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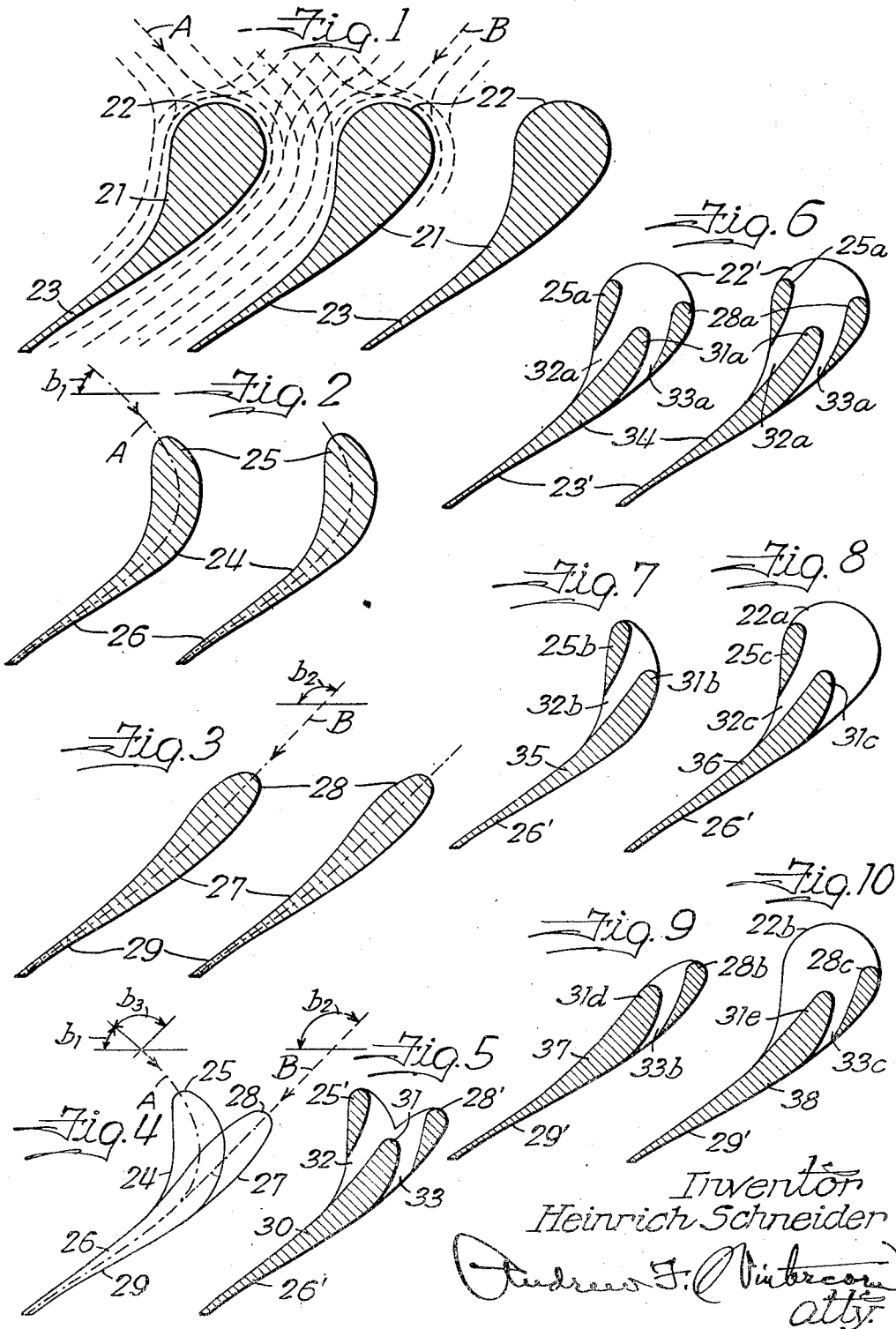
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2,576,700

BLADING FOR FLUID FLOW DEVICES

Filed June 2, 1947

2 SHEETS—SHEET 1



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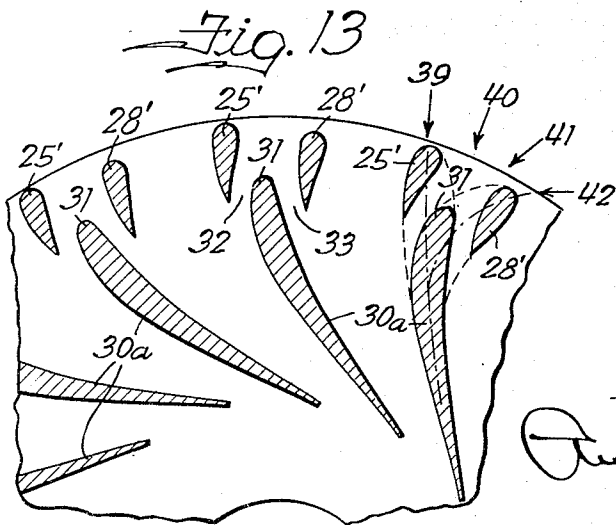
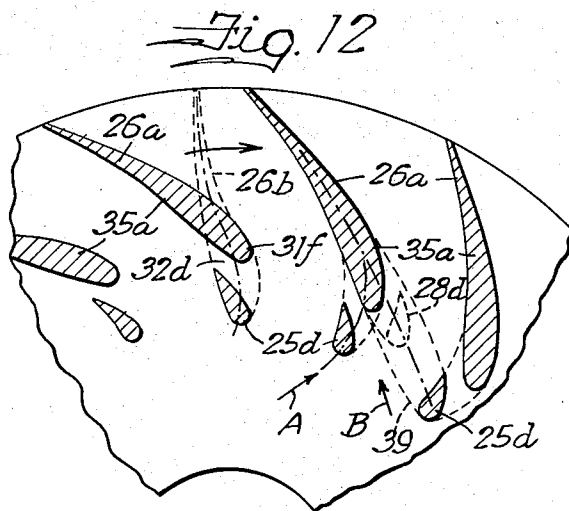
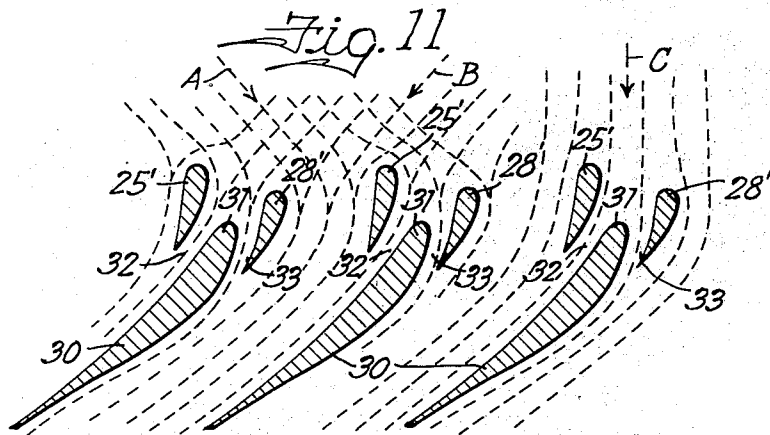
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BLADING FOR FLUID FLOW DEVICES

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2 SHEETS—SHEET 2



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BLADING FOR FLUID FLOW DEVICES

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1 Claim. (Cl. 170-172)

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This invention relates to new and improved blading for fluid flow devices generally, such as turbines, centrifugal pumps and blowers, propellers, guide vanes, reaction members, and so forth.

This invention is more particularly concerned with blades of improved constructions for more efficiently intercepting fluid, particularly in those cases where the fluid changes its direction of flow under different operating conditions or with variation of load or speed, as, for example, in hydraulic torque converters where there is an appreciable change in fluid velocities and direction of flow with variable speed ratios, although, of course, it should be understood at the outset that my invention is in no way limited to use in torque converters, but is applicable to blades for various fluid flow devices, operating with any fluid, namely, water, oil, gases, etc.

The principal object is to reduce by improvement in the blade design and construction losses in efficiency in blades receiving fluid from first one direction and then another, where the losses in efficiency are termed shock losses and turbulence losses.

Another object is to reduce by improvement in the blade design and construction restriction to fluid flow and at the same time improve the guiding function of the blades and reduce tendency for the fluid to leave the surfaces of the blades.

Other objects and advantages of the invention will be apparent from the following description in which reference is made to the accompanying drawings, wherein:

Figs. 1 to 3 are sections through more or less conventional blades;

Fig. 4 is a diagram showing the blade forms of Figs. 2 and 3 superimposed;

Fig. 5 is a section illustrating one of my improved blade constructions, the design of which is based on the diagram, Fig. 4;

Fig. 6 is a section similar to Fig. 5 but showing another improved blade construction related to that of Fig. 1;

Figs. 7 and 8 are views similar to Figs. 5 and 6, but showing two other blade constructions;

Figs. 9 and 10 are similar to Figs. 7 and 8 showing two other blade constructions;

Fig. 11 is a section through a set of blades of the kind illustrated in Figs. 5 and 6, and indicating diagrammatically the flow lines when the fluid is delivered first from one direction and then another;

Fig. 12 is a section of the blades for a centrifugal pump or blower showing two different

types of blades of the kinds illustrated in Figs. 7 to 10, and

Fig. 13 is a section through the blades for a turbine in which the blades are of the type shown in Figs. 5 and 6.

Figs. 1 to 11 each show blades in section in a developed plane, as is customary in the illustration of blading. Figs. 12 and 13 show blades in wheels and it will be understood that the blades of Figs. 1 to 11 are similarly employed and could all be similarly illustrated.

Similar reference numerals are applied to corresponding parts throughout the views.

The blades shown at 21 in Fig. 1 have well-rounded bulbous-shaped entrance portions 22 and tapered and appropriately curved exit portions 23. These blades may be taken as good examples of what are commonly used in turbines of hydraulic torque converters to intercept fluid entering first from one direction and then another at various speed ratios or loads with the limited efficiency this conventional construction affords. Incoming fluid is indicated as entering from one direction at A under one set of operating conditions and at B under another set of operating conditions.

In Fig. 2 are indicated blades 24 that are heavily curved between the entrance portions 25 and the exit portions 26 to make for the best efficiency under conditions when the fluid is delivered from direction A, this direction being the same indicated at A in Fig. 1. In Fig. 3 are indicated other blades 27 that are only slightly curved between the entrance portions 28 and the exit portions 29 with a view to most efficient operation when the fluid is delivered thereto from the direction B, this angle of delivery being the same as that indicated at B in Fig. 1. Obviously, a single set of blades having so far as possible and practical the combined flow intercepting and guiding characteristics of the blades 24 and 27 would result in greater efficiency than the set of conventional blades shown in Fig. 1 which has operating characteristics different from both of the other two designs just mentioned, and represents a compromise in design, the entrance portions 22 throughout approximately 180° or more being substantially cylindrical in form in order to bear the same relationship to fluid delivered from either of the two directions A and B, whereas the entrance portions 25 and 28 of the blades 24 and 27, respectively, are of streamline form so as to intercept the fluid with minimum shock loss. The blade constructions of my invention, as hereinafter described afford so far as

possible and practical the combined fluid intercepting and guiding functions of blades of opposite extreme designs to intercept with minimum shock losses fluid delivered thereto from either of two extremes and also from directions intermediate these extremes, the fluid from any of these directions being guided by the blades with minimum losses.

In Fig. 4, I have shown diagrammatically the outlines of blades 24 and 27 superimposed with their exit portions 26 and 29 matching, and in Fig. 5, I have shown a blade 30 which represents a composite design of blades 24 and 27, the same having a single section exit portion 26' and a three-section entrance portion, the opposed sections of which are numbered 25' and 28' inasmuch as they correspond to the entrance portions 25 and 28, previously mentioned, and the intermediate section being numbered 31. Nozzle shaped channels 32 and 33 are formed in the entrance portion of the blade between the three sections. Special attention is called to the fact that the sections 25', 28' and 31 are all of streamline form. Obviously, with these blades 30 high efficiency of operation is obtainable when the fluid flow is from direction A or direction B (Fig. 4), or from some intermediate direction.

Fig. 6 illustrates two other blades 34 of the same bulbous form shown in Fig. 1 as indicated by the entrance portion 22'. However, nozzle-shaped channels 32a and 33a are provided in the entrance portion to define the streamlined entrance sections 25a, 28a and 31a similarly as in blade 30 (Fig. 5), whereby to obtain the same advantages as were mentioned in connection with the description of that blade.

Fig. 7 illustrates another blade 35 similar to the blades 24 of Fig. 2, but having a nozzle-shaped channel 32b dividing the entrance portion into two sections 25b and 31b which correspond to the sections 25' and 31 of the blade 30 shown in Fig. 5, and sections 25a and 31a of the blade 34 shown in Fig. 6. A blade of this form gives reduced shock losses regardless of whether the fluid flow is from direction A or direction B indicated in Figs. 1 and 4.

The blade 36 shown in Fig. 8 has the bulbous shaped entrance portion 22a similar to what is shown in Figs. 1 and 6, but has a nozzle-shaped channel 32c formed in the entrance portion whereby to define the two streamline shaped sections 25c and 31c which are similar to sections 25b and 31b of blade 35 of Fig. 7 and sections 25a and 31a of blade 34 of Fig. 6. The operating characteristics of this blade are obviously closely similar to those of blade 35 (Fig. 7).

Figs. 9 and 10 illustrate two other blades 37 and 38 which are patterned after the blades 27 shown in Fig. 3, but have nozzle-shaped channels 33b and 33c in their entrance portions whereby to define sections 31d and 28b in the entrance portion of blade 37 and sections 31e and 28c in the entrance portion of blade 38. The blade 38 has a bulbous shaped entrance portion as indicated at 22b. Sections 31d and 28b of blade 37 correspond to sections 31 and 28' of blade 30 (Fig. 5) and sections 31a and 28a of blade 34 (Fig. 6), and the same is true of sections 31e and 28c of blade 38.

The operation of blades like those shown in Figs. 5 and 6 is illustrated in Fig. 11 in which three blades 30 are shown in a set, flow lines being indicated in dotted lines from directions A and B, a third and intermediate direction

of flow being indicated at the right at C. It should be clear from this illustration to what extent the efficiency of operation is improved.

Fig. 12 shows blading for a centrifugal pump or blower in which the blades 35a are similar to the blade 35 of Fig. 7, and generally similar to the blade 36 of Fig. 8, each having a two-section entrance portion 25d and 31f on opposite sides of a nozzle-shaped channel 32d. The section 25d on the blade at the right hand end of the view takes the place of the second entrance section 28d, shown in dotted lines, to give the same effect as a streamline blade 39 indicated in dotted outline in Fig. 12 so that section 28d can be omitted. In other words, the single outermost section 25d performs in this blading the function of both of the entrance portions 25' and 28' of Figs. 5 and 11 for two basic blades. All of the blades shown in full lines have exit portion 26a with an exit angle between 30 and 60 degrees, but I have shown in dotted lines a blade exit section 26b with a radial exit, which is preferably used with impellers for air compressors.

Fig. 13 shows an example of the blade made in accordance with my invention for a turbine, the blades being numbered 30a to correspond with the blades 30 of Fig. 11 and having three-section entrance portions 35', 31 and 28' with nozzle-shaped channels 32 and 33 therebetween. The arrows 39 to 42, shown in connection with the right hand blade indicate various directions of fluid streaming into the blades, all streams being intercepted smoothly.

Comparing Figs. 1 and 11, attention is called to the fact that in Fig. 1 the streamlines are crowded between the bulbous shaped entrance portions 22 of the blades and the streamlines are rather sharply curved and irregularly bent compared with the evenly distributed streamlines of Fig. 11, whether the fluid enters from direction A, B, or C. It is also noteworthy that the total channel width in the entrance portion of the blades is almost twice as large with the blades of Fig. 11 as with the blades of Fig. 1, even though the spacing of the blades and the total length of the blades and their exit angles are exactly the same in both cases. As a result, more fluid can flow through and between the three-section blades of my invention than between the bulbous blades used heretofore, of which the blades 21 of Fig. 1 are good examples, and I therefore secure an appreciable increase in efficiency.

Another advantage obtained with the multiple section blade of my invention is due to the preferably convergent nozzle action of the channels 32 and 33, or 32a and 33a, as the case may be; these convergent nozzles serve to direct the fluid along the surfaces of the exit portions of the blades so that the fluid streams do not leave the surfaces of the blades, thus greatly reducing turbulence losses. Inspection of Fig. 11 indicates that the fluid flowing in either of the three directions A, B or C flows smoothly between the exit portions so that the losses from restriction, shocks and turbulence are greatly reduced as compared with any other known blading, intercepting fluid with similarly great variation in the direction of flow.

The entrance angles of blades 24 and 27 shown in Figs. 2 and 3, indicated in connection with the arrows A and B in Figs. 2, 3, 4 and 11 will be selected according to the actual variation in direction of fluid flow and will correspond to the required range of operation to be covered by the particular blading in each case. Hence, it will

be understood that the shape, forms and angles of the blades shown in Figs. 1 to 13 are merely exemplary and not intended in any way to restrict the scope of application of my invention. Thus, in Figs. 2 and 4, for example, the entrance angle b_1 of blade 24 equals 45 degrees, and the entrance angle b_2 for blade 27 in Figs. 3 and 4 equals 135 degrees, these two angles forming together an enclosed or included angle b_3 equaling 90 degrees. Each angle b_1 and b_2 and the corresponding included angle b_3 will be chosen according to the particular operating condition of the blading in each case and may vary in a large degree for different applications, such as in turbines, propellers, guide vanes, reaction members and so forth. I prefer, for example, in the use of the present invention in the blading for a torque converter to have included entrance angles between the two basic entrance blades up to 120°, more particularly, in the pump between 30° and 90°, in the turbine between 30° and 90°, and in the reaction member between 30° and 120°.

The exit portion of the blades, 26', 23', or 26a as the case may be, performs the function of change of momentum of the fluid by changing the direction and velocity of the fluid, while the entrance sections 25' and 28', or 25a and 28, as the case may be, perform the function of receiving fluid from different directions smoothly and efficiently. The directions of fluid flow indicated at A, B, and C in the various figures may indicate absolute or relative velocity corresponding to stationary or rotating blades.

It is believed the foregoing description conveys a good understanding of the objects and advantages of my invention. The appended claims have

been drawn to cover all legitimate modifications and adaptations.

I claim:

In a bladed wheel, a series of circumferentially spaced blades, each blade comprising a streamlined entrance section and an uniformly streamlined exit section in radially spaced relation to the entrance section, the two sections being separated by a channel having substantially the form of a convergent nozzle directed toward the one side of the exit section, and the two sections together representing a well streamlined basic blade form, the blades being so spaced circumferentially and the sections of the blades being so arranged that each entrance section cooperates with its own companion exit section and also the exit section of the next neighboring blade to represent two streamlined blade forms.

HEINRICH SCHNEIDER.

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