Sept. 3, 1968 W. G. WESTWELL ETAL 3,399,747

HYDRODYNAMIC FLUID BRAKE

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Fig. 1.

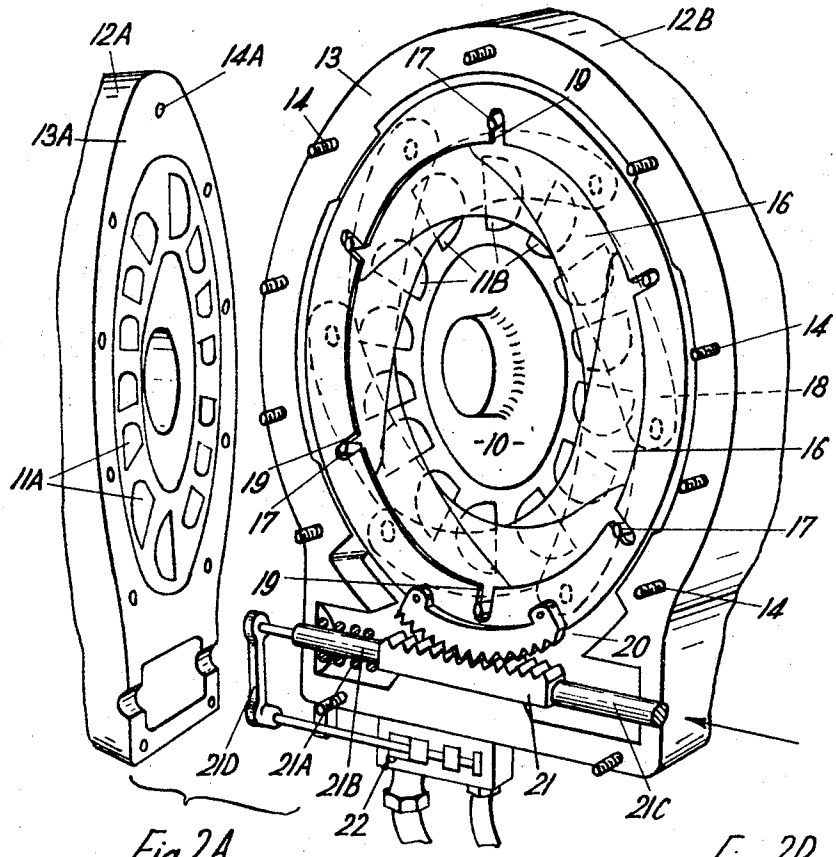


Fig. 2A.

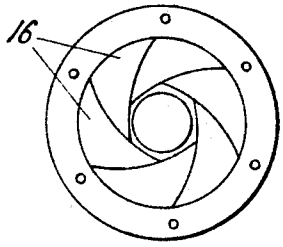
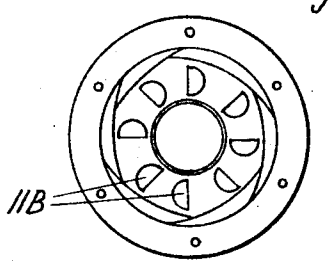


Fig. 2B.



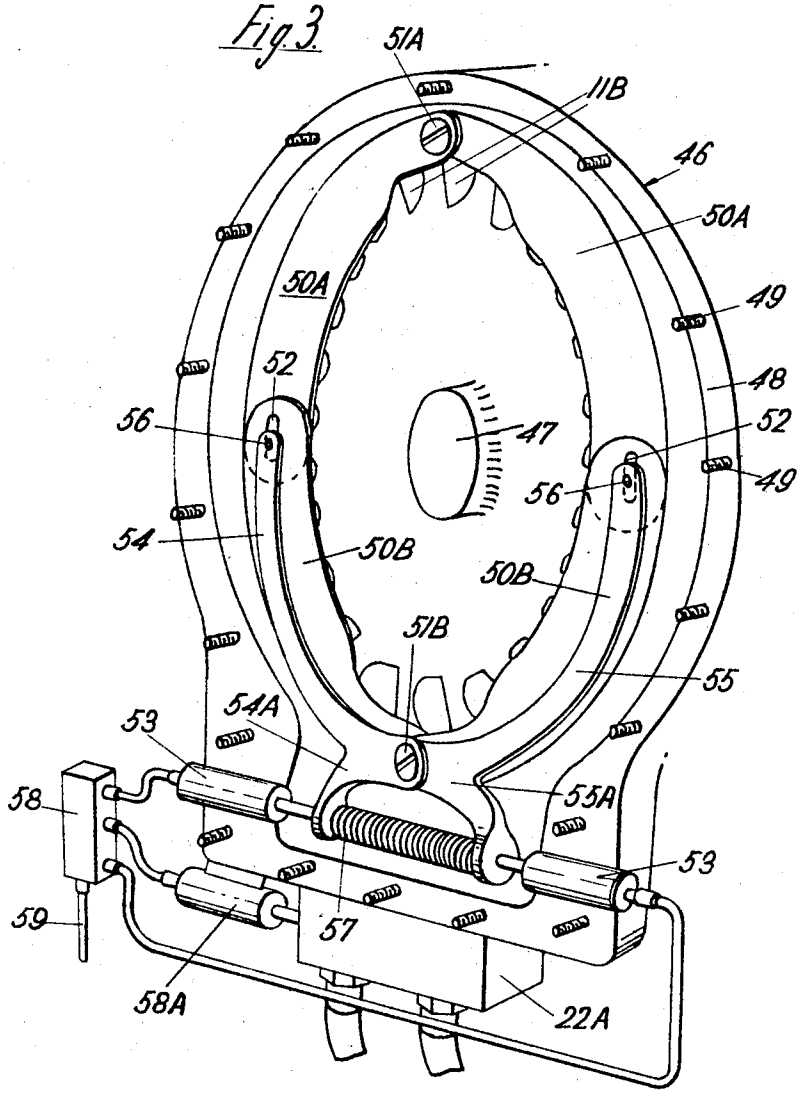
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Fig. 3.



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HYDRODYNAMIC FLUID BRAKE

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ABSTRACT OF THE DISCLOSURE

A hydrodynamic fluid brake including a casing housing a rotor and stator. A plurality of shutter members are located between the rotor and stator. When the casing is empty of hydraulic fluid, the shutters may be closed to interrupt the flow of air between the rotor and stator. For braking, the shutters are opened and hydraulic fluid is introduced into the casing. The interaction of the fluid between the rotor and stator provides a braking effect.

This invention relates to fluid machines of the type having a rotor and a stator and which, when the machine has fluid therein, can provide a braking effect by interaction of the fluid between the rotor and stator.

One example of a fluid machine of this type is a hydrodynamic fluid brake in which the braking action is obtained by filling the casing of a rotor and stator with hydraulic fluid which circulates in a vortex between blading or pockets on the rotor and stator. However, it is a disadvantage that when the hydraulic fluid is removed from the casing, air contained in the casing gives rise to appreciable windage losses.

It is an object of the present invention to provide means for reducing the windage losses of fluid machines of this type.

In accordance with the present invention, a plurality of shutter members are located between the rotor and stator. When the casing is empty of hydraulic fluid, the shutters may be closed to interrupt the flow of air between the rotor and stator. For braking, the shutters are opened and hydraulic fluid is introduced into the casing. The interaction of the fluid between the rotor and stator provides a braking effect.

Preferably, the shutters are mounted on a stationary part of the machine having control means for opening and closing the shutters.

The control means may include spring means for effecting movement of the shutter members to the closed position, and a hydraulic control system for effecting movement of the shutter members to the open position.

The shutter members may be pivotally mounted at one end on the machine, and may overlap and together form a variable aperture device or "iris."

Embodiments of the invention will now be described, by way of example, with reference to the accompanying drawings, in which:

FIG. 1 is a fragmentary exploded perspective of the rotor and stator of one embodiment of a fluid machine according to the present invention;

FIGS. 2A and 2B are front views of the stator corresponding to FIG. 1 to a reduced scale and showing the shutter members respectively in their closed and open positions; and

FIG. 3 is a view corresponding to FIG. 1 of a rotor and showing another embodiment of the invention.

Referring to FIG. 1, reference numeral **10** designates a rotor having a plurality of rotor pockets **11B** disposed on a pitch circle. Rotor **10** is rotatably contained in one part **12B** of a split casing of which the other part is indicated at **12A** and forms the stator of the machine. The

casing part **12B** has an annular land **13** from which project a plurality of studs **14** which engage in a corresponding plurality of holes **14A** in a corresponding land **13A** on the part **12A** for fastening the casing parts together. The stator has a plurality of pockets **11A** which are axially opposite the rotor pockets **11B** when the parts **12A**, **12B** are assembled. By virtue of the lands **13**, **13A** there exists a small axial space between the rotor pockets **11B** and stator pockets **11A**.

Located in the space between pockets **11A** and **11B** provided by lands **13**, **13A** is means for interrupting flow of fluid between the rotor pockets **11B** and the stator pockets **11A**. In the illustrated embodiment, this means consists of a plurality of shutter members **16** pivotally mounted on the casing part **12B** on a pitch circle beyond the outer diameter of the rotor **10**. The shutter members **16** are thin metal blades of generally arcuate shape and overlap so as to form a variable aperture device or "iris." Each member **16** has an axial pin **17**. In order to pivot the shutter members **16**, a rotatably adjustable ring **18** is provided which has slots **19** in which the pins **17** are located. Each slot **19** is generally radially directed so that, when the ring **18** is adjusted, the shutter members **16** are induced to pivot on the stationary casing **12A**. The shutter members **16** are movable between an open position allowing hydraulic fluid flow between the rotor and stator, and a closed position in which the members **16** interrupt air flow between the rotor and stator. FIGS. 2A and 2B show the shutter members **16** respectively in their closed and open positions.

Control of rotation of ring **18** is provided by a gear segment **20** attached to the ring **18**, an axially slideable rack **21** housed in the machine and meshing with the segment **20**, and control means, which may be hydraulic, pneumatic, or mechanical for example, controlling axial movement of the rack **21**.

Rack **21** is loaded by a compression spring **21A** on an extension rod **21B** of the rack **21** and has a control rod **21C**. Extension rod **21B** is connected by a coupling **21D** to a hydraulic fluid control valve **22** through which fluid may flow to fill the machine. When the rack **21** is moved in one direction, the direction of the arrow in FIG. 1, the supply of hydraulic fluid to the machine is increased, whereas movement of the rack **21** in the opposite direction causes less hydraulic fluid to be supplied to the machine, or the supply to be cut off.

Movement of the rack **21** in the direction of the arrow in FIG. 1 also effects movement of the shutter members **16** to their closed position, and movement of the rack **21** in the opposite direction by spring **21A** effects opening of the shutter member **16**.

When the machine contains no hydraulic fluid, and the shutter members **16** are in the position in which they interrupt flow of air between the rotor and stator, little or no windage effect is experienced.

In the embodiment shown in FIG. 3, there is a split casing part **46**, generally similar to the casing part **12B** of FIG. 1, housing a rotor **47** and having an annular land **48** with studs **49**. Four shutter members are grouped in opposed pairs **50A**, **50B**. The shutter members **50A** have a common pivotal connection **51A** with the casing part **46**, and the shutter members **50B** have a common pivotal connection **51B** with the casing part **46** which is diametrically opposed to pivotal connections **51A**. The shutter members **50A**, **50B** of each pair extend circumferentially in opposite directions and the adjacent free ends of the members **50A** and **50B** overlap. Each free end of the shutter member has a circumferentially directed slot **52**.

The shutter members **50A**, **50B** can be pivoted on the pivot **51A**, **51B** respectively between an open position and a closed position in which they interrupt flow of air and hence the windage effect between the rotor and stator

when the machine contains no hydraulic fluid. The means for effecting such movement consists of a pair of hydraulic rams **53** in the casing wall for closing the members and acting on arms **54A**, **55A** of a lever device having a pair of bellcrank levers with a common pivot point coincident with the pivot **51B**, the other arms **54**, **55** of the levers overlaying a pair of shutter members **50B**. At the free end of each of the arms **54**, **55** there is an axial pin **56** projecting into the slots **52** of the overlapping shutter members **50A**, **50B**. A compression spring **57** for effecting closing of the shutters acts on the arms **54A**, **55A** and urges the lever device to move the members **50A**, **50B** to a position in which the air transmission effect or windage effect is interrupted whenever the pressure in the rams **53** is removed.

Rams **53** are controlled by a control valve **58** which also controls, through a hydraulic ram **58A** and a valve in a casing **22A**, the amount of hydraulic fluid supplied to the machine. The control valve **58** may be operated by known control means, for example hydraulic or pneumatic through a pipe **59** or by mechanical control means.

When there has to be interaction of the hydraulic fluid between the rotor and stator so as to cause a braking effect on the rotor, the control valve **58** is first operated so as to actuate the rams **53** and **58A** in a direction such that the shutter members **50A**, **50B** are held open by the lever device, and fluid is fed into the machine via the valve in the casing **22A**.

If it is desired to remove the braking effect, the control valve **58** is actuated so that the hydraulic fluid supply is cut off and the hydraulic pressure in the rams **53** falls, and the spring **57** then acts on the arms **54A**, **55A** so that the pins **56** move radially inwards, causing the shutter members **50** to close and interrupt air flow between rotor and stator.

It is not necessary that there be four shutter members, as any even number of such members may be used.

By pivoting the shutter members on a stationary fixture, a quick, reliable operation is obtained.

In the embodiments described, the control systems are so arranged that the shutter members cannot be moved to their closed position while there is hydraulic fluid in the vortex path, and hydraulic fluid cannot be admitted while the shutters are closed.

Modifications may be made, for example the rotor and stator could be provided with blades, instead of pockets.

We claim:

1. A fluid machine comprising a casing, a rotor and a stator received in the casing, reaction elements in the opposed faces of the rotor and stator cooperable when in fluid communication with each other to generate fluid forces resisting rotation of the rotor relative to the stator, a plurality of shutter members mounted between the rotor and stator for selective movement between a closed position to interrupt the fluid flow between the rotor and stator and an open position permitting fluid flow between the rotor and stator, said shutter members comprising arcuate blades pivotally mounted at one end of the casing, control means for actuating said shutter members, said control means including a rotatable adjusting ring connected with said shutter members operable upon rotation in opposite directions to open and close the shutter members, a movable control valve for controlling fluid flow to the casing, gear means interconnecting the control valve and adjusting ring operable to rotate the adjusting ring in opposite directions in response to movement of the control valve in opposite directions, said gear means including a rack slideably mounted on the casing, and movable in opposite directions by said control valve, and a toothed segment mounted on the adjusting ring in engagement with said rack.

2. A fluid machine as claimed in claim **1** further including a pin on each shutter member spaced from the pivotal axis of the shutter member, and a plurality of radial slots in the adjusting ring each receiving one of said pins, the engagement of said pins and slots transmitting rotation of the adjusting ring to the shutter members to cause pivotal movement of the shutter members between open and closed positions.

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