edge portion of the tips of the blades, means to create a magnetic field through the poles and blade tips, and generator coils coupled to the magnetic field, the pole faces extending circumferentially of the case a distance approximately equal to the circumferential width of the blades, and the poles of each element being aligned axially of the case.

No references cited.