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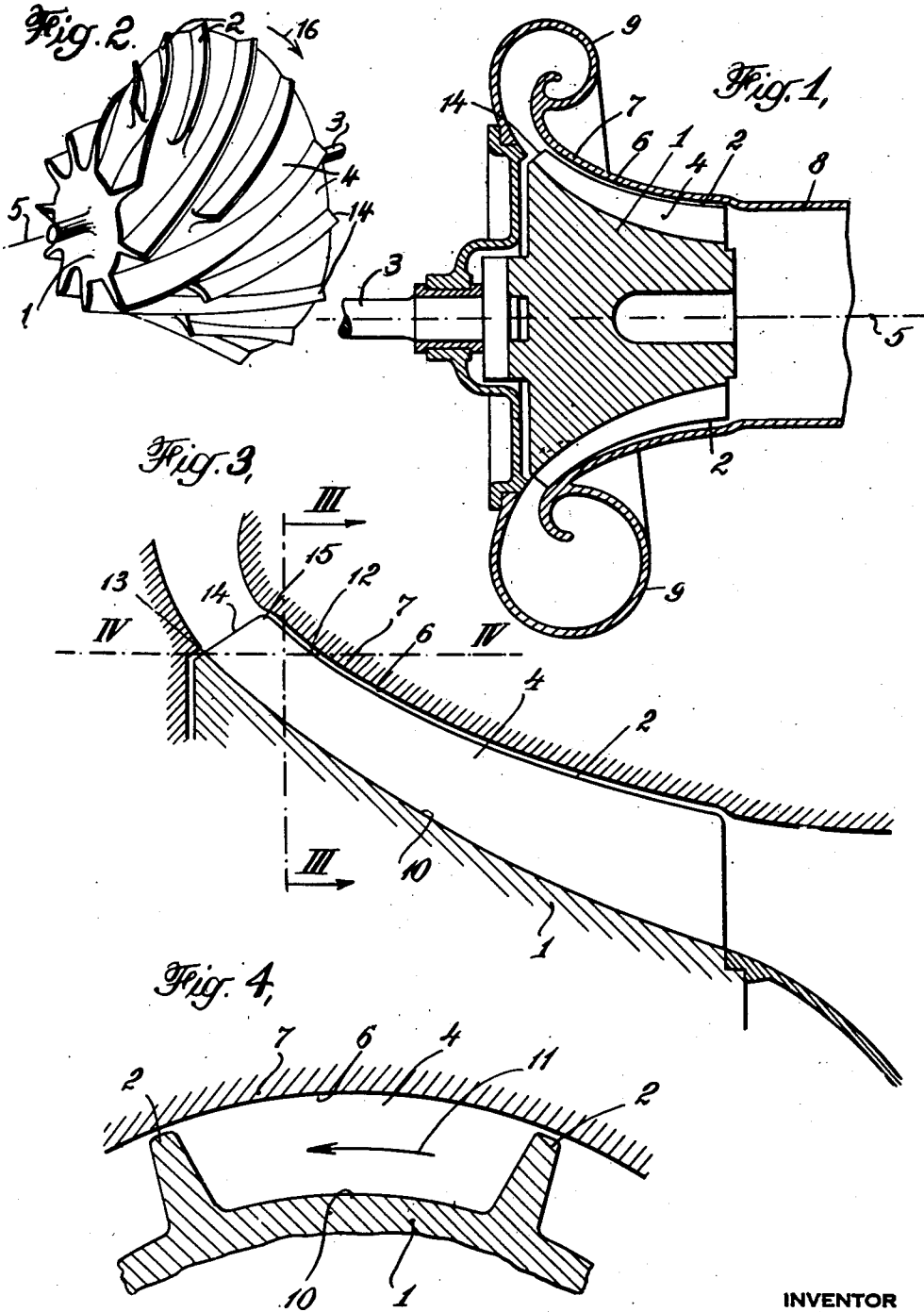
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2,465,625

CENTRIFUGAL COMPRESSOR

Filed Aug. 10, 1944

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

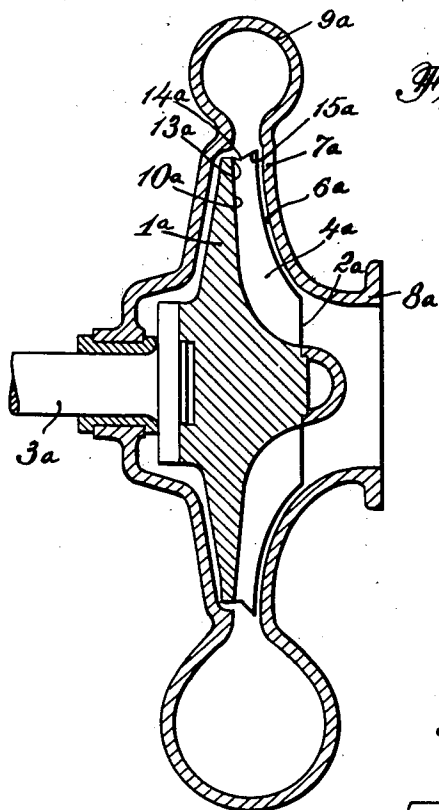


Fig. 5,

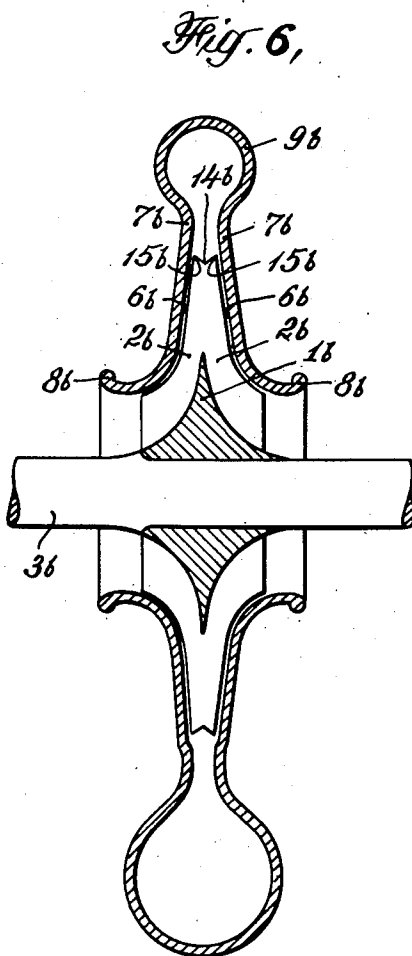


Fig. 6,

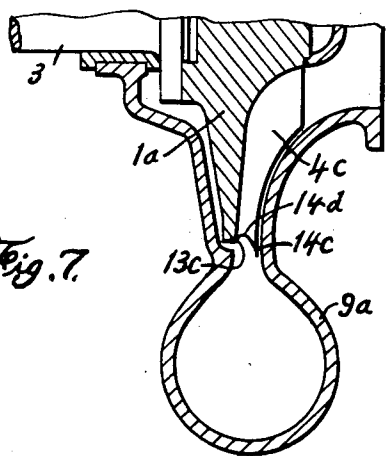


Fig. 7.

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CENTRIFUGAL COMPRESSOR

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4 Claims. (Cl. 230—127)

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The invention relates to a centrifugal compressor in which the passages through the impeller are bounded at least on one side directly by the wall of the fixed casing without the intermediary of a covering plate.

The invention is characterized in that the part of the blade outlet edge which lies in the flow disturbed by the stationary wall of the casing has a greater radius of rotation than the part lying in the undisturbed flow, and by this means the end is attained that the disturbed flow, on account of the increased supply of energy, leaves the impeller with at least approximately the same energy as the undisturbed flow.

If the flow passages of the impeller are arranged so as to be oblique to the impeller axis, it is advisable to give the blade outlet edge a direction which is inclined relative to the impeller axis, so that this edge has a greater radius of rotation in the neighborhood of the stationary wall of the casing than in the neighborhood of the rotating surface of the impeller body. For compressors in which only one side of a flow passage is directly bounded by the stationary casing wall, while the other side is bounded by the surface of the impeller body, it may be preferable to give the blade outlet edge in the neighborhood of the surface of the impeller body and in the neighborhood of the stationary casing wall a greater radius of rotation than in the middle region of the edge in which the undisturbed flow emerges. In centrifugal compressors whose impellers have double blades which are bounded on both sides directly by the wall of the stationary casing without the intermediary of a covering plate, the outlet edge may to advantage have a greater radius of rotation in the parts adjacent to the stationary wall of the casing than in the middle region where the undisturbed flow emerges.

The accompanying drawings illustrate apparatus embodying the invention, in which:

Fig. 1 shows a longitudinal section through one example of execution.

Fig. 2 shows the impeller in perspective.

Fig. 3 shows the development in one plane of a flow passage in the impeller of the compressor according to Fig. 1.

Fig. 4 shows a cross-section to a larger scale on the line III—III of Fig. 3.

Figs. 5 and 6 are sectional views of other modifications of the invention, and Fig. 7 is a fragmentary sectional view of still another modification of the invention.

The compressor (Figs. 1-4) has an impeller 1,

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which is formed in one piece with the blades 2 by forging and milling and is mounted overhung on the shaft 3. The flow passages 4 of the impeller, formed by the blades, are arranged inclined to the axis 5 of the impeller. On the outer side they have no covering plate, and lie therefore direct on the stationary wall 6 of the casing 7, whilst on the inner side they are bounded by the surface 10 of the impeller body. Air or another gas or a vapour is drawn out of the passage 8 and led in a compressed state through the passage 9.

The energy which is imparted to the medium to be compressed through the impeller, is not equally great for all parts of a cylindrical section (for instance IV—IV) in spite of the fact that all parts have the same peripheral speed. The flow passages 4 of the impeller turn with a very high peripheral speed. The medium led through the flow passage has therefore a considerable relative speed with respect to the casing wall surface 6, a speed which is considerably greater than the relative speed with respect to the impeller surface 10.

In the neighbourhood of the casing wall 6 the flow encounters friction which impedes it. The flow particles led in the neighborhood of the casing wall 6 have, in consequence of the withdrawal of energy, less energy than the flow particles led in the neighbourhood of the surface 10 or of those in the interior of the flow passage 4.

At the position 12 of the cylindrical section IV—IV, the medium to be compressed, in spite of having the same peripheral speed, has less energy than at the position 13. The blade outlet edge 14 is therefore arranged inclined to the axis 5 of the impeller. At the position 15 in the neighbourhood of the casing wall it has the greatest radius of rotation. The flow parts which are led along near the casing wall 6 leave the flow passage in the region of a greater blade speed.

Additional energy is supplied to the part of the medium to be compressed which is flowing along the casing wall. With a suitable obliquity of the edge 14, so much additional energy will be imparted that also the disturbed flow particles will issue at the outlet edge 15 with essentially the same energy content as the other flow parts which are disturbed less or not at all. In this way a uniform flow in the diffuser, free from disturbance, is ensured.

In order to maintain particularly high compression ratios, the flow passages 4 can rotate with a peripheral speed which exceeds the ve-

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locity of sound of the medium to be compressed, at least in the neighbourhood of the outlet edge 14. In order that the increased centrifugal forces thereby caused may be taken without any bending, the blades 2 are formed in such a way that sections situated at right angles to the axis of the impeller are directed radially, at least in the neighbourhood of the high peripheral speeds.

In Fig. 2 the blades 2 follow helical lines and are curved backwards relative to the direction of rotation 16 of the impeller 1. In this way it is possible to have the absolute outlet speed of the compressed medium not exceeding, or at least not essentially exceeding, the velocity of sound, in spite of the peripheral speeds of the impeller being considerably over the speed of sound.

The impeller 1a of the compressor according to Fig. 5 has radial blades 2a which lie close to the wall 6a of the stationary casing 1a without the intermediary of a covering plate. The outlet edge 14a has a greater radius of turning in its part 15a in the neighbourhood of the stationary casing wall than in its part 13a in the neighbourhood of the body of the impeller. The increase is chosen in such a way that the flow disturbed by the friction on the casing wall 6a issues from the wheel, in consequence of the increased energy introduced by the blade projecting out to a greater outlet radius, with approximately the same quantity of energy as the undisturbed flow in the middle of the blade passage 4a.

If the flow along the surface of the impeller body 1a should also experience a perceptible disturbance, for instance as a result of friction on the wall, the blade outlet edge 14c may have a somewhat greater radius of rotation also in the region of the point 13c than in the region 14d of the edge, which is farther away from the impeller body 1a, as shown in Fig. 7. In this way the boundary layer flowing along the surface of the impeller will be accelerated in such a way that it also issues with the same amount of energy as the undisturbed flow in the middle of the flow passage.

The compressor according to Fig. 6 has an impeller 1b with double blades 2b which lie close to the wall 6b of the stationary casing 1b without the intermediary of a covering plate. The outlet edge 14b has therefore at both sides at the position 15b a greater radius of rotation than in the middle. In this way the flow disturbed by friction on the casing wall 6b is accelerated in such a way that it issues from the impeller with the same amount of energy as the average undisturbed flow.

Preferably the impeller is made from the full

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material by milling. In order to reduce the amount of milling required, the impeller may for instance be previously pressed in a die. Suitable materials to use are those which have the most favourable relation between specific gravity and strength. Particularly suitable are light metals and their alloys.

I claim:

1. In a centrifugal compressor, a rotor hub, blading attached to said hub having radially directed cross-sections in planes normal to the rotor axis, said blading being attached the length of one of its edges to said hub, a casing enclosing said hub and said blading, inlet and outlet passages in said casing, a surface of said casing lying along, out of contact with, but in close proximity to the length of an edge of said blading opposite the edge of its attachment to said rotor, said surface together with said hub and said blading defining flow passages through the compressor, and inlet and outlet edges to said blading adjacent said inlet and outlet passages respectively completing with the aforementioned two edges the bounding of said blading, said outlet edges being so shaped as to have a greater radius of rotation about said rotor axis adjacent said casing surface than intermediate said surface and said hub.

2. A compressor according to claim 1 in which the flow passages are arranged oblique to the rotor axis.

3. A compressor according to claim 1 in which there are a pair of oppositely directed inlet openings to the flow passages defined both by the hub, the blading and casing surfaces and a single outlet opening from the flow passages defined by the blading and casing surfaces alone.

4. A compressor according to claim 1 in which the outlet edges are so shaped as to have a greater radius of rotation about the rotor axis adjacent the hub than intermediate the casing surface and said hub.

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