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[33] **Canada**
[31] **30,953**

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[54] **REMOVABLE RUNNER SEAL**
8 Claims, 1 Drawing Fig.

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[50] **Field of Search** 415/112, 106, 170, 171, 172, 173, 174, 175, 201

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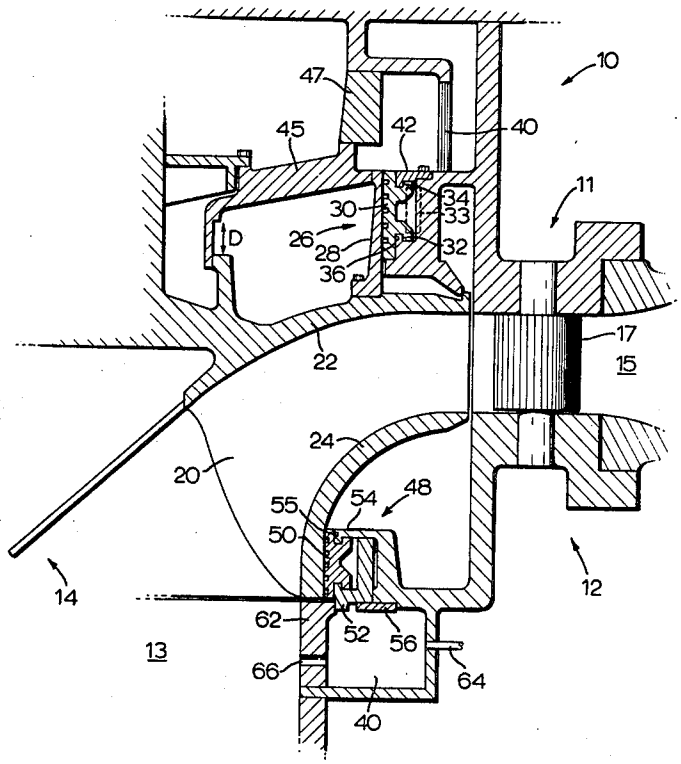
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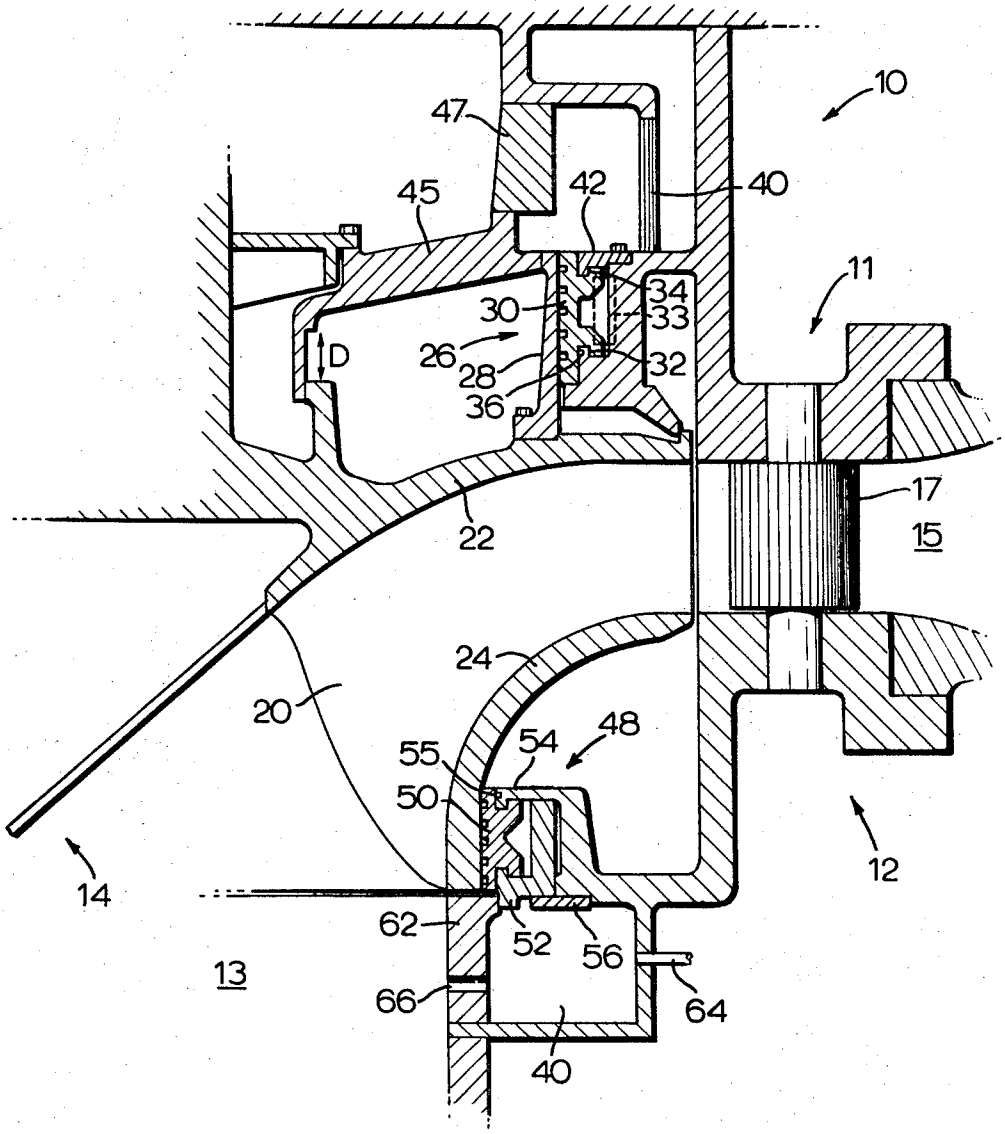
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ABSTRACT: A hydraulic turbomachine such as a pump, pump turbine or Francis turbine having a shrouded runner is provided with sheared seals to minimize leakage through the shroud spaces, and seal access means, to permit servicing of the seals without removal of the runner from its housing, in the form of a service housing adjacent the throat and a crown service housing, permitting disassembly of the seals from within.





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REMOVABLE RUNNER SEAL

This invention is directed to an improved seal mounting arrangement and in particular to the mounting arrangements for seals of a hydraulic turbomachine such as a turbine or pump.

In the operation of shrouded hydraulic turbomachines such as Francis turbines the efficiency of machine operation and the effective utilization of the motive fluid is dependent upon the provision of effective seal means to prevent the leakage of working fluid past the runner of the machine, by way of the annular space surrounding the shroud of the runner. In order to provide effective sealing it is necessary to maintain runner clearances at a minimum value. Unbalanced hydraulic loads can deflect the runner from its main axis, and the possibility of rubbing of the shroud outer surface against the sealing means arises, with consequent damage to the seals, and even the possibility of seizure of the seal to the shroud outer surface.

Owing to the location of the runner thrust bearing in substantial axial alignment with the crown seal, axial upward withdrawal of the seal assembly is not practical.

The present invention provides an arrangement whereby it is possible to service the shroud seals, both for the crown shroud and the skirt shroud, with the runner of the machine remaining in the assembled position. It will be appreciated that the ability to provide initial minimal seal clearances, to replace worn seals without disassembly of the runner, and to permit withdrawal of the runner together with any seized seals greatly enhances the operating efficiency and the serviceability of the machine.

In the case of the turbine or pump crown seal, while the illustrated preferred embodiment relates to an axially extending "barrel" type seal, it will be understood that the present invention is susceptible of use with an axially facing seal arrangement.

In providing for the withdrawal of the skirt shroud seal, the seal withdrawal chamber which circumscribes the draft tube is provided with an air supply, together with communicating passageways to the draft tube, so that the withdrawal chamber can serve the double function of acting as a "bounce" chamber in order to permit fluid interchange between the withdrawal chamber and the working liquid in the draft tube, whereby quietening of the machine and smoother running may be promoted.

It will be understood that while the present disclosure is directed to a seal embodiment in relation to a Francis turbine it is contemplated that certain of the benefits may be obtained with any shrouded turbomachine of a size and type to accommodate the presently disclosed seal arrangements or adaptions thereto.

Certain embodiments of the present invention are described, reference being had to the accompanying drawing which is a partial sectional elevation of a Francis turbine showing related portions of the runner and machine housing.

Referring to the drawing, the turbine portion **10** includes an upper stationary casing portion **11** and a lower stationary casing portion **12** within which the runner **14** is mounted for rotation. The water or other motive fluid enters from the speed ring **15** by way of guide vanes **17**, passing between the runner blades **20** which extend between the crown shroud **22** and the skirt shroud **24**.

Referring first to the crown shroud seal arrangement **26** the shroud annular extension ring **28** is provided with a plurality of segmental seals **30** that are secured within the head cover of the machine.

The segments **30** are keyed into the housing **32** and **34**, a circumferential O-ring seal **36** being shown to prevent bypass leakage and exclude dirt, and to assist in setting the seal.

A seal withdrawal chamber **40** within the machine head cover permits removal of the keep means **42**, being in the form on an annular ring which may be segmented.

In a typical seal arrangement as many as 24 seal segments **30** may be provided, a plurality of spaced keys **33** being shown in phantom. These circumferentially spaced keys **33** limit the circumferential movement of the seals **30**, so that the clearances between adjacent seals may not be totally cumulative to provide a leakage gap comprising the aggregate clearance between all individual segments.

In order to provide access to the chamber **40** the inner head cover **45** may be lowered the distance D in order to rest on the crown shroud **22**. This actual displacement of the inner head cover **45** then provides free access to the head cover barrel **47**, which is segmented in such fashion as to permit inward withdrawal of one segment towards the runner main axis, thus providing a manhole for clear access to the chamber **40**, for servicing the crown seal.

In the case of the skirt or band seal **48**, the seal segments **50** are secured in a cartridge arrangement by lower keep **52**, and upper keep **54** and a lower retaining ring **56**.

The seal segments **30**, **50** are illustrated having annular recesses at the working surface extending substantially parallel with the motion of the adjacent runner surface when in operation.

A seal access chamber **60** permits servicing of the seal **48**. Access to the chamber **60** is provided by a removable draft tube wall portion **62**, the segmental plan form of which is tapered to permit inward withdrawal towards the main axis of the machine. The ring **56** may be lowered by jacking, to permit withdrawal of the individual seal segments **50**.

An air supply pipe **64** connects with the chamber **60** and a plurality of circumferentially arranged passages **66** permit fluid interchange between the draft tube **13** and the chamber **16**. The dual function of the chamber **60** enhances quiet operation of the machine, together with the provision of full seal serviceability.

A particular advantage of the present arrangement is that owing to the relative flexibility of the seal segments **30**, **50** due to the way in which they are mounted within the respective housings the inherent danger of seizure to the respective shroud portions is substantially excluded, while close seal clearances may be maintained and continuous serviceability ensured without protracted machine downtime.

I claim:

1. A hydraulic turbomachine having a bladed runner mounted for rotation within a stationary housing and having at least one shroud portion, and axially retractable shroud seal means mounted in the housing in sealing relation with the shroud, including a plurality of seal segments forming a seal annulus in sealing relation with an annular surface of the shroud means, segment mounting means to position the segments within the housing, and keep means to secure the segments to the mounting means, a service housing located axially adjacent the seal, within said stationary housing, and means to provide access thereto whereby the shroud seal may be serviced insitu.

2. The machine as claimed in claim 1, being of the Francis type having a crown shroud, said access means including a moveable portion of the machine head cover to provide access to said service housing.

3. The machine as claimed in claim 2, including an inner head cover within said stationary housing having at least a portion thereof moveable axially relative to the housing, to permit displacement of said moveable head cover portion inwardly from said service housing, relative to the runner main axis, whereby the service housing is made accessible.

4. The machine as claimed in claim 1, wherein each said seal segment has a working surface having a plurality of recesses extending thereacross in a direction substantially parallel with the direction of movement of the runner facing surface when in operation.

5. The machine as claimed in claim 2, wherein said head cover moveable portion comprises a segment of an annular barrel, the segmental walls thereof being inclined relative to the other segments to permit inward withdrawal of the segment towards the runner main axis.

6. The machine as claimed in claim 1, being of the Francis type and having a band shroud, said service housing being located adjacent the draft tube of the machine, to permit axial withdrawal of said seal means away from the runner.

7. The machine as claimed in claim 6, wherein said service housing in an annular chamber, at least one wall portion of said draft tube being moveable to provide access to said chamber to permit the installation of jacking means for the retraction of said seal means from the runner.

8. The machine as claimed in claim 7, having air admission means connected with said service housing, and fluid passage means extending from the housing to said draft tube to permit substantial pressure interchange therebetween.