

April 27, 1965

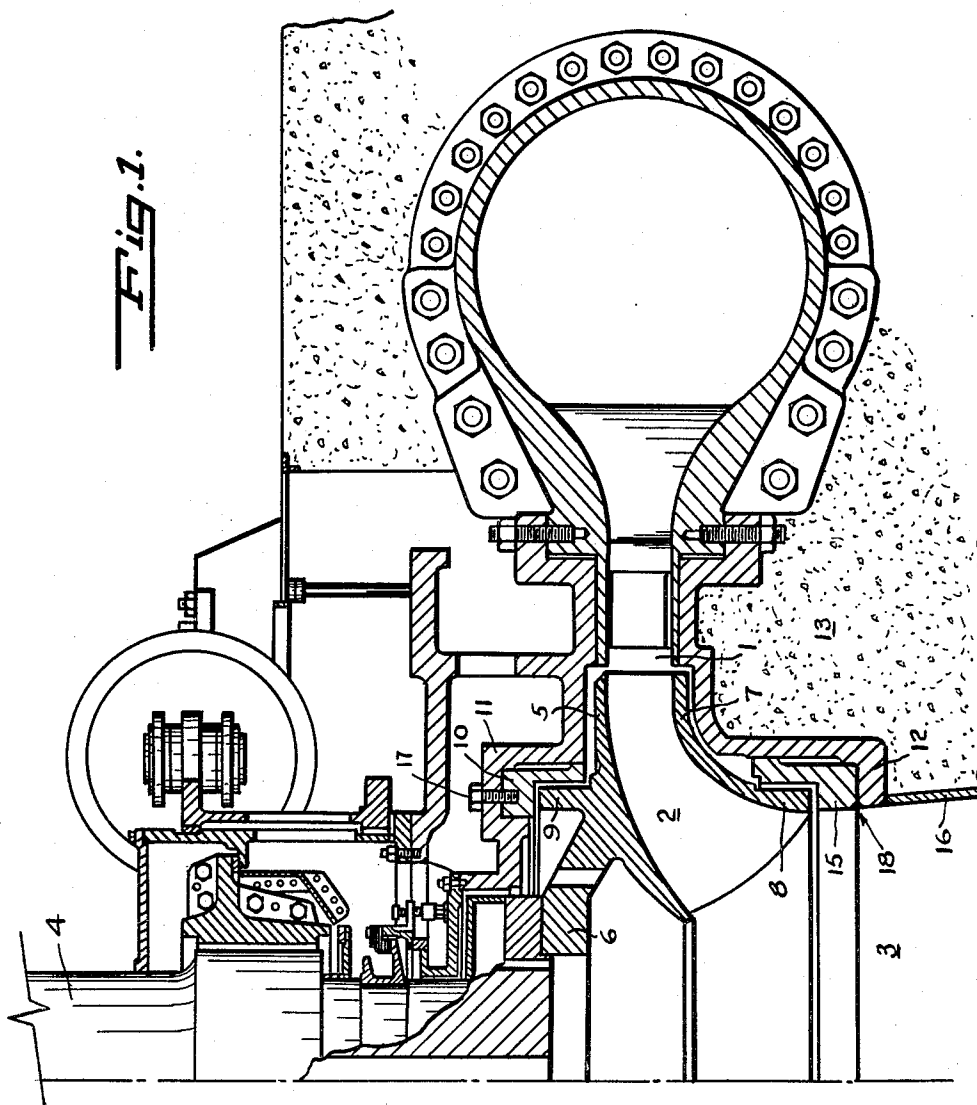
R. S. SPROULE

3,180,613

REMOVABLE FRANCIS TURBINE SEALS

Filed Nov. 14, 1962

2 Sheets-Sheet 1



INVENTOR.  
ROBERT S. SPROULE

BY

*Raymond A. Ragun*  
ATTORNEY.

April 27, 1965

R. S. SPROULE

3,180,613

REMOVABLE FRANCIS TURBINE SEALS

Filed Nov. 14, 1962

2 Sheets-Sheet 2

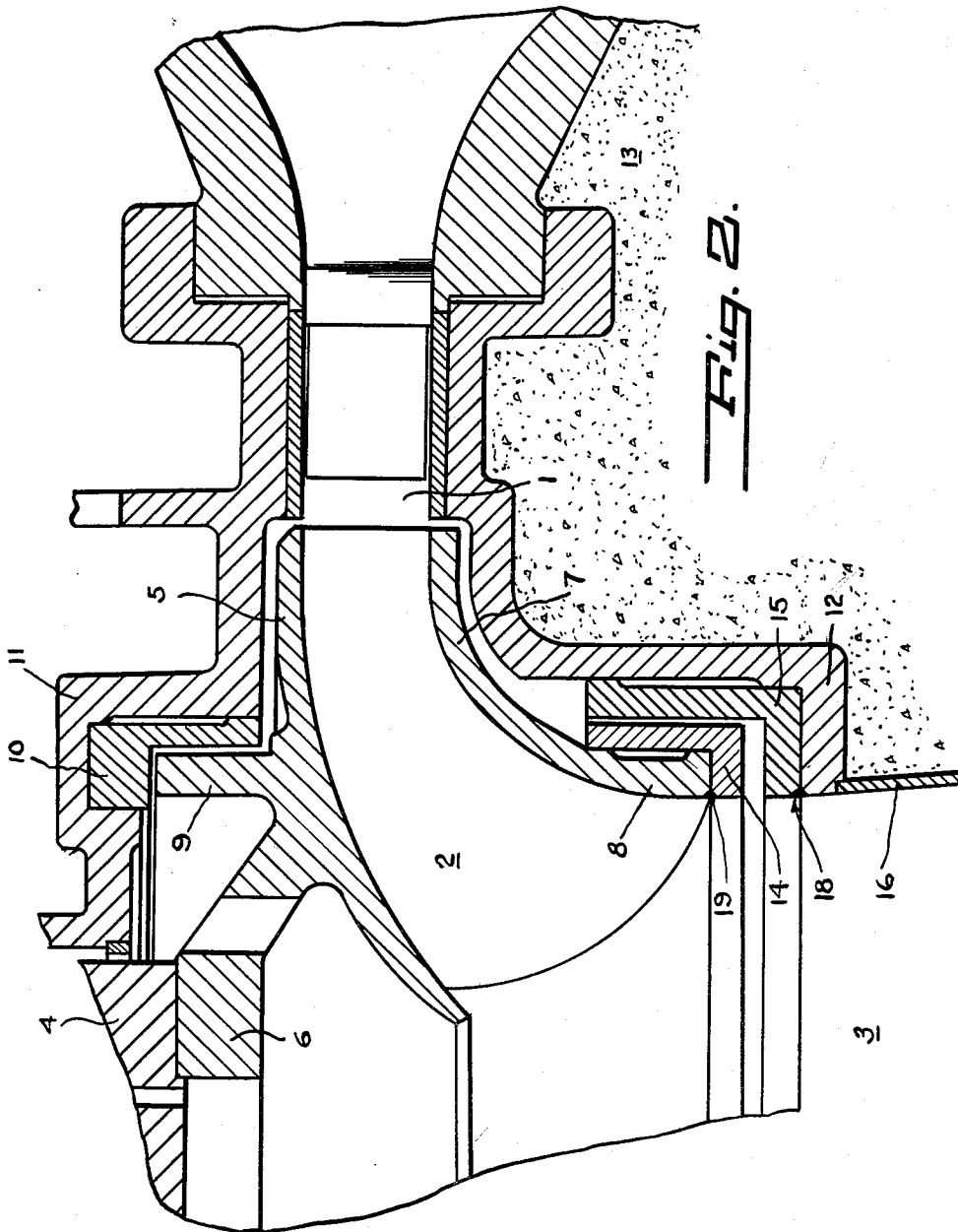


Fig. 2.

INVENTOR.  
ROBERT S. SPROULE

BY  
*Raymond A. Paquin*  
ATTORNEY.

1

3,180,613

**REMOVABLE FRANCIS TURBINE SEALS**  
Robert S. Sproule, Montreal, Quebec, Canada, assignor to  
Dominion Engineering Works Limited  
Filed Nov. 14, 1962, Ser. No. 237,666  
1 Claim. (Cl. 253-26)

This application is a continuation in part of my application Serial No. 114,877 filed June 5, 1961 now abandoned.

This invention relates to turbines of the Francis type and has particular reference to a new and improved runner band seal for such turbines.

For high head Francis turbines the preferred location of the runner band seal is close to the runner discharge and the preferred location of the runner crown seal, between the crown and cover, is at the same diameter as the band seal.

In order to obtain high efficiency it is desirable to keep the seal clearance small and this small clearance introduces the danger of seal fouling and seizure. With the seals located in these preferred, but inaccessible positions, dismantling of the turbine becomes very difficult if the seals have seized, thus preventing dismantling in the normal way. This invention is designed to minimize the inconvenience of seized seals by permitting the normally fixed portions of the seal to be readily detached from the fixed portions of the turbine so that they may be removed with the turbine runner.

Prior methods include provision of dismantling means and passages in the foundations so that the turbine lower cover may be removed with the runner from below.

The disadvantage of this method is the very high cost of providing dismantling means and the spaces in the power house. Furthermore, dismantling the runner and bottom cover together merely permits removal of a seized runner and bottom cover assembly to a more convenient place to work on them and separating one from the other may still be a very difficult task and may involve further serious damage. If both the crown and band seals are seized it may not be possible to remove any of the major turbine parts without doing serious damage to one or more of them.

The principal object of the invention is to provide a new and improved runner band seal for a Francis type turbine which seal is readily removable when seized to the runner, though attached firmly to the stationary structure of the turbine when functioning normally.

Other objects and advantages of the invention are that a smaller seal clearance may be used which provides a higher turbine efficiency. Also in the event of a seizure repairs can be made faster and more economically than with prior constructions. In this connection it is pointed out that the saving in repair time can be a factor of great economical importance with a hydro-electric turbine.

Another object is to provide a device of the type set forth which eliminates the need for provision of dismantling facilities below the runner whereby a large saving in power house cost may be realized.

Other objects and advantages of the invention will be apparent from the following description taken in connection with the accompanying drawings in which the preferred form of the invention has been shown by way of illustration only.

Referring to the drawing:

FIG. 1 shows a sectional view of high head Francis turbines embodying the preferred form of the invention.

FIG. 2 is a fragmentary sectional view showing a modified form of the invention.

Referring more particularly to the figures wherein simi-

2

lar reference characters designate corresponding parts throughout, the turbine includes an inlet 1, a runner generally designated by 2, an outlet generally designated by 3 and a shaft 4. The runner is formed with an upper shroud 5 integral with the runner crown 6; the runner is also provided with lower shroud 7 of which the lower extremity forms the runner band 8. Crown 6 is formed with a flange 9 which constitutes the rotary element of the crown seal. Head cover 11 is provided with stationary crown seal element 10, and the lower stationary structure 12 of the turbine is embedded in a concrete foundation shown generally at 13. Runner band 8 is provided with rotary band seal element 14 which cooperates with stationary band seal element 15 which is fitted into static structure 12. Turbine outlet 3 is defined by the wall 16 of the draft tube. Stationary crown seal element 10 is held to head cover 11 by bolts 17. Stationary band seal element 15 is held to static structure 12 by means of weld 18. Where the rotary band seal element (as in FIG. 2) is not an integral part of runner band 8, rotary band seal element 14 is held to runner band 8 by means of weld 19.

In the event of seizure at the sealing interface of stationary band seal element 15, seal element 14 may readily be freed from static structure 12 by removal of weld 18, after which seal element 15 may be withdrawn vertically along with runner 2 to which it has seized. This is to say that, when weld 18 has been removed, runner 2 may be lifted vertically as in normal dismantling procedure. If stationary crown seal element 10 has seized to flange 9 of runner crown 6, bolts 17 are withdrawn, permitting removal of head cover 11, leaving seal element 10 attached by seizure to runner 2.

When runner 2 has been vertically withdrawn with either seal element 15 or seal element 10, or both, seized to it, the seals, which are much less costly than runner 2 or static structure 12 or head cover 11, may be removed from runner 2 by machining or any other method, even destructive; replacement seals may then be quickly fitted, and runner 2 returned to service undamaged.

The arrangement of FIG. 2 is a modified form of the invention in which detachable rotary band seal element 14 is attached to runner band 8 by weld 19. With this execution, it is possible to return the turbine to service, following a seizure of the band seal elements, more rapidly than in the case of the execution shown in FIG. 1.

The spirit of the invention would be observed if the rotary band seal element were executed as shown in FIG. 2 and the stationary band seal element were to form an integral part of static structure 12. With such an arrangement it would still be possible to release the runner for easy vertical withdrawal in the event of a band seal seizure.

From the foregoing it will be seen that I have provided new and improved means for realizing the objects and advantages of the invention.

I claim:

In a vertically mounted Francis turbine including a stationary structure embedded in concrete, a rotating structure comprising a runner secured to a shaft for rotation within said stationary structure, said runner having band and crown elements, sealing means located between adjacent portions of said band and said stationary structure, said sealing means comprising removable sealing elements secured to the stationary structure and the band segment of the runner and adapted to be released from within the confines of said stationary structure thereby facilitating withdrawal of the runner from the stationary structure in the event said sealing elements seize together.

(References on following page)

## References Cited by the Examiner

## UNITED STATES PATENTS

|           |       |                   |          |    |
|-----------|-------|-------------------|----------|----|
| 786,922   | 4/05  | Smith et al. .... | 103—114  |    |
| 971,850   | 10/10 | Krogh .....       | 103—103  |    |
| 1,114,238 | 10/14 | Doble .....       | 103—114  | 5  |
| 1,238,731 | 9/17  | Anderson .....    | 103—108  |    |
| 1,525,884 | 2/25  | Plummer .....     | 253—77.3 |    |
| 1,783,427 | 12/30 | Jennings .....    | 103—112  |    |
| 1,820,150 | 8/31  | Moody .....       | 253—117  |    |
| 2,475,316 | 7/49  | Garraway .....    | 103—112  | 10 |

|           |       |                 |         |  |
|-----------|-------|-----------------|---------|--|
| 2,818,227 | 12/57 | Suss .....      | 253—26  |  |
| 2,869,471 | 1/59  | Copeland .....  | 103—102 |  |
| 2,919,103 | 12/59 | Schelp .....    | 253—55  |  |
| 2,921,533 | 1/60  | Williams .....  | 103—103 |  |
| 3,066,612 | 12/62 | Haentjens ..... | 103—112 |  |

## FOREIGN PATENTS

1,134,269 11/56 France.

KARL J. ALBRECHT, *Primary Examiner.*JOSEPH H. BRANSON, JR., *Examiner.*