Nov. 4, 1941. A. GARVE 2,261,463

IMPELLER

Filed Oct. 22, 1938

Fig. 1.

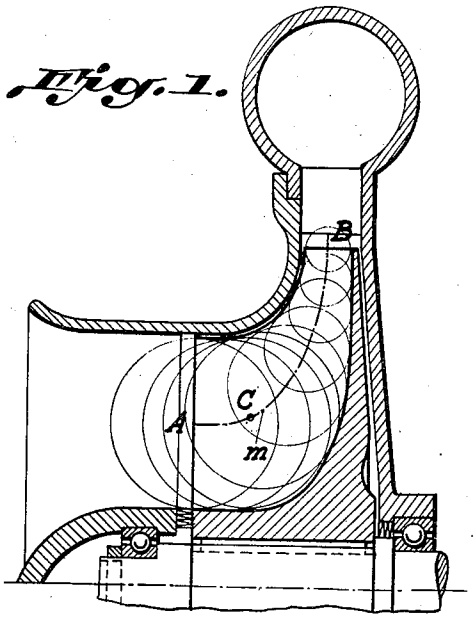



Fig. 2.

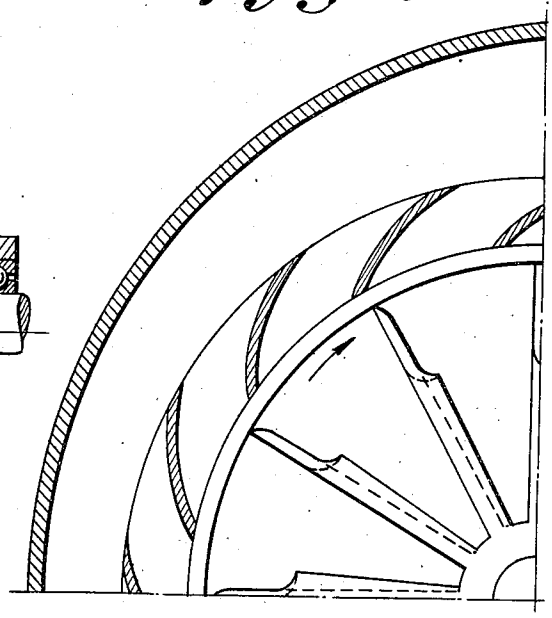
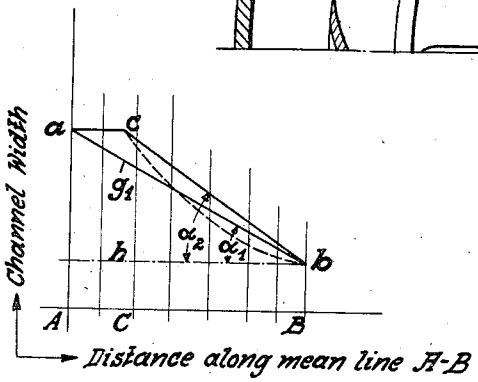


Fig. 3.




Inventor
Alexander Garve
by Maréchal & Nor
attys.

Patented Nov. 4, 1941 2,261,463

# UNITED STATES PATENT OFFICE

2,261,463

## IMPELLER

Alexander Garve, Augsburg, Germany, assignor to Maschinenfabrik Augsburg-Nürnberg A. G., Augsburg, Germany, a corporation of Germany

Application October 22, 1938, Serial No. 236,521
In Germany October 19, 1937

4 Claims. (Cl. 230—134)

This invention relates to air or gas compressors.

One object of the invention is the provision of a compressor such as may be used for compressing air or combustible mixture for charging the cylinders of aircraft engines and the like, the compressor having a rotatable member provided with radial blades forming impelling passages that extend substantially axially at their inlet ends and radially at their outlet ends and in which the width of the passages measured in an axial plane decreases towards the outlet ends thereof at such a rate that the propelling effect on the gas or air flowing through the passages will be maintained and a pressure of the air or gas in back of the blade will be maintained as the flow through the passages continues.

Another object of the invention is the provision of an impeller of the character mentioned in which the number of blades is low enough to prevent excessive blade friction losses but sufficient to provide a moderate angle between adjacent blades, the width of the blade passages measured in an axial plane decreasing towards the outlet ends at such rate that the inclination of a line connecting points plotting the passage width at the inlet and outlet ends of the passage against the distance along the passage is at an angle of 19° or more to the base line on which the distance along the passage is measured.

Another object of the invention is the provision of an impeller of the character mentioned in which the cross sectional area at the outlet end of a blade passage is less than 65% of the cross sectional area of the blade passage at the inlet end thereof.

Another object of the invention is the provision of an impeller of the character mentioned in which the ends of the blades are convexly curved on the leading side of the blade in accordance with the direction of flow discharge from the blade, while the rear side of the blade is substantially straight.

Other objects and advantages of the invention will be apparent from the following description, the appended claims and the accompanying drawing, in which:

Fig. 1 is an axial sectional view through the upper half of an impeller embodying the present invention;

Fig. 2 is a side view of a portion of the impeller; and

Fig. 3 is a diagrammatic showing of the channel width with relation to different mean distances along the channel passages.

In accordance with the present invention Figs. 1 and 2 show portions of a rotatable impeller wheel adapted to be rotated at high speed in a casing having a circumferential discharge or volute passage to which the compressed air or gas is supplied from the radially outer portions of the impeller, the casing extending along and closing one side of the passages in the impeller and providing a substantially axial inlet. The passages provided between the adjacent blades are suitably curved and streamlined to gradually change the direction of flow of the medium handled from a generally axial direction to a generally radial direction. The gaseous medium such as air or combustion mixture compressed by the impeller may be employed for charging the cylinders of aircraft engines, the impeller of the present invention being particularly adaptable for use with a fluid pressure turbine drive.

The impeller is provided with a series of blades which extend substantially radially. As herein shown, the blades of an impeller are twelve in number so that the number of blades will not be so high as to create excessive friction losses due to the friction of the air or gas acted upon, and will not be so small as to present a disadvantage of a large angle of divergence between adjacent blades such as would decrease the rate of flow and the air pressure of the delivered air or gas because of an excessive rate of increase in the passage dimensions measured circumferentially.

The width across each passage measured in an axial plane diminishes towards the outlet end of the passage at a considerably greater rate than has been customary so as to maintain air or gas pressure against the rear sides of the blades during its flow from inlet to outlet. Thus the air or gas in the channel is effectively propelled as the air or gas travels along the passage. As shown in Fig. 3 the passage widths at different distances along the mean or meridinal line $m$ of the passage are shown plotted against the distance along the passage. In this figure, the channel width at the points A and B of Fig. 1 are represented by the height of the lines $a$—A and $b$—B respectively while the distance between the points A and B in Fig. 3 is the lineal distance of the mean dot and dash line $m$ of the passage. The dotted line in Fig. 3 shows the actual passage widths in the construction herein shown, in which the passage width is maintained substantially constant immediately adjacent the inlet end, and then starts to decrease in width at the point C in Fig. 1. Fig. 1 shows the different diameters of the several circles whose centers are arranged at spaced intervals along the mean line $m$ so that the circles touch opposite sides of the passage. A line $g_1$ connecting the points $a$ and $b$ in Fig. 3 thus shows an inclination which is a measure of the rate of decrease of the passage width from the inlet end to the outlet end of the passage, and the inclination of this line in accordance with the present invention is 19° or more to the base line AB on which the distance along the passage is measured in order that the passage will be maintained full of the

gaseous medium and a pressure will be maintained on the rear sides of the blades as the gas travels along the passage to the outlet end thereof. As shown in Fig. 3, the angle $\alpha_1$ between the points *a* and *b* is somewhat in excess of 19°. Since the taper of the passage in the form of construction illustrated does not start exactly at the inlet end but rather at the point C, the taper of the passage between the points *c* and *b* in Fig. 3 must be at an angle of $\alpha_2$ which is in excess of 22°.

It is a further feature of the invention that the cross sectional area at the inlet end of the passage should be greatly in excess of the cross sectional area through the entire passage at the discharge end thereof, the outlet cross sectional area being smaller than 65% of the inlet cross sectional area of the passage.

As will now be apparent, although the number of blades is neither excessively large nor excessively small, and although the distance between the blades increases in an outward direction, the cross sectional area of the passage provided between adjacent blades decreases in an outward direction and at such a rate that the pressure and impelling effect of the blades is maintained on the gas during its flow through the passages. Where the width of the passage decreases towards the outlet end at such a rate that the inclination of a line plotting the width at the inlet and outlet ends of the passage against the distance along the passage is at an angle of 19° or more to the base line on which the distance along the passage is measured, there will result a very considerable increase in the quantity of air or gas delivered, an increase in the delivered pressure and in the efficiency.

In order to further prevent any decrease in the pressure of the gas or air in the passage at the ends of the passages, the ends of the blades are convexly curved on their front sides at their tip portions so as to conform substantially to the direction of discharge flow, and the gas or air leaving the compressor blades may depart from the blades without abruptly changing their direction, the rear sides of the blades extending substantially straight or radially so as to maintain their effectiveness to the end of the passages.

While the form of apparatus herein described constitutes a preferred embodiment of the invention, it is to be understood that the invention is not limited to this precise form of apparatus, and that changes may be made therein without departing from the scope of the invention which is defined in the appended claims.

What is claimed is:

1. A rotatable impeller wheel of the character described for compressing a gaseous medium comprising a wheel having a series of substantially radial straight blades twelve or less in number and diverging at an angle considerably less than 90° to one another and providing impeller passages extending substantially axially at their inlet ends and radially at their outlet ends, the width of the passages measured in an axial plane decreasing towards the outlet ends thereof at such rate that the inclination of a line connecting points plotting the passage width at the inlet and outlet ends of the passage against the distance along the passage is at an angle of 19° or more to the base line on which the distance along the passage is measured to maintain an effective propelling action on the medium flowing through the passages.

2. A rotatable impeller wheel of the character described for handling a gaseous medium comprising a wheel having a series of substantially radial blades diverging at an angle of the order of 30° to one another and providing impeller passages extending substantially axially at their inlet ends and radially at their outlet ends, the width of the passages measured in an axial plane being substantially constant for a limited distance adjacent the inlet end and then decreasing toward the outlet end of the passage at such rate that the inclination of a line plotting the passage width of the tapered portion of the passage at different distances along the meridian line of the passage is at an angle of 22° or more to the base line on which the distances along the passage are measured to maintain an effective propelling action on the medium flowing through the passages.

3. A rotatable impeller wheel of the character described for handling a gaseous medium comprising a wheel having a series of substantially radial blades diverging at an angle of the order of 30° to one another and providing impeller passages extending substantially axially at their inlet ends and radially at their outlet ends, the width of the passages measured in an axial plane decreasing towards the outlet ends at such rate that the inclination of a line connecting points plotting the passage width at the inlet and outlet ends of the passage against the distance along the passage is of an angle of 19° or more to the base line on which the distance along the passage is measured so as to maintain a pressure of the gaseous medium against the rear sides of the blades as the gas travels along the passage, the outer ends of the blades having a convex form on the leading sides thereof while the rear side of the blade is substantially straight.

4. A rotatable impeller wheel of the character described for handling a gaseous medium comprising a wheel having a series of substantially radial blades diverging at an angle of the order of 30° to one another and providing impeller passages extending substantially axially at their inlet ends and radially at their outlet ends, the width of the passages measured in an axial plane being substantially constant for a limited distance adjacent the inlet end and then decreasing toward the outlet end of the passage at such rate that the inclination of a line plotting the passage width of the tapered portion of the passage at different distances along the meridian of the passage is at an angle of 22° or more to the base line on which the distance along the passage is measured whereby the propelling effect on the medium flowing through the passage will be kept from dropping as the flow through the passage continues, each passage having a cross-sectional area at the outlet portion which is smaller than 65% of the cross-sectional area of the passage at the inlet portion, and the outer ends of the blades having a convex form on the leading sides thereof while the rear sides of the blades are substantially straight.

ALEXANDER GARVE.