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E. A. STALKER

2,344,835

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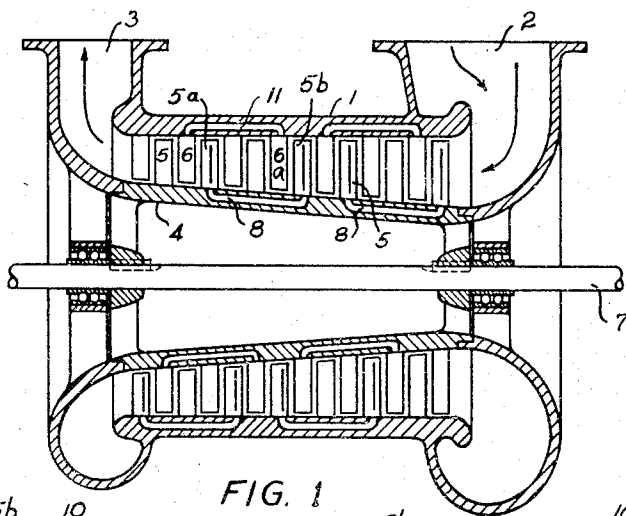


FIG. 1

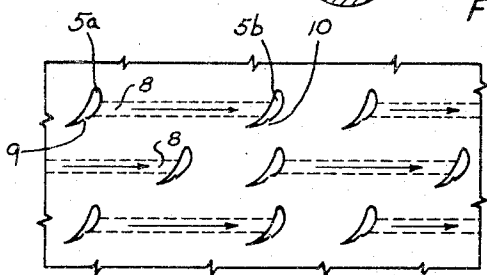


FIG. 2

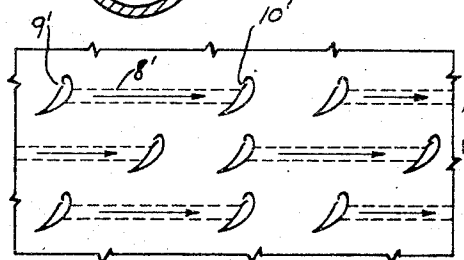


FIG. 6



FIG. 4



FIG. 5

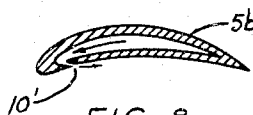


FIG. 8

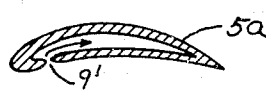


FIG. 9

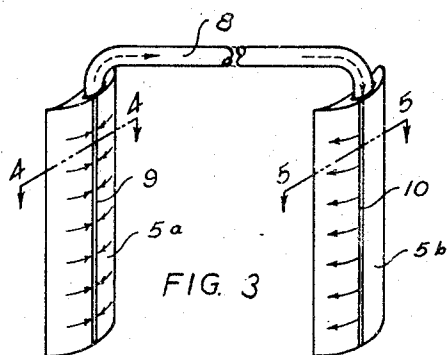


FIG. 3

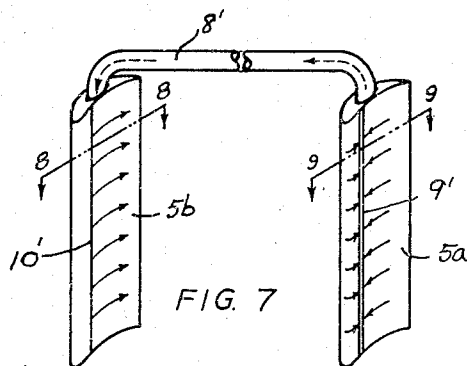


FIG. 7

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Application August 7, 1943, Serial No. 497,762

14 Claims. (Cl. 230-122)

This case is a continuation-in-part of my copending applications, Serial Number 447,822, filed June 20, 1942, entitled "Pumps," and Serial Number 447,823, filed June 20, 1942, entitled "Blowers."

My invention relates to pumps having impeller blades or guide vanes. It has for its principal object to provide a simple and self-contained pump arrangement in which the lift of the blades is increased while the drag or resistance encountered thereby is decreased, and in which the blades are made to function efficiently and effectively over a wide range of back pressures. It is also an object to develop a system of boundary layer control for the surface of the blades making direct use of the pressure differentials which exist within the pump itself. It is a still further object to provide sets of blades within the pump having surface slots therein and interconnected with each other so that a downstream blade in a zone of higher pressure will induct a flow which is transmitted to an upstream blade in a zone of lower pressure, the flow thus being utilized for establishing boundary layer control where it is discharged, the same flow thus being utilized for establishing boundary layer control over the surfaces of both blades.

Other objects will appear from the description and drawing.

I accomplish the above objects by the means illustrated in the accompanying drawing in which—

Fig. 1 is an axial section through the pump;

Fig. 2 is a fragmentary development of one form of construction of the impeller;

Fig. 3 shows schematically how the blades of such construction are interconnected by a duct;

Figs. 4 and 5 are sectional views through the blades on the lines 4-4 and 5-5 respectively of Fig. 3;

Fig. 6 is a view similar to Fig. 2 showing a modified form of construction;

Fig. 7 is a schematic view of the duct connections of such modified construction; and

Figs. 8 and 9 are section views through the blades on the lines 8-8 and 9-9 of Fig. 7 respectively.

In Fig. 1 the pump case is 1, the inlet is 2 and the exit is 3. The impeller hub is 4 having fixed to it the blades 5 forming a series of impellers disposed along the axis of the pump. The guide vanes are 6 also disposed along the axis and alternated with the impeller blades. The hub is fixed

to the shaft 7 which rotates the impeller blade 5 relative to the guide vanes 6.

As shown in Figs. 2 and 3, the blades are arranged in axially spaced relation with each pair of adjacent blades in an axial plane, such as 5a and 5b, constituting a set and the blades of each set being interconnected by means of separate air flow conduits 8. The blade sets are staggered in a peripheral direction, preferably as shown in Fig. 2, so that each alternate set is offset, and provision is thus made for separately interconnecting each pair of blades by the several conduits 8. The blades 5 and 5a of the rotating element alternate with similarly arranged guide vanes or blades and 6 and 6a of the casing. The blades of the casing are also arranged with pairs of adjacent blades in the same axial plane forming a set and being interconnected by separate conduits or ducts 11. The sets of stator blades are staggered similarly to those on the rotor and arranged to alternate with those on the rotor as shown in Fig. 1.

The blades have hollow interiors and are formed with surface slots 9 and 10 on the suction or convex surfaces thereof. As will be seen from Fig. 5, slot 10 has overlapping walls to direct the slot jet rearward substantially along the surface of the blade.

The downstream blade 5a is located in a zone of higher pressure and hence its slot 9 acts to induct a flow of air in the direction of the arrows shown in Figs. 3 and 4. Such flow passes through conduit 8 and into the hollow interior of blade 5b which is upstream and hence in a zone of lower pressure. The flow is then discharged from slot 10 over the surface of the blade in the direction indicated by the arrows in Figs. 3 and 5.

The flow as inducted over the surface of one blade and as discharged over the surface of the other acts to impart additional energy to the boundary layer on the surface of both blades, reducing the tendency of the boundary layer to drag and to separate from the blade surface and causing the external or main flow to follow the blade surface to large angles of attack. Such additional energizing of the boundary layer produces an increase in lift and a reduction in drag, and makes it possible for the blade to operate efficiently over a wide range of lift angles and against substantial variation in back pressures. By using both an induction slot and a discharge slot located in zones of different pressure as generated by the blower itself, the same duct flow is made to serve a plurality of blades, and a highly

efficient and economical operation is secured. This is an improvement over the design in my application Serial No. 399,310, Patent No. 2,314,058.

The blades 6 and 6a on the casing function in a similar manner to that described for the rotating blades, thus providing efficient over-all operation.

In the modified arrangement shown in Figs. 6 through 9, the construction and arrangement are essentially similar to that described above with respect to Figs. 1 through 5 with the exception that the suction slot 9' and the discharge slot 10' are formed on the lower nose surfaces of the blades 5a and 5b respectively, i. e., on the pressure or concave sides thereof. As will be seen from Fig. 8, slot 10' has overlapping walls to direct the slot jet rearwardly substantially along the surface of the blade.

The parts are numbered similarly to the corresponding parts in the earlier described modification, and the construction and mode of operation are substantially the same so that the same will be readily understood without further detailed description.

While I have illustrated a certain specific form of this invention it is to be understood that I do not intend to limit myself to this exact form but intend to claim my invention broadly as indicated by the appended claims.

While the forms of apparatus herein described constitute a preferred embodiment of the invention, it is to be understood that the invention is not limited to these precise forms 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. In combination in a fluid machine, a casing, a plurality of hollow blades of which some are supported for rotation in the casing, said blades upon rotation developing a fluid flow relative thereto, said flow possessing regions of different pressures at different blades, and means defining a closed duct communicating between the interiors of at least two blades situated in regions of different fluid pressure, one of said blades having an induction slot and the other a discharge slot in its exterior wall in communication with its hollow interior so that a common slot flow is induced by the pressure difference to control the flow about the two blades.

2. In combination in a fluid machine, a casing adapted to receive a fluid flow, a plurality of hollow blades supported in the casing for rotation about an axis, said blades upon rotation developing a fluid flow through said casing relative to said blades and possessing regions of different pressures at different blades, and means defining a duct communicating between the interiors of at least two blades situated in regions of different fluid pressure, one of said blades having an induction slot and the other a discharge slot in its wall in communication with its hollow interior and with said duct to utilize the same flow for control of the boundary layer on both blades.

3. In combination in a fluid machine, a casing containing a fluid flow therein, a plurality of hollow blades supported in the casing to form a plurality of stages spaced axially, and means defining a duct communicating through the ends of two blades with their interiors, said blades being displaced axially on opposite sides of an intervening stage, said blades having slots in their external walls in communication with their hol-

low interiors and said duct, the blades of said intervening stage being staggered relative to the blades having said duct to provide access for the duct through said intervening stage.

4. In combination, at least two wing-like hollow elements bathed by a relative flow and each having a slot in its surface, said elements being spaced from each other and located in a region of different fluid pressure, and a duct communicating between the said slots to conduct a flow arising from the pressure difference and inducted at the slot of one of said elements and discharged through the slot of the other of said elements to control the boundary layer on both said elements.

5. In combination in a fluid machine, a casing adapted to receive a fluid flow, a plurality of hollow blades arranged in sets and supported in said casing for rotation about an axis, said blades upon rotation developing a fluid flow through said casing relative to said blades and possessing regions of different pressures at different blades, one of the blades of a set having an induction slot for inducting a flow and another blade of the same set situated in a region of different pressure having a discharge slot in its wall in communication with its hollow interior, and means defining a duct communicating between the interiors of said two blades to conduct the same flow from one of said blades to the other to provide control of the boundary layers on both of said blades.

6. In combination in a fluid machine, a casing, a rotating element within said casing, a plurality of blades supported in said casing, a plurality of hollow blades carried on said rotating element and arranged in sets, a duct communicating between the interiors of the blades of each set, said hollow blades having slots on the surfaces thereof in communication with said hollow interiors providing for the induction of a flow through the slot of the downstream blade of a set and discharge of the same flow from the slot of the upstream blade of said set to control the boundary layers on both said blades.

7. In combination in a fluid machine, a casing, a rotating element within said casing, a plurality of blades supported in said casing, a plurality of hollow blades carried on said rotating element and arranged in sets, a duct communicating between the interiors of the blades of each set, said hollow blades having slots on the convex surfaces thereof in communication with said hollow interiors providing for the induction of a flow through the slot of the downstream blade of a set and discharge of the same flow from the slot of the upstream blade of said set to control the boundary layers on both said blades.

8. In combination in a fluid machine, a casing, a rotating element within said casing, a plurality of hollow blades supported by said casing and arranged in sets, a plurality of hollow blades carried on said rotating element and also arranged in sets, and a duct communicating between the interiors of the blades of each set, said blades having slots on the surfaces thereof in communication with said hollow interiors providing for induction of a flow through the slot of the downstream blade of a set and discharge of the same flow from the slot of the upstream blade of said set.

9. In combination in a fluid machine, a casing, a rotating element within said casing, a plurality of hollow blades supported in said casing and arranged in pairs, a plurality of hollow

blades carried on said rotating element and also arranged in pairs, said stator blades alternating with those of said rotating element, and a duct communicating between the interiors of the blades of each pair, said blades having slots on the surfaces thereof in communication with said hollow interiors providing for the induction of a flow through the slot of the downstream blade of a pair and discharge of the same flow from the slot of the upstream blade of said pair.

10. In combination in a fluid machine, a casing, a hub within the casing and defining therein with an annular passage therebetween, said hub being rotatably borne in said machine, a plurality of hollow blades carried on said hub in said passage and adapted to develop a relative flow therethrough, said blades forming a plurality of axially related stages, a blade of one stage having a slot in its lower surface in communication with its hollow interior, a blade of another stage at a zone of different pressure having a slot in its lower surface in communication with its interior, and a duct communicating between said interiors to conduct a flow from one of said slots to the other.

11. In combination in a fluid machine, a casing, a hub within the casing and defining therein with an annular passage therebetween, said hub being rotatable about an axis, a plurality of hollow blades carried on said hub in said passage and adapted to develop a relative flow therethrough, said blades forming a plurality of axially related stages, a blade of one stage located downstream in a zone of relatively higher pressure having an induction slot in its lower surface in communication with its interior, a blade of a second stage located upstream in a zone of relatively lower pressure having a discharge slot in its lower surface, the interiors of said blades being in communication to conduct a flow from said induction slot to said discharge slot.

12. In combination in a fluid machine, a casing, a hub within the casing and defining therein with an annular passage therebetween, said hub being rotatable about an axis, a plurality of hollow blades carried on said hub in said casing and arranged with adjacent blades in the same axial plane forming a set, a blade of one set located downstream in a zone of relatively higher pressure having an induction slot in its lower nose surface in communication with its interior,

another blade of said set being located upstream in a zone of relatively lower pressure and having a discharge slot in its lower nose surface, and a duct communicating between the interiors of the blades of each set to conduct a flow from said induction slot to said discharge slot to control the boundary layers on both blades of said set by a common flow.

13. In combination in a fluid machine, a casing, a hub within the casing and defining therein with an annular passage therebetween, said hub being rotatable about an axis, a plurality of hollow blades carried on said hub in said casing and arranged with adjacent blades in the same axial plane forming a set, the blade sets being staggered in a peripheral direction, a blade of one set located downstream in a zone of relatively higher pressure having an induction slot in its lower nose surface in communication with its interior, another blade of said set being located upstream in a zone of relatively lower pressure and having a discharge slot in its lower nose surface, and a duct communicating between the interiors of the blades of each set to conduct a flow from said induction slot to said discharge slot to control the boundary layers on both blades of said set by a common flow.

14. In combination in a fluid machine, a casing, a hub within the casing and defining therein with an annular passage therebetween, said hub being rotatable about an axis, a plurality of hollow blades carried on said hub and on said casing and arranged in an alternate relation in said passage for developing a relative flow therethrough, the blades of said hub and those of said casing forming a plurality of axially related stages, adjacent blades on said hub and on said casing respectively being arranged in sets, a blade of one set located downstream in a zone of relatively higher pressure having an induction slot in its lower nose surface in communication with its interior, another blade of said set located upstream in a zone of relatively lower pressure having a discharge slot in its lower nose surface, and duct means communicating between the interiors of the blades of the several sets for conducting a flow from said induction slot to said discharge slot to control the boundary layers on both blades of said set by a common flow.

EDWARD A. STALKER.