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Exley

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[54] **CHANNEL DIFFUSER WITH SPLITTER VANES**

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[51] **Int. Cl.** **F04d 29/44,** F04d 21/00

[58] **Field of Search** 415/53, 181, 211

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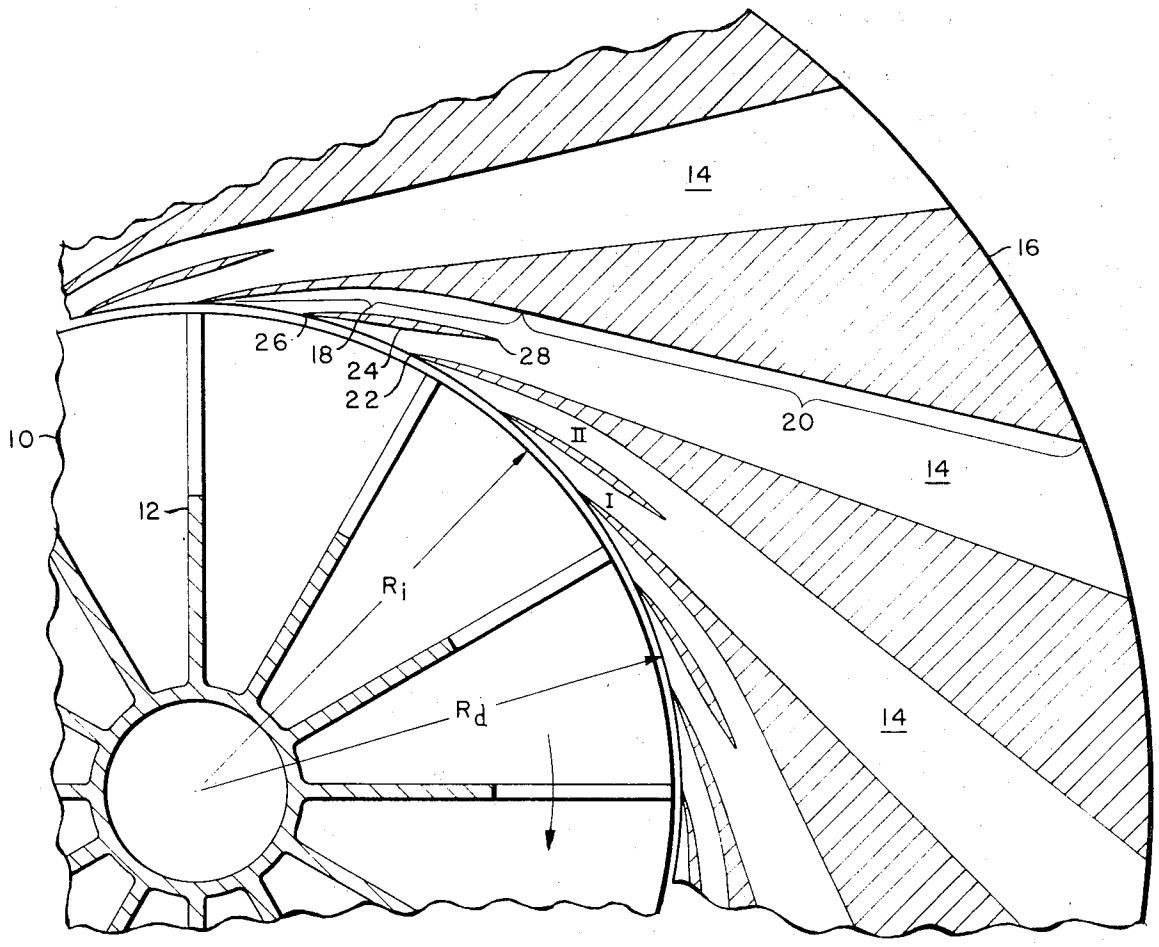
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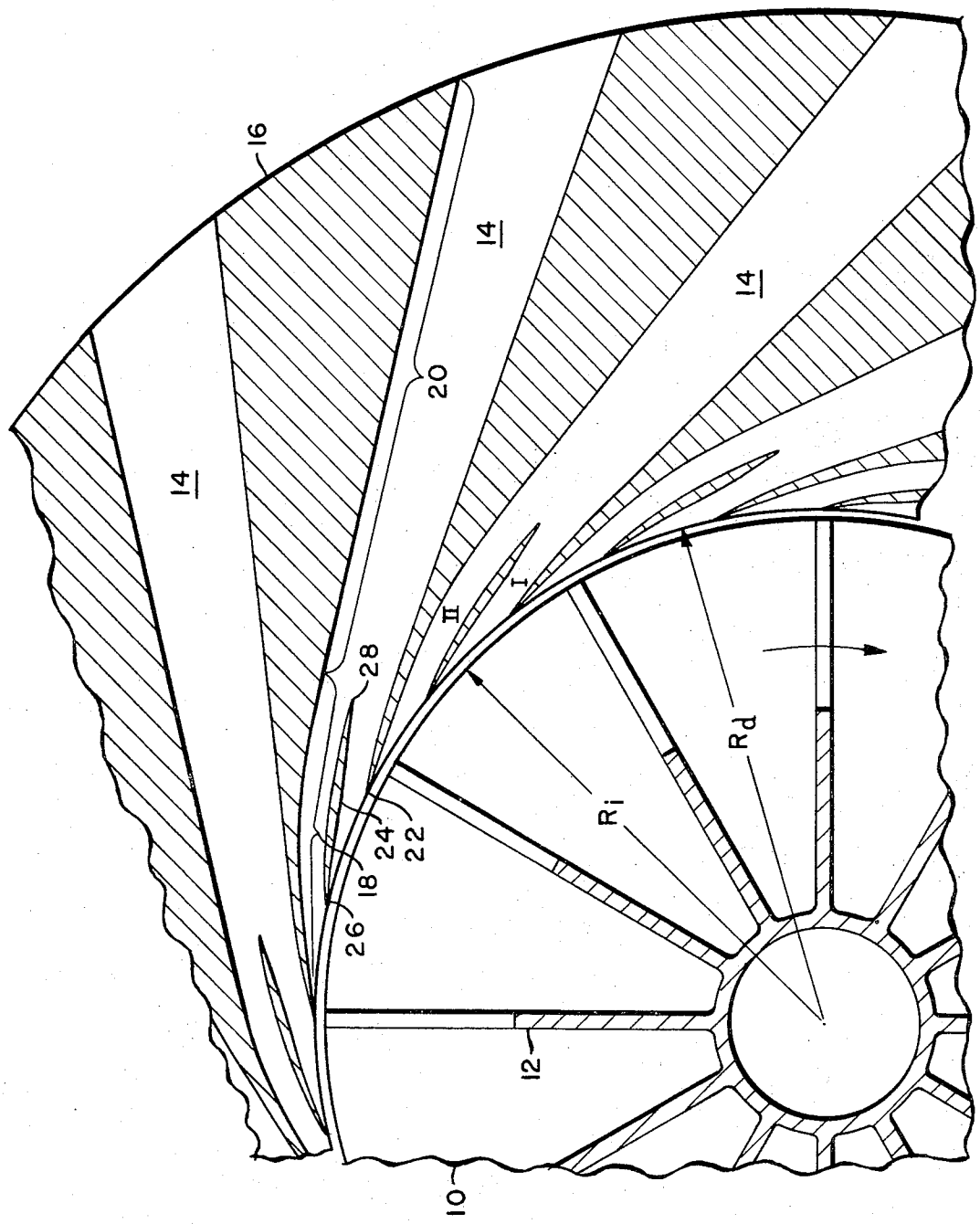
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[57] **ABSTRACT**

A centrifugal impeller discharges supersonic flow into a channel diffuser having a plurality of passages of rectangular cross section with leading edges closely adjacent the periphery of the impeller. A series of splitter vanes in the passage inlets have leading edges closely adjacent the periphery of the impeller and divide the inlet region into two separate passages through which the supersonic flow is shocked down to a subsonic level with an efficient pressure increase.

2 Claims, 1 Drawing Figure




16
14
14
14
20
II
I
28
24
22
18
26
12
10
R_i
R_d

CHANNEL DIFFUSER WITH SPLITTER VANES

The present invention relates to diffusers for centrifugal compressors and more particularly to diffusers adapted to receive supersonic flow.

In the supersonic centrifugal compressor art it is a common object to provide a diffuser that efficiently shocks down supersonic flow from the periphery of the impeller to a subsonic level so that its pressure can be increased by subsonic diffusion passages in the outlet portion of the diffuser.

Therefore it is an object of the present invention to provide a diffuser for a centrifugal impeller which can effectively and efficiently handle supersonic flow discharged from an impeller.

These ends are achieved by a diffuser having a series of passages intersecting at their inlet regions to form leading edges closely adjacent the periphery of a centrifugal impeller. A splitter vane, or vanes, is positioned in the inlet region for each passage, the splitter vane having a leading edge also disposed closely adjacent the periphery of the impeller to divide the inlet region of each passage into two or more flow paths.

The above and other related objects and features of the present invention will be apparent from a reading of the description of the disclosure shown in the accompanying drawing and the novelty thereof pointed out in the appended claims.

The single FIGURE illustrates a centrifugal compressor having a diffuser which embodies the present invention.

Referring to the drawing, there is shown a centrifugal impeller **10** having a series of radially extending vanes **12.** The impeller has a suitable inlet region for entry of air adjacent its axis of rotation. Rotation of the impeller accelerates and diffuses the air so that it is discharged at a supersonic velocity from the periphery of the impeller.

From there the air is discharged into a series of diffuser passages **14** formed in an annular housing **16** surrounding the periphery of the impeller. The various diffuser passages are shown herein as being formed in a solid housing **16.** However, it should be apparent to those skilled in the art as the discussion proceeds that the diffuser passages may be formed from sheet wall members to produce the appropriate shape for the diffuser passage.

Each of the passages **14** have inlet regions **18** closely adjacent the periphery of impeller **10** and a downstream subsonic diffusion region **20.** The passages extend generally tangentially with respect to the impeller **10** and they intersect one another to form a series of leading edges **22** at a predetermined distance closely adjacent the periphery of the impeller **10.** As herein shown, the passages **14** are rectangular in cross section so that the leading edges **22** are straight and are normal to the gas flow emanating from the centrifugal impeller.

At least one splitter vane **24** is positioned in each of the inlet regions of the passages **18.** As is apparent to those skilled in the art, additional splitter vanes may be employed in each inlet region to divide it into more than two flow paths. The splitter vane has a straight leading edge **26** positioned at the same predetermined distance closely adjacent the periphery of the impeller **10** as the leading edges **22** of the passage **14.** The splitter vanes **24** have a trailing edge **28** positioned generally in the inlet region **18** of the passage **14.**

The splitter vane **24** is positioned in the inlet regions **18** of the passages **14** and shaped so that it provides a pair of passages having substantially the same divergence to produce substantially equal velocities at the trailing edge **28** of the vane **24.** The splitter vane has a relatively sharp leading edge and has a thin cross section to avoid Mach number and shock losses.

In operation the air enters the inlet regions **18** of the passages **14** at a supersonic level generally between Mach 1 and Mach 1.2. The leading edges **22** of the passages **14** and the leading edges **26** of the splitter vanes **24** induce shock waves closely adjacent the periphery of the impeller **10** so that the process of shocking down begins immediately to minimize the losses associated with supersonic flow. The air in the inlet region **18** on both sides of the splitter vane **24** passes through a shock wave system in which its velocity is reduced to a level below sonic and its pressure increased. Since the splitter vanes form passages of equal divergence, the velocity of the air passing from the trailing edge **28** of the splitter vane **24** has substantially the same velocity. The subsonic diffusion region **20** has a substantially diverging cross-sectional area to greatly increase the static pressure level of the gas and reduce its velocity.

As mentioned previously, both the leading edges **26** of the splitter vanes and the leading edges **22** of the passages **14** are positioned at predetermined distances closely adjacent the periphery of the impeller **10.** An example of a distance which is particularly suited for this application is where the leading edges defining the inlet to the diffuser are positioned at a distance R_d from the center of rotation of the impeller that is approximately 1.02 times the radius of the impeller R_i. The splitter vanes divide the inlet regions of the passages into a pair, or more, of passages having substantially equal divergence. A typical example of such a configuration would be an area ratio (that is, the ratio between the upstream and downstream cross-sectional area of the passages) of 1.200 for channel I and an area ratio of 1.267 for channel II. It should be apparent to those skilled in the art that other ratios may be selected to give optimum performance for a given application.

The use of the splitter vanes enables a highly efficient transition from supersonic to subsonic flow. They increase the number of leading edges closely adjacent the periphery of the impeller to induce shock wave systems as quickly as possible. Since the splitter vanes extend for only a short distance in the inlet region, the losses normally associated with an equivalent diffuser having the same number of inlet edges are eliminated.

While the preferred embodiment of the present invention has been described, it should be apparent to those skilled in the art that other modifications may be performed without departing from its spirit and scope.

Accordingly, what is claimed as novel and desired to be secured by Letters Patent of the United States is:

1. A diffuser for a centrifugal impeller capable of discharging air at a supersonic velocity, said diffuser comprising:

means for forming a plurality of passages generally tangent to the periphery of said impeller, said passages having rectangular cross-sectional shapes and intersecting one another at their inlet ends closely adjacent the periphery of said impeller to form a series of substantially straight leading edges disposed normal to the flow from said impeller and at a predetermined distance closely adjacent the pe-

riphery of said impeller, each of said passages having an inlet region adjacent said impeller and a downstream subsonic region forming a diverging cross-sectional area;

at least one thin splitter vane positioned in the inlet region of each one of said passages, said splitter vane having a relatively sharp, substantially straight leading edge disposed at said predetermined distance from the periphery of said impeller and having a predetermined shape for dividing the inlet regions of each passage into at least two flow paths having substantially the same divergence to produce substantially equal velocities of the flow on both sides of the trailing edge of the splitter vane.

2. A diffuser as in claim **1** wherein said predetermined distance from the periphery of said impeller is approximately 1.02 times the radius of the periphery of said impeller.

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