May 5, 1964 J. E. CYGNOR 3,131,641

DYNAMIC SEAL IMPROVEMENT

Filed Aug. 17, 1962

FIG. 2

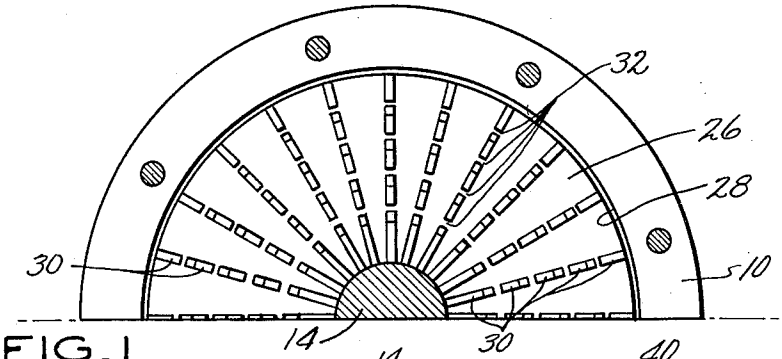


FIG. 1

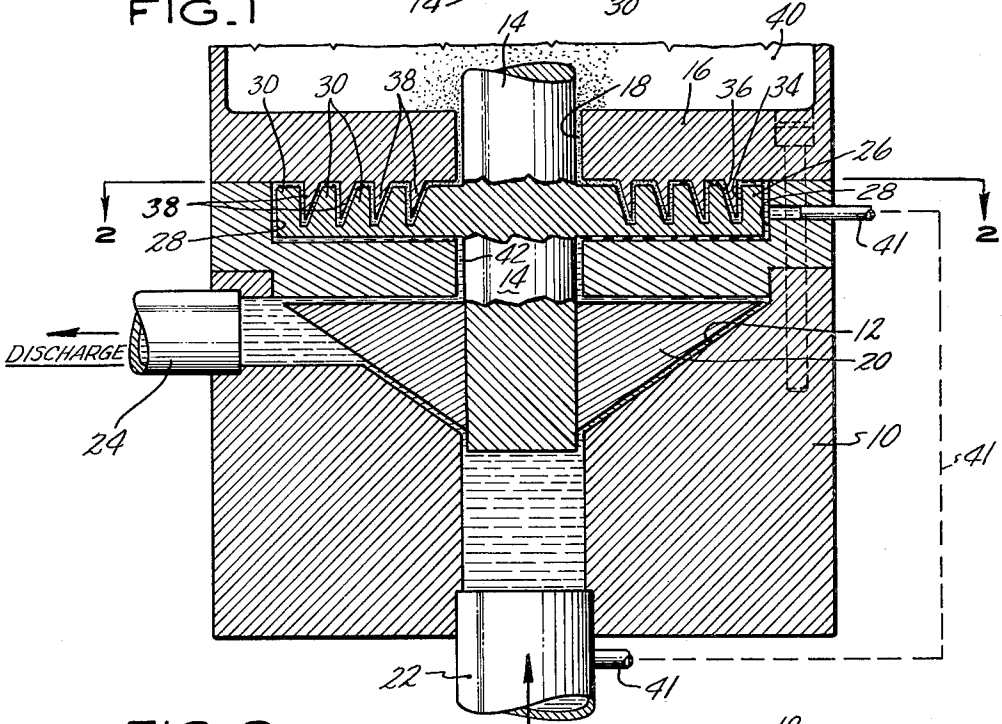
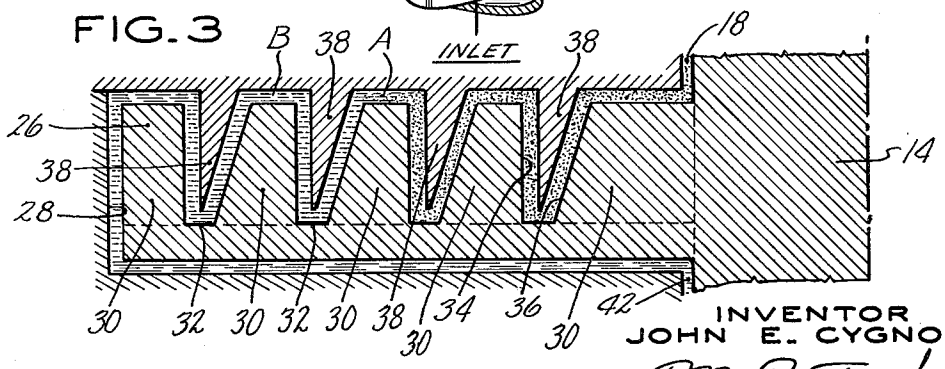


FIG. 3



INVENTOR
JOHN E. CYGNOR

BY M. B. O'Tasker
ATTORNEY

United States Patent Office

3,131,641

Patented May 5, 1964

3,131,641

DYNAMIC SEAL IMPROVEMENT

John E. Cygnor, Middletown, Conn., assignor to United Aircraft Corporation, Hartford, Conn., a corporation of Delaware

Filed Aug. 17, 1962, Ser. No. 218,222
1 Claim. (Cl. 103—103)

This invention relates to improvements in dynamic seals and has among its objects to provide a seal of this type in which fluid gassing in the vanes of the dynamic seal impeller is overcome even at extremely high impeller speeds; in which a clean interface is maintained at the impeller face; and in which the horsepower requirement for the seal is much less than for previous seals.

A further object of this invention is to provide a dynamic seal construction especially adapted for use in high-temperature liquid metal pumps in which the operating characteristics of the seal are little affected by changes in clearance in the dynamic seal impeller.

These and other objects and advantages of the improved seal construction will be pointed out or will be evident from the following detailed description of a preferred embodiment of the seal shown in the accompanying drawing.

In this drawing FIG. 1 is a diagrammatic, vertical, sectional elevation through a pump provided with the seal of this invention;

FIG. 2 is a transverse sectional view through the pump casing on line 2—2 showing one half of the seal impeller in plan; and

FIG. 3 is a much enlarged view showing the gas-liquid interface.

As herein shown, a typical liquid metal pump includes a casing **10** having a main pump impeller chamber **12**. A shaft **14** extends through a wall **16** of the casing in which it is journalled at **18** and carries an impeller **20** at its free end in chamber **12**. A main liquid metal inlet **22** supplies liquid to the impeller **20**. The liquid metal is discharged under pressure through a usual outlet **24**.

Shaft **14** also carries a dynamic seal impeller **26** which rotates in a chamber **28**. As shown most clearly in FIG. 2, this impeller has a plurality of radial vanes **30**, herein 24 in number. In accordance with this invention, impeller **26** has a plurality of concentric grooves **32** which transect the vanes on one side of the impeller. These grooves have outer side walls **34** which are normal to the plane of the impeller and inwardly and upwardly directed oblique inner walls **36**. Casing wall **16**, which is shown as a separate casing member, has an equal number of concentric ribs, or deflector rings, **38** formed on its vane-confronting face. The cross section of these ribs conforms to the cross section of the grooves **32** and the ribs enter into these grooves, suitable operating clearance being allowed between the walls of the grooves and the ribs.

Casing wall **16** also forms one wall of an outer chamber **40** in which inert gas, which may be helium, is provided under pressure in a well-known manner in dynamic seals. A recirculating pipe **41** is provided for bleeding off liquid metal from chamber **28** at the tip of impeller **26** and returning it to the low pressure inlet **22**.

In operation, high pressure fluid which leaks past the vane tips of impeller **20** passes along shaft **14** at **42** and enters the seal chamber **28** where it is picked up by the vanes **30** of the dynamic seal impeller. This leakage fluid is opposed by the blanket gas which passes from chamber **40** through the journal **18** into the impeller chamber **28** and forms the usual interface with the leakage liquid. This interface is shown in FIG. 3 at A.

For purposes of illustration, the clearances at **42** and **18** have been greatly exaggerated.

By reason of the cooperating grooves **32** and the ribs **38**, this dynamic seal has superior operating characteristics as compared to previous seals which lacked these features. First, it has been found that fluid gassing in the vanes of impeller **26** is eliminated even at pump speeds of 5500 r.p.m. to 8000 r.p.m. The seal runs with a good, clean interface even at these high speeds. The ribs **38** give the interface a guide to run on when the interface is in such a position that it coincides with a rib. When the interface is between two ribs, the ribs effectively isolate the slight amount of gassing that takes place at the interface from the rest of the liquid. The gassing is very slight except for interface positions beyond point B, FIG. 3. From this point on gassing gets progressively worse until the interface gets beyond the last rib **38**. At this point the fluid is a foam and remains that way until the interface goes off the seal impeller. If the interface is then brought back up to point A, the fluid will clear up immediately. Clearances of the fluid between the vanes is very important because this affects the cooling flow which is passed by the dynamic seal tip to remove the heat put into the fluid by the vanes and by recirculation. The amount of gas this cooling flow has in it is very important in some instances; for example, when the pump is used with an inpile loop. If the flow is not absolutely clear, it will gas up the loop fluid in a short time.

Even though some blade material is removed to make the grooves **32**, an increase in pressure differential between the gas-liquid interface and the dynamic impeller tip is noted. This pressure differential compares very favorably with the theoretical differential which was 109 p.s.i. by test and 112 p.s.i. by calculation at 5500 r.p.m. and radius of 1.4" in a specific pump tested.

The horsepower requirement for the dynamic seal of this invention is much less than for previous seals. In the pump tested it was found that at 5500 r.p.m. 6.2 horsepower is needed to drive the seal compared with 7.75 horsepower for previous seals. This is a reduction of 21%. The reason for this horsepower drop can be explained by the reduction of recirculation between the vanes **30** of the seal impeller. This recirculation is virtually eliminated by the deflector rings **38** which effectively block it.

The seal of this invention has been tested at well over 8000 r.p.m. and its good operating characteristics were not affected at all by this high speed. In fact, it is possible to run the pump at this speed with a gas-liquid interface position nearer the tip of impeller **26** than at lower speeds. The seal has been run at different clearances over a substantial range and it was found that no change occurred in the operating characteristics, showing that the seal is not sensitive to clearance change.

It will be evident that as a result of this invention a dynamic seal has been provided having improved operating characteristics as regards gassing of the fluid in the vanes, the quality of the interface, the pressure differential between the interface and the dynamic impeller tip, and the horsepower required to operate the seal.

While only one embodiment of this invention has been shown herein, it will be evident that various changes may be made in the construction and arrangement of the parts without departing from the scope of the invention as defined in the following claim:

I claim:

A pump having an impeller casing including a wall, said casing enclosing a main pump impeller chamber and a seal impeller chamber, a drive shaft extended through the wall of said casing through said seal impeller chamber and into said pump impeller chamber, a main pump

impeller on said shaft in said main pump impeller chamber, a liquid inlet and a liquid outlet for said main impeller chamber, a dynamic seal impeller on said shaft in said seal impeller chamber receiving the liquid which leaks past said main impeller tip, said seal impeller having generally radially extended vanes provided with a plurality of radially spaced concentric annular grooves in the face thereof remote from said main pump impeller which transect said vanes, a casing member having an equal number of annular continuous ribs on a face thereof which confronts said grooved vanes, said ribs registering with and entering into said grooves, each of said grooves in said vanes having its outer wall normal to the plane of said seal impeller and having its inner wall inclined from the bottom of the groove upwardly and away from said normal wall, and each of said annular ribs having a radial cross section which conforms to the cross section of said grooves, and means for effecting a gas-liquid interface between said confronting surfaces including a chamber on the remote side of said casing member from said confronting ribbed surface for supplying inert gas under pressure to seal said chamber.

References Cited in the file of this patent

UNITED STATES PATENTS

1,394,959	Wilkinson	Oct. 25, 1921
1,806,515	Zoelly	May 19, 1931
2,005,429	Lichtenstein	June 18, 1935
2,136,799	MacLean	Nov. 15, 1938
2,301,722	Vaughn	Nov. 10, 1942
2,573,425	Fletcher	Oct. 30, 1951
2,695,246	Jurgensen	Nov. 23, 1954
2,913,989	Boardman et al.	Nov. 24, 1959
2,992,618	Means	July 18, 1961

FOREIGN PATENTS

13,852	Great Britain	June 8, 1915
234,751	Germany	May 19, 1911
246,941	Germany	May 14, 1912
425,652	Italy	Oct. 10, 1947
684,207	Germany	Nov. 24, 1939
708,593	Germany	July 24, 1941
1,122,374	Germany	Jan. 18, 1962