June 13, 1961 J. W. HUGHES **2,988,266**

SELF-COOLED RADIAL ROTOR

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FIG. 1

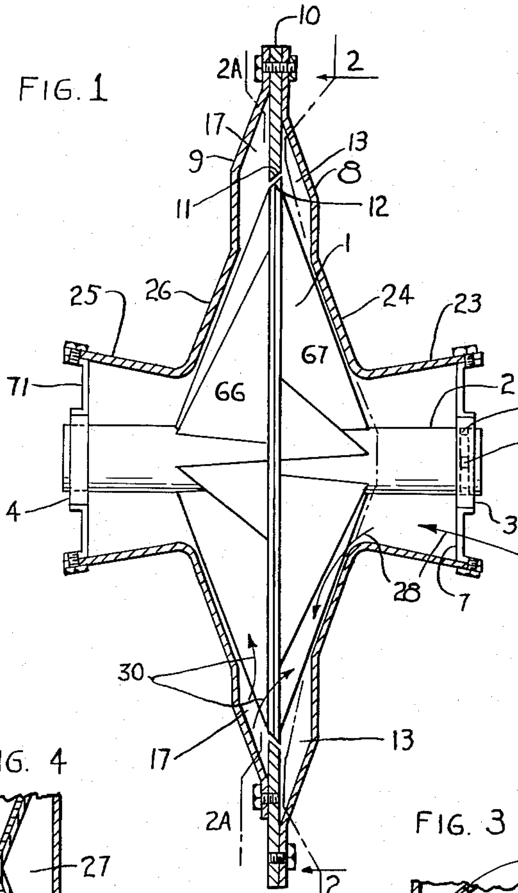


FIG. 5

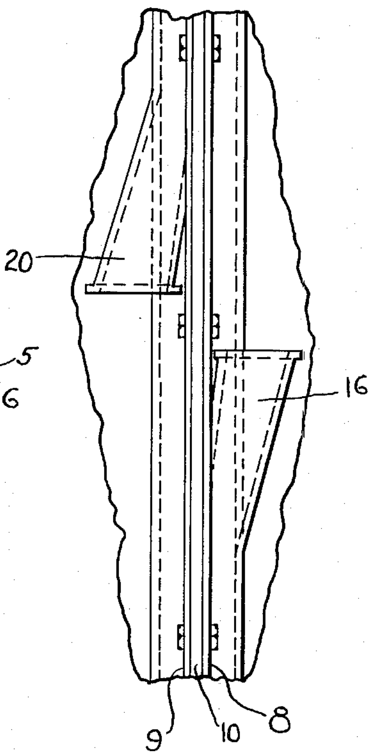


FIG. 4

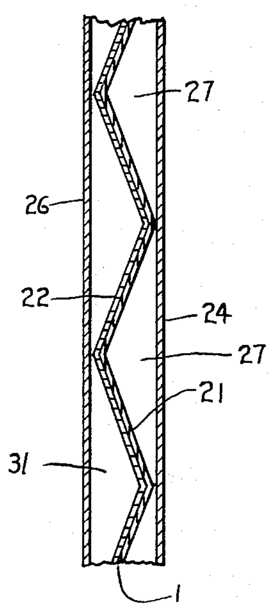
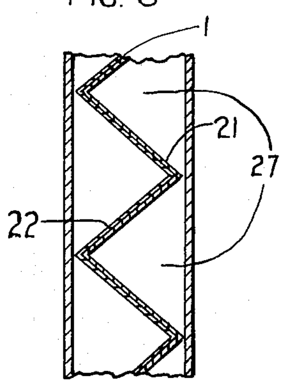


FIG. 3



John Wesley Hughes
INVENTOR

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FIG. 2

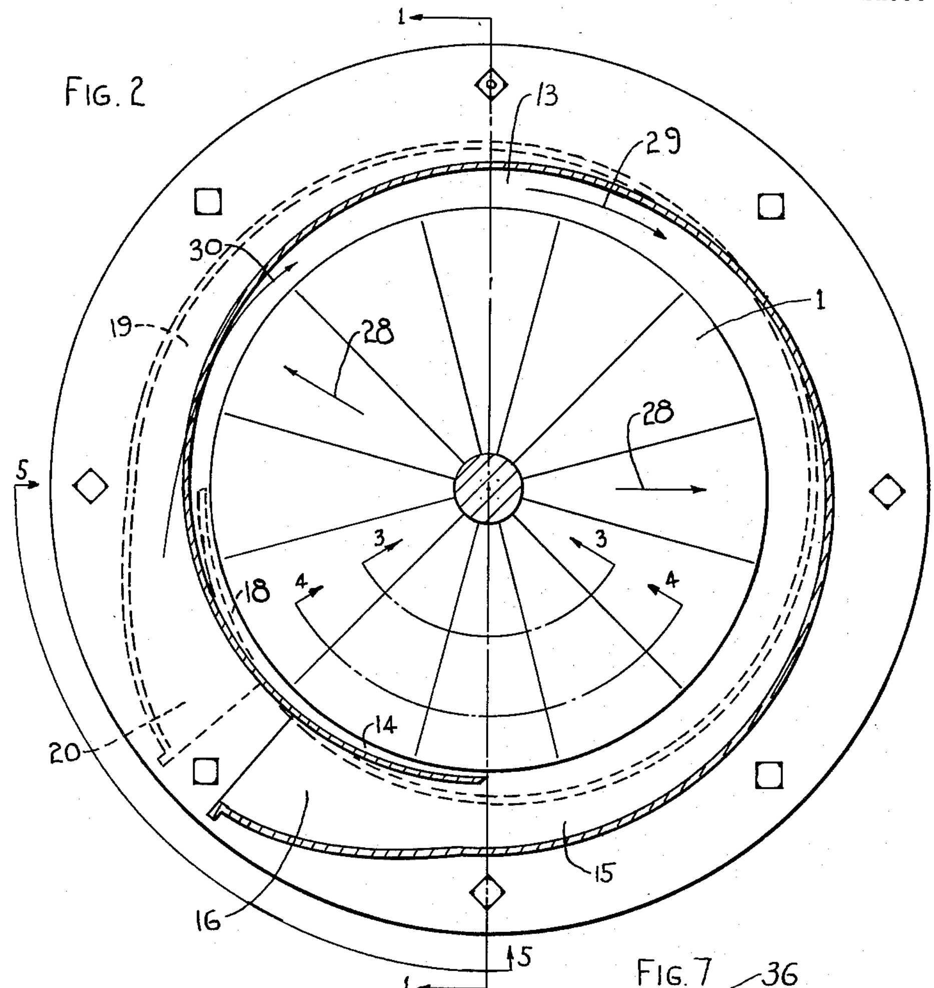


FIG. 6

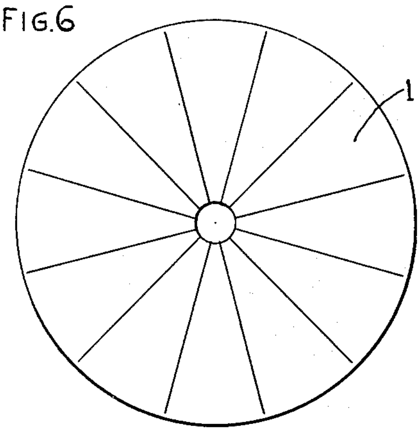
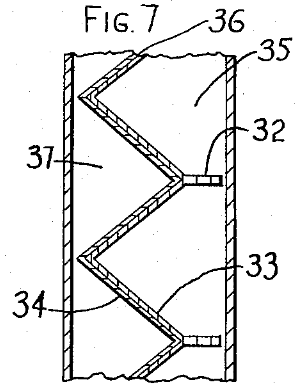


FIG. 7



John Wesley Hughes
INVENTOR

United States Patent Office

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2,988,266
SELF-COOLED RADIAL ROTOR

John Wesley Hughes, Rte. 1, Box 92, Jamestown, N.C.

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5 Claims. (Cl. 230—116)

This invention relates to means for cooling the blades of the rotors in radial fluid machines that are exposed to the action of hot fluids. Especially, it relates to means for cooling these blades where heat is a limiting factor. It is the prime objective of this invention to have the fluid that is cooling the aforementioned blades to be undergoing an essential acceleration at the same time that it is cooling the blades. In this manner, efficiency will be increased by the elimination of a cooling system whose mere function is to cool, while at the same time retaining the advantages of a cooling system.

Accordingly, I form the blades that are exposed to the action of the hot fluids in a manner such that their interiors are hollow and open to the back side, the back side being another radial fluid machine. Thus, the interiors of the hot blades function as passageways while cooling said blades.

These radial fluid machines are of three types: double turbine, turbine-compressor, and double compressor. To facilitate understanding, the embodiments shown are the combination turbine-compressor to show inward and outward flow in the same embodiment. The most familiar turbine-compressor is the gas turbine, and the specific embodiments illustrated are of this type. It is also in the gas turbine that heating is almost invariably critical.

The details of two embodiments of this invention are illustrated by the accompanying drawings, in which

FIGURE 1 is a side elevation of a preferred embodiment of the invention with associated casing cut away on line 1—1 of FIGURE 2;

FIGURE 2 is a section on line 2—2 of FIGURE 1;

FIGURE 3 is a circular section on line 3—3 of FIGURE 2;

FIGURE 4 is a circular section on line 4—4 of FIGURE 2;

FIGURE 5 is an elevational view along line 5—5 of FIGURE 2;

FIGURE 6 is a side view of the rotor by itself;

FIGURE 7 is a circular section of a modification.

Referring to FIGURE 1, the rotor **1** is shown together with auxiliary components to form a two-sided turbine-compressor. The turbine is indicated generally by the number **66**, and the compressor is indicated generally by the number **67**. The turbine side will hereafter be called the front side and the compressor side the back side. When the term gas turbine-compressor is used, reference is made to the entire machine. When the more specific terms of turbine or compressor are used, reference is made to the single section. The rotor **1** is fixed on a shaft **2** which rotates in bearings **3** and **4** in a clockwise direction with reference to FIGURE 2. The shaft **2** has a groove **5** in it. A rectangular pin **6** extends through the bearing **3** and into the groove **5**, preventing lateral motion. The bearings **3** and **4** are supported by arms **7** and **71** which are attached to the back casing **8** and the front casing **9**. Both casings are secured to a dividing plate **10** whose inside edge **11** is beveled to match the corresponding bevel of the rotor's outside edge or rim **12**, these bevels serving as a labyrinth impeding fluid flow from one side to another.

The back casing **8** is composed of an inlet section **23** and a back rotor cover **24**. The back casing **8** is so constructed that a back spiral passageway **13** is created near the outside of the rotor **1**. Referring to FIGURE 2, the back spiral passageway **13** increases in cross-sectional area, as it proceeds in a clockwise direction, from a very small width at **14** to a relatively large width at **15**. Continuing in a clockwise direction, the back spiral passageway **13** connects to an expanding orifice **16**.

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The front casing **9** is composed of an outlet section **25** and a front rotor cover **26**. The front casing **9** is so constructed that a front spiral passageway **17** is created near the outside of the rotor **1**. Again with reference to FIGURE 2, the front spiral passageway **17** increases in cross-sectional area, as it proceeds in a counter-clockwise direction, from a small width at **18** to a relatively large width at **19**. The width of the front spiral passageway **17** is shown in FIGURE 2 by the space between the rotor **1** and the dotted lines which represents where section line *2a*—*2a* crosses the front casing **9** in FIGURE 1. Continuing from **19** in a counterclockwise direction, the front spiral passageway **17** connects to a contracting inlet **20**.

The zigzag construction of the rotor **1** is shown in FIGURES 3 and 4. It consists of a metallic or strength element **21** and a heat insulator **22** that is bonded to it. Near the shaft **2** the rotor **1** sharply zigzags, as FIGURE 3 shows; as it proceeds radially outward the amount of zigzag decreases, as shown in FIGURE 4, until at the outside edge **12** the rotor **1** is substantially flat. Thus an effective blading is produced on both sides of the rotor **1** by the zigzagging.

The operation proceeds as follows: Air from the atmosphere is drawn in between the arms **7** through the inlet section **23** of the back casing **8**. The air then proceeds radially away from the shaft **2** through the back interstices **27** in the rotor **1**, as shown by arrows **28**. Here the air is accelerated in a clockwise direction by the rotation of the rotor **1**. The air, which is relatively cool at this point, flows over the metallic element **21** of the rotor **1** and cools it. The air then flows into the back spiral passageway **13**, where it proceeds along toward the expanding orifice **16**, as shown by arrow **29**. In the back spiral passageway **13** the air is in a slightly compressed condition. The air then proceeds through the expanding orifice **16** where it is further compressed by having part of its velocity energy converted into pressure energy.

The compressed air is then taken from the expanding orifice **16**, by means not shown, and heated. One suitable means is a combustion chamber. Another is a gas engine, in which case the gas turbine functions as a turbo-supercharger.

The heated and compressed gas is fed into the contracting inlet **20** from the heating means, by means not shown, where it is allowed to expand while gaining in velocity and decreasing in pressure. Then it travels around the contracting spiral of the front spiral passageway **17**, as shown by arrow **30**. The gas is forced to travel in toward the shaft **2**, as shown by the arrows **50**, in the front interstices **31** between the zigzags due to the contracting spiral; the hot gas, however, is kept physically separated from the cool air by the rotor **1**. As it travels in toward the shaft **2** the hot gas decelerates in a clockwise direction and gives up its energy to the rotor **1**. Although the gas at this point in the cycle is hot and would tend to weaken the metallic element **21** of the rotor **1** by heating it, the heat insulator element **22** of the rotor **1** along with the flow of the cool air on the metallic side **21** of the rotor **1** will counteract the heating effect of the hot gases and will keep the rotor **1** in a temperature range where it retains more of its strength. The addition of the heat insulator element **22** to the rotor **1** gives a marked decrease in the temperature of the rotor, because the relatively small amount of heat that does pass through the insulator has only a very short distance to travel across the narrow width of the metallic element 21 of the rotor before it is conducted away by the cool air.

After the gas travels past the rotor 1, it passes out through the outlet section 25 to the atmosphere or to additional stages of turbines of the present type or other types which are not shown. If the present type of turbine is used for some of the additional stages, the compression of the air can be effected in stages to cool the rotor at each stage. These additional stages can be conveniently located on an extension of the same shaft. The excess energy can be taken from the shaft in a manner best suited for the particular use, the methods being so diverse and well known that no attempt will be made to show them.

Figure 7 shows a variation wherein a fin 32 is added to the metallic part 33 of the rotor 36. The front side of the rotor is covered by a heat insulator 34 which protects it from the hot gases which flow in the interstices 37. The fin 32 increases the area 35 wherein the cool air flows. This has the advantage of allowing the rotor more easily to compress a larger volume of air.

Although the drawings in this patent make use of a zig-zag shape for the rotor, it is to be understood that the invention is not limited to this one illustrative type. On the contrary, the designer of an engine using the principles illustrated above is left considerable latitude by way of modifying the strict zig-zag shape to achieve better streamlining and aerodynamic efficiency or altering the volume that each side of the rotor can handle.

I claim:

1. In a radial gas turbine-compressor, a radial rotor with a front side and a back side, the front side functioning as a radial gas turbine rotor, the back side functioning as a radial compressor rotor, substantially radial blades on the front side and back side of the rotor, the blades on the front side being folded, forming passageways open on the back side of the rotor, said passageways beginning and ending on the back side of the rotor a circular dividing rim, near the periphery of the rotor, separating the sides.

2. In a radial gas turbine-compressor, a rotor, as defined in claim 1, which has the front face of the rotor and the front blades covered with a heat insulator.

3. In a radial gas turbine-compressor, a rotor with blades on the front and back thereof, the blades on the front being folded forming passageways in their interiors, the passageways being open on the back side, the passageways serving as a part of the compressor and as a cooler for the front blades, the interior of the blades being closed to the front side, so that the components of the turbine rotor that are subjected to the heat of the hot gas are cooled on their opposite side by the flow of cold gas in the compressor side, all the components of the rotor coming together near the periphery to form a dividing rim.

4. In a radial gas turbine-compressor, a rotor, as defined in claim 3, which has the front face of the rotor and the front blades covered with a heat insulator.

5. A combination radial gas turbine-compressor comprised of: a two-sided radial rotor with radial blades on both sides, one side functioning as an inward flow hot gas turbine rotor, the blades on the turbine side of the rotor being hollow, the hollow interiors of the blades being open only on the compressor side, so that the interiors of the turbine blades are cooled by the cool air from the compressor side, the two sides of the rotor separate from one another so that all of the rotor that faces on the turbine side is adjacent to the compressor side, the rotor coming together at its periphery to form a rim, a rotatable shaft that the rotor is mounted on, a two-sided casing enclosing the rotor, a dividing plate separating the two sides of the casing, said dividing plate being in proximity on its inner edge with the outer edge of the rim of the rotor and each side of the casing being equipped with suitable inlet and outlet passageways.

References Cited in the file of this patent

UNITED STATES PATENTS

833,482	Prindle	Oct. 16, 1906
1,445,310	Hall	Feb. 13, 1923
1,728,204	Falla	Sept. 17, 1929
2,304,259	Karrer	Dec. 8, 1942
2,447,292	Van Acker	Aug. 17, 1948
2,540,136	Oliphant	Feb. 6, 1951
2,911,138	Birmann	Nov. 3, 1959

FOREIGN PATENTS

12,912	Great Britain	of 1913
218,636	Switzerland	Apr. 1, 1942