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F. H. KLUGE  
CENTRIFUGAL IMPELLER  
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*Fig. 1*

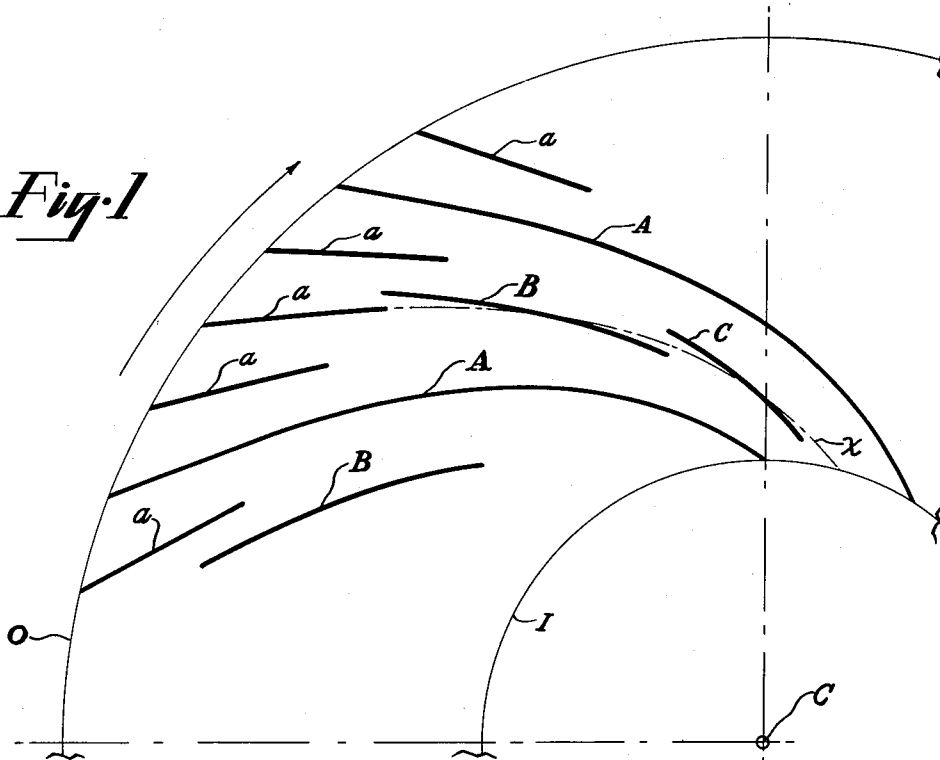
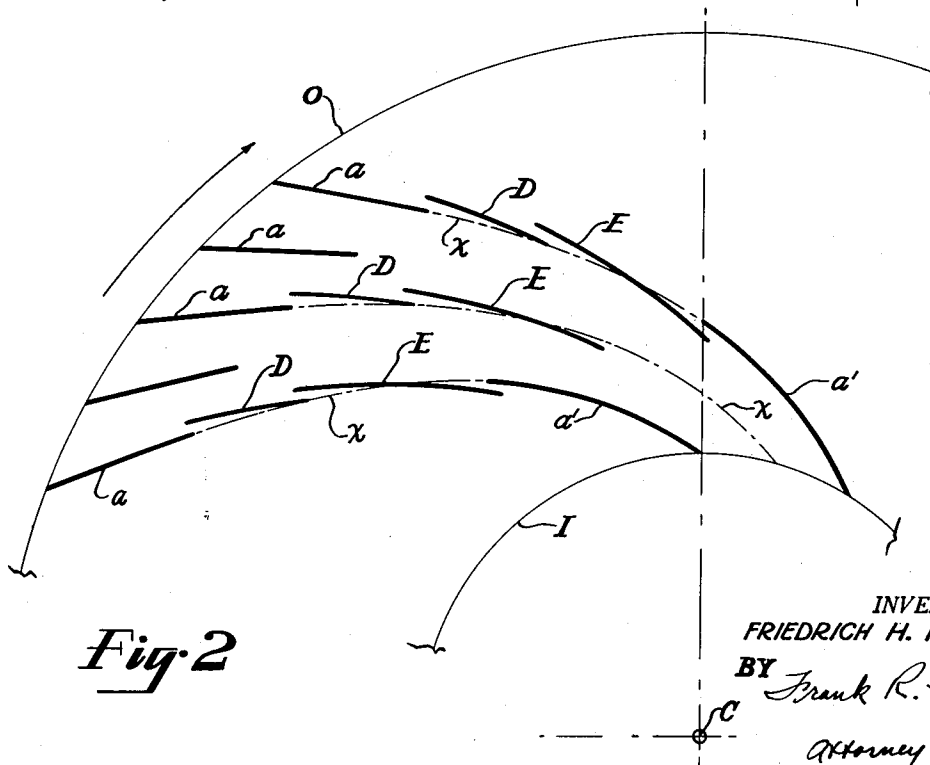


*Fig. 2*



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## CENTRIFUGAL IMPELLER

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1 Claim. (Cl. 103—115)

This invention relates to centrifugal apparatus for moving liquid or gaseous fluids, such as blowers, compressors, and pumps; wherein typically the apparatus includes an impeller rotatably driven at very high speed within a casing, the casing providing fluid inlet to the impeller generally centrally thereof, the impeller discharging peripherally thereof and the casing having a diffuser, guide vanes, or volute, receiving impeller discharge.

More particularly, this invention has to do with the vanes or blades of the impeller, by which the fluid flow through the impeller channels between the vanes is had.

As is known in the art, non-uniform distribution of velocity throughout the sectional area of the fluid stream in a rotating channel, is caused by tendency to higher velocity on the suction side of a vane than on the pressure side of the following vane, from occurrence of so-called channel-recirculation-vortex, resulting in a tendency to depart from a blade especially on its suction side; such tendency being particularly great at partial loads.

The invention herein is directed toward avoidance of such disadvantages, including occurrence of the so-called channel-recirculation-vortex, to attain an equalized distribution of velocity at the exit of the impeller about its entire circumference, thereby increasing its efficiency at all loads and particularly its stability at loads below normal.

The invention comprises, generally, means for forcing the fluid flow to conform to the form of the principal vanes of the impeller, wherever such flow has the tendency to leave such vanes; means for reducing turbulences between principal vanes tending to cause departure or cavitation of the fluid stream therefrom; means for attaining equalized distribution of velocity throughout the circumferential exit of the impeller; and means for improving generally the efficiency and stability of the impeller as well as the head developed thereby.

Generally speaking and as will more particularly hereinafter appear, the invention comprises in addition to the usual primary vane means, disposed along desired principal lines of flow through the impeller, the provision of auxiliary vane means cooperative with the primary vane means to cause flow lines to conform thereto, and for the purpose disposed along lines having slight angular displacement relative to those of the primary vane means in the direction of impeller operation.

Further objects and advantages of the invention will be apparent from the following description taken in connection with the accompanying drawings which are more or less conventionalized and similarly diagrammatic views indicating application of the invention to impellers having rearwardly curved vanes or blades, the example of Fig. 1 including through primary vanes extending from the impeller inlet to its outlet and Fig. 2 indicating an impeller having relatively short primary vanes disposed only at its inlet and outlet portions. It will be appreciated that the primary vanes indicated in each of the drawings, are disposed with uniform distribution about the impeller axis, to define similar principal flow lines leading from

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the impeller inlet to the impeller outlet, in a symmetrical pattern extending entirely about the axis; and that the impeller is driven at high speed by any suitable means well known in the art, about such axis in the direction indicated by the arrow.

It is to be understood that whereas the vanes indicated in the drawings are of the general order known as backwardly curved, wherein the inlet angle thereof to the tangent is greater than the exit angle, the invention is equally applicable to impellers having straight backwardly disposed vanes such as those indicated in the Patent No. 2,106,040 issued January 18, 1938, to Schmidt, straight radial vanes, or even forwardly disposed vanes. Moreover, whereas the vanes illustrated are as of uniformly thin section throughout their lengths, it is to be understood that the invention is applicable to vanes of streamline or airfoil sectional form such for example as those indicated in Patent No. 1,622,930 issued March 29, 1927, to Von Karman et al.

With reference now to the drawings and first to Fig. 1 thereof, the impeller, the center of which is indicated at C, is provided with a set of primary vanes A each disposed along a desired principal line of flow through the impeller from the inlet I thereof to its peripheral outlet O thereof; the vanes A being rearwardly curved relative to the direction of impeller rotation as indicated by the arrow, with the inlet angle of each greater than its exit angle as will be well understood by one familiar with the art.

Also, at its peripheral portion, the impeller is provided with additional primary vane means comprising exit vanes a, each located between a pair of through primary vanes A disposed along a line of desired principal flow in the path between its adjacent pair of primary through vanes A. Such a line for one of the exit vanes a is indicated in dot-dash form by the line x, Fig. 1.

According to this invention I provide auxiliary vane means disposed along lines having slight angular displacement relative to the primary vane lines in the direction of impeller operation, to improve flow through the impeller by deflecting it through the channels relative to the primary vanes so as to conform to the desired principal lines of flow through the impeller.

As here indicated such auxiliary vane means includes a set of auxiliary vanes B and another set thereof C, each set having each of its member vanes located between a pair of primary vanes A, the set B being located generally upstream of the primary exit vanes a and the set C being located generally upstream of the set B.

As here indicated, with reference to the line x, the auxiliary vanes B and C are each in crossing relation to the desired principal line of flow through the impeller and particularly that of one of the exit vanes a.

By this arrangement, when the impeller is driven at high speed about its axis C in the direction of the arrow, the auxiliary vanes B and C inhibit tendency of fluid flow within their channels between adjacent primary vanes A, to depart from the primary vanes particularly on their suction side faces, so that discharge from the impeller, particularly at loads below normal, is maintained substantially uniform about its entire periphery.

With reference now to the modification of Fig. 2, dot-dash lines x indicate as before desired principal lines of flow through the impeller, and exit vanes a are disposed at the periphery of the impeller along such lines also generally as before.

However, instead of the through primary vanes A, a number of short inlet vanes a' are provided, each along one of the lines x of one of the exit vanes a.

A set of auxiliary vanes D is provided each generally upstream of the exit vanes a and another set E each generally upstream of the set D is provided, all such auxiliary

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vanes being disposed with slight angular displacement relative to a desired principal line of flow through the impeller, in the direction of its operation, generally as in the arrangement of the auxiliary vanes B and C of Fig. 1.

Of these sets, for each pair of inlet and exit vanes  $a'$  and  $a$  respectively, there is a group comprising one of the auxiliary vanes E and one of the auxiliary vanes D disposed generally in the line of flow from that inlet to that exit vane. Also, as indicated centrally in Fig. 2 where an inlet vane is omitted because of the smaller radius at the inlet of the impeller, there may be still employed a group of auxiliary vanes D and E disposed generally in the line of flow ahead of one of the exit vanes  $a$ .

What I claim is:

In a centrifugal impeller comprising a supporting disc having a central inlet and means forming flow passages from said inlet to the periphery of said disc, said means comprising a plurality of primary vanes extending from said inlet to the periphery of the disc, said vanes being circumferentially spaced in a uniform pattern about the disc, each of said vanes being rearwardly curved from the inlet edge to the periphery of the disc, a plurality of spaced auxiliary vanes between adjacent primary vanes, each of said auxiliary vanes being rearwardly curved, a first of said auxiliary vanes having an entrance end disposed closely adjacent the inlet formed by adjacent primary vanes and the disc and terminating in an exit end a short distance from the entrance end, a second of said

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auxiliary vanes having an entrance end in overlapping relation to the exit end of said first auxiliary vane and spaced rearwardly therefrom and terminating in an exit end short of the periphery of the disc, a plurality of exit vanes between adjacent of said primary vanes, said exit vanes being rearwardly curved and having substantially the same degree of curvature as adjacent portions of said primary vanes, each of said exit vanes having an entrance end in spaced overlapping relation to the exit end of said second auxiliary vanes and terminating at the periphery of the disc, one of said exit vanes being disposed on either side of the second auxiliary vane.

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