May 22, 1956 P. P. NEWCOMB 2,746,671

COMPRESSOR DEICING AND THRUST BALANCING ARRANGEMENT

Filed April 14, 1950

FIG. 1

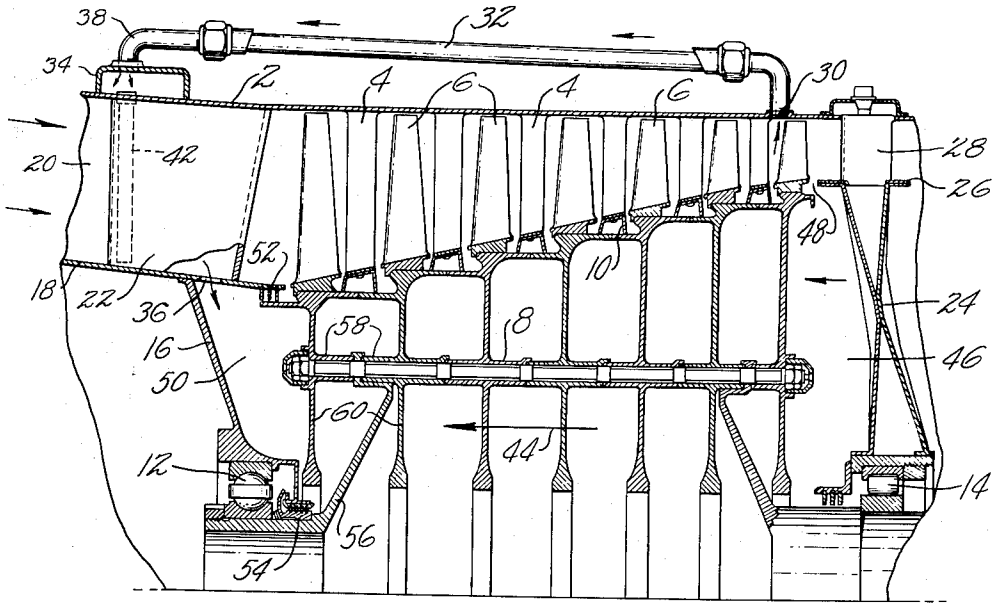
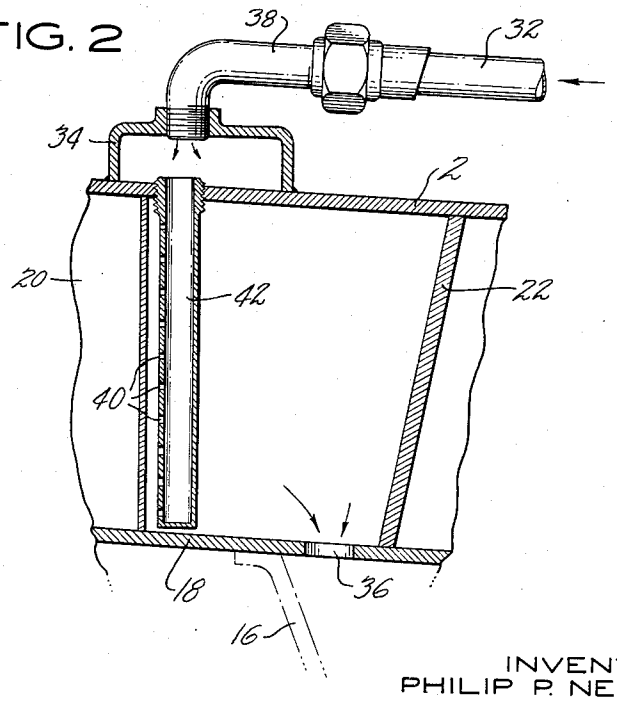


FIG. 2



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United States Patent Office 2,746,671 Patented May 22, 1956

2,746,671

COMPRESSOR DEICING AND THRUST BALANCING ARRANGEMENT

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Application April 14, 1950, Serial No. 155,835

2 Claims. (Cl. 230—120)

This invention relates to axial flow compressors and particularly to an arrangement for minimizing icing at the compressor inlet.

When the compressor is operating under conditions that will produce icing, the collection of ice at the compressor inlet can quickly cause serious restriction of the airflow and in the case of a compressor forming a part of a gas turbine power plant the restricted flow may result in an overheated turbine or the loss of so much power that the power plant will not continue to operate. Prior to my invention, air has been bled from the compressor after it has been compressed and heated, and this air has been discharged directly into the compressor inlet air. This arrangement requires that all of the entering air be heated thereby reducing the compressor efficiency by raising the inlet air temperature. A feature of this invention is the localized heating of the inlet ends of the struts or guide vanes at the compressor inlet by compressed air bled into the vanes from the compressor thereby minimizing the amount that the inlet air is heated and at the same time applying the heat where it is the most effective.

The compressed air which has been used for heating the guide vanes may be disposed of by bleeding it into the airstream and into the compressor since its pressure is considerably higher than the inlet air surrounding the vanes. A feature of this invention, however, is the use of the compressed air in counter-balancing the axial thrust on the compressor rotor by discharging the air from the vanes into a chamber one wall of which is formed by the inlet end of the rotor.

Other objects and advantages will be apparent from the specification and claims, and from the accompanying drawings which illustrate an embodiment of the invention.

Fig. 1 is a longitudinal sectional view through the compressor.

Fig. 2 is a fragmentary sectional view on a larger scale showing the flow of the air against the inner surface of the guide vane.

Referring to Fig. 1 the compressor has a casing **2** supporting spaced rows of stator vanes **4** which alternate with radially extending rows of compressor blades **6** carried by the rotor **8**. The inner ends of the stator vanes carry seals **10** which cooperate with parts of the rotor to prevent leakage of air around the ends of the vanes.

The rotor is supported in predetermined relation to the casing by bearings **12** and **14** at the inlet and discharge ends of the compressor. The bearing **12** is supported by supporting means in the form of a diaphragm **16** extending inwardly from the inner wall **18** of the air inlet passage **20**. Inlet guide vanes or supporting struts **22** extend transversely of the passage **20** and it is on these vanes that the formation of ice first occurs.

At the downstream end of the compressor the bearing **14** is supported by diaphragm **24** which extends inwardly from a ring **26** supported by a series of vanes **28**. The outer ends of the vanes **28** are supported in a part of the casing **2**.

Air from a point adjacent the high pressure end of the compressor is withdrawn through a port **30** and delivered through a duct **32** to the hollow inlet guide vanes **22**. It will be understood that a manifold ring **34** extending around the compressor casing forms an annular passage around the compressor for distributing the high pressure air which has been heated during the compression process to the several inlet guide vanes. The hot air entering these vanes raises the temperature of the vanes enough to melt the ice as it forms on the vanes or may in certain instances keep the vanes at such a temperature that the ice will not begin to form. Air escapes from the vanes through passages **36**.

Referring now to Fig. 2, the thickest icing generally occurs on the leading edges of the guide vanes and accordingly the hot air entering the guide vane through a pipe **38** communicating with the manifold **34** is blown against the inside surface of the guide vane at its leading edge by radially arranged openings **40** in a tube **42** supported by the casing and positioned radially within the vane. With this arrangement the hottest part of the guide vane is the leading edge where icing occurs most rapidly although the remainder of the vane is warmed by the warmed air within the vane as it flows away from the leading edge. It will be understood that if icing occurs most rapidly on another part of the vane, the tube would be so located as to flow the hot air against this part.

The loads on the rows of compressor blades **6** develop an axial thrust on the rotor in the direction of the arrow **44**, Fig. 1, and this thrust is also increased by the pressure loading on the downstream end of the compressor rotor in the chamber **46** since high pressure air from the compressor leaks directly into this chamber through the space **48** between the rotor and the ring **26**. This thrust may be counterbalanced at least in part by causing the air escaping from the vanes **22** to be discharged into a chamber **50** at the inlet or upstream end of the compressor rotor. This chamber is defined, as shown, by the diaphragm **16**, a part of the inner wall **18** and the upstream end of the compressor rotor. The end wall of the rotor consists of the portion of the first rotor disc **60** outwardly from the spacing flange **58**, to the seal **52**, the flange **58** on the inside of the first rotor disc and the end bell **56**. The space between the end of the inner wall **18** and the rotor is closed by a plurality of seals **52** and another seal **54** closes the space between the rotor and the diaphragm **16** at its inner end to limit the leakage of air at this point. The pressure is thus contained within the chamber **50** except for such leakage that occurs at the seals. The leakage at the seals **52** may be controlled as by selecting the spacing of the fins forming part of the seal from the adjacent sealing surface, so as to permit the necessary flow of air through the inlet vanes for preventing the accumulation of ice. It may be noted that air will not leak through the compressor since the end bell **56** forming a part of the rotor prevents the flow of air axially through the rotor. It will be understood that the spacing flange **58** between the outer edge of the end bell and the adjacent rotor disc **60**, that is, the first disc, forms a continuous annular ring concentric to the axis of the rotor thereby forming a complete enclosure for the chamber **50** at this point. Together, end bell **56**, flange **58**, and first disc **60** form a balance piston which is urged to the right by the pressure in chamber **50** to partially compensate for the axial thrust **44**.

It is to be understood that the invention is not limited to the specific embodiment herein illustrated and described, but may be used in other ways without departure from its spirit as defined by the following claims.

I claim:

1. An axial flow compressor including a casing having

means thereon forming an annular passage therewith, hollow inlet guide vanes extending from said casing and at least one stage of compression downstream of said vanes, in combination with means receiving air from said compressor and connected to said casing, said last means communicating with said passage for discharging into said passage a portion of the compressed air from the compressor, a tube positioned within and surrounded by each hollow vane and communicating with the passage to receive air therefrom, said tube having openings therein for directing fluid from said tube against a selected portion of the inner surface of the surrounding hollow vane, and means venting each of said vanes.

2. An axial flow compressor including a casing having means thereon forming an annular passage therewith, hollow inlet guide vanes extending from said casing and at least one stage of compression downstream of said vanes, in combination with means receiving air from the compressor and connected to said casing, said last means communicating with said passage forming means for discharging into said passage a portion of the compressed air from the compressor, a tube positioned within and surrounded by each hollow vane and communicating with the passage to receive air therefrom, said tube having at least one row of forwardly directed openings

therein for directing fluid from said tube against the upstream end of the inner surface of the vanes, said tube extending substantially parallel to and in spaced relation to said upstream end of said inner surface, and means venting each of said vanes.

References Cited in the file of this patent

UNITED STATES PATENTS

2,333,053	Stroehlen	Oct. 26, 1943
2,429,681	Griffith	Oct. 28, 1947
2,441,135	Chalupa	May 11, 1948
2,446,663	Palmatier	Aug. 10, 1948
2,462,600	Boestad et al.	Feb. 22, 1949
2,469,375	Flagle	May 10, 1949
2,474,068	Sammons et al.	June 21, 1949
2,474,258	Kroon	June 28, 1949
2,477,798	Griffith	Aug. 2, 1949
2,599,470	Meyer	June 3, 1952

FOREIGN PATENTS

237,475	Switzerland	Sept. 1, 1945
619,390	Great Britain	Mar. 8, 1949
629,044	Great Britain	Sept. 9, 1949
897,709	France	June 5, 1944