ABSTRACT

TITLE: "AN IMPROVED HIGH PRESSURE OIL HEADER WITH SUBMERGED LEAKAGE OIL DISCHARGE FOR BLADE TURNING MECHANISM OF KAPLAN TURBINES"

The invention relates to an improved high pressure Oil Header with submerged leakage oil discharge for blade turning mechanism of Kaplan turbines, the oil header (10) mounted on the top shaft of the generator to supply high pressure oil to a runner servomotor through a plurality of concentric metallic tubes (9) rotating in registration with the rotation of the turbine blades, the rotating tubes acting as a continuous oil passage from the generator up to a servo chamber disposed inside the (12, 13, 14) with sealing means provided to allow efficient operation of blade movement and minimize oil leakage, the improvement is characterized in that a first plurality of throttle grooves to minimize oil leakage constructed on the bearing bushes (12, 13, 14) extending till a location where a relief chamber (15) is provided for oil bleed off tapping (16) to relieve oil pressure; a second plurality of throttle groove provided after the bleed off (16) to ensure both reduction in oil pressure and minimization of oil leakage one each oil chamber (18, 21) provided respectively at top and bottom bush ends (12, 14) to allow the pressurized leakage oil jets to be submerged instead of directly discharged to the atmospheric air; multiple divergent and angular exit grooves (20) in a direction opposite to the rotational direction of the turbine blades are configured on an end relief groove (19) formed beyond the second plurality of throttle grooves to ensure exit of leaking oil at a low velocity.

{ FIGURE 4 }

WE CLAIM:

1. An improved high pressure Oil Header with submerged leakage oil discharge for blade turning mechanism of Kaplan turbines, the oil header (10) mounted on the top shaft of the generator to supply high pressure oil to a blade turning mechanism through a plurality of concentric metallic tubes (9) rotating in registration with the rotation of the turbine blades, the rotating tubes acting as a continuous oil passage from the generator up to a servo chamber disposed inside the (12, 13, 14) with sealing means provided to allow smooth operation of the turbine and minimize oil leakage, the improvement is characterized in that:

- a first plurality of throttle grooves to minimize oil leakage constructed on the bearing bushes (12, 13, 14) extending till a location where a relief chamber (15) is provided for oil bleed off tapping (16) to relieve oil pressure;

- a second plurality of throttle groove provided after the bleed off (16) to ensure both reduction in oil pressure and minimization of oil leakage;

- one each oil chamber (18, 21) provided respectively at top and bottom bush ends (12, 14) to allow the pressurized leakage oil jets to be submerged instead of directly discharged to the atmospheric air; and multiple divergent and angular exit grooves (20) in a direction opposite to the rotational direction of the turbine blades are configured on an end relief groove (19) formed beyond the second plurality of throttle grooves to ensure exit of leaking oil at a low velocity.

Dated this 10TH day of JANUARY 2014

(P D GUPTA)
OF L.S. DAVAR & CO
APPLICANTS' AGENT

BHARAT HEAVY ELECTRICALS LIMITED

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SHEET-1

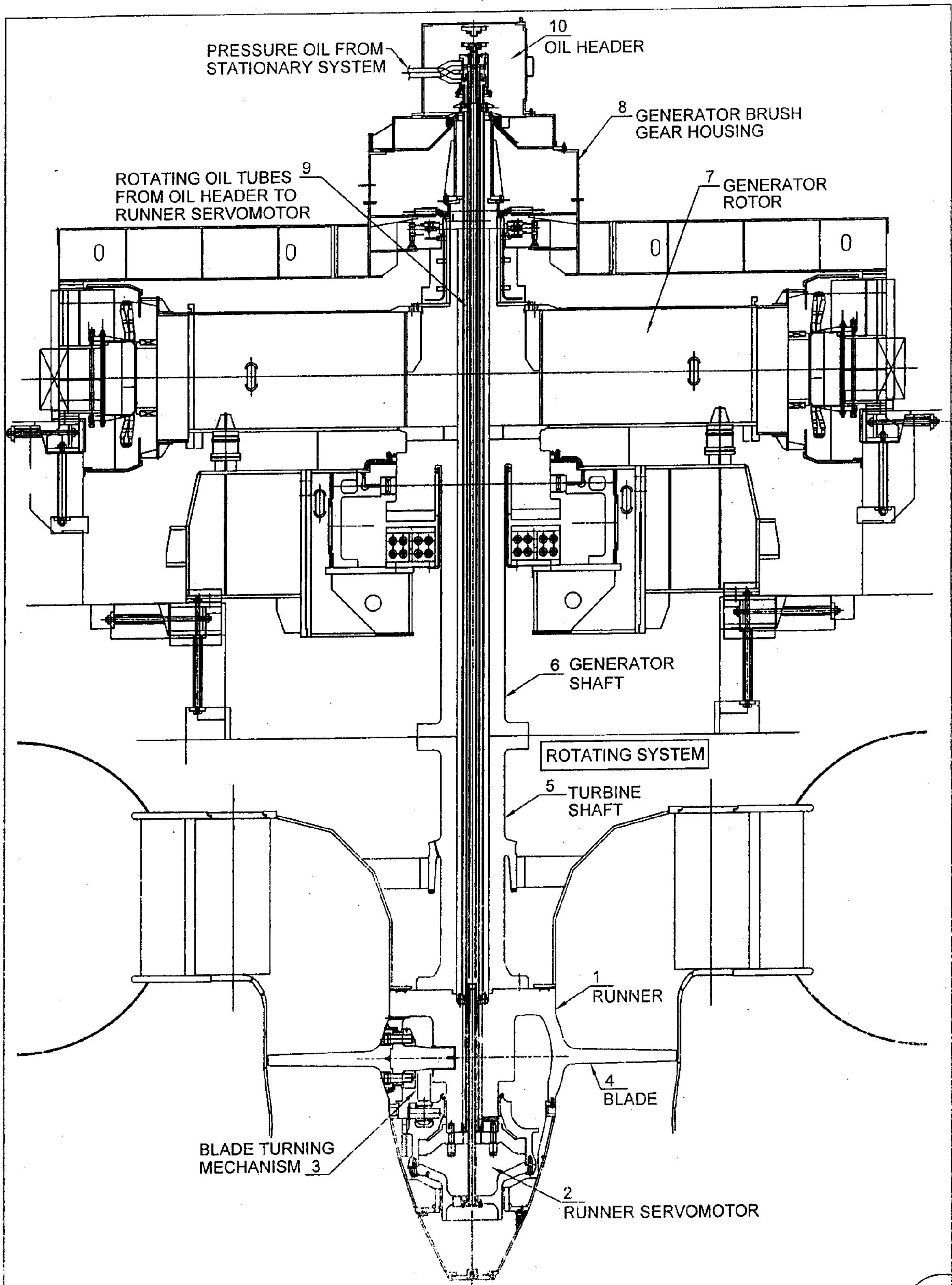

Fig-1

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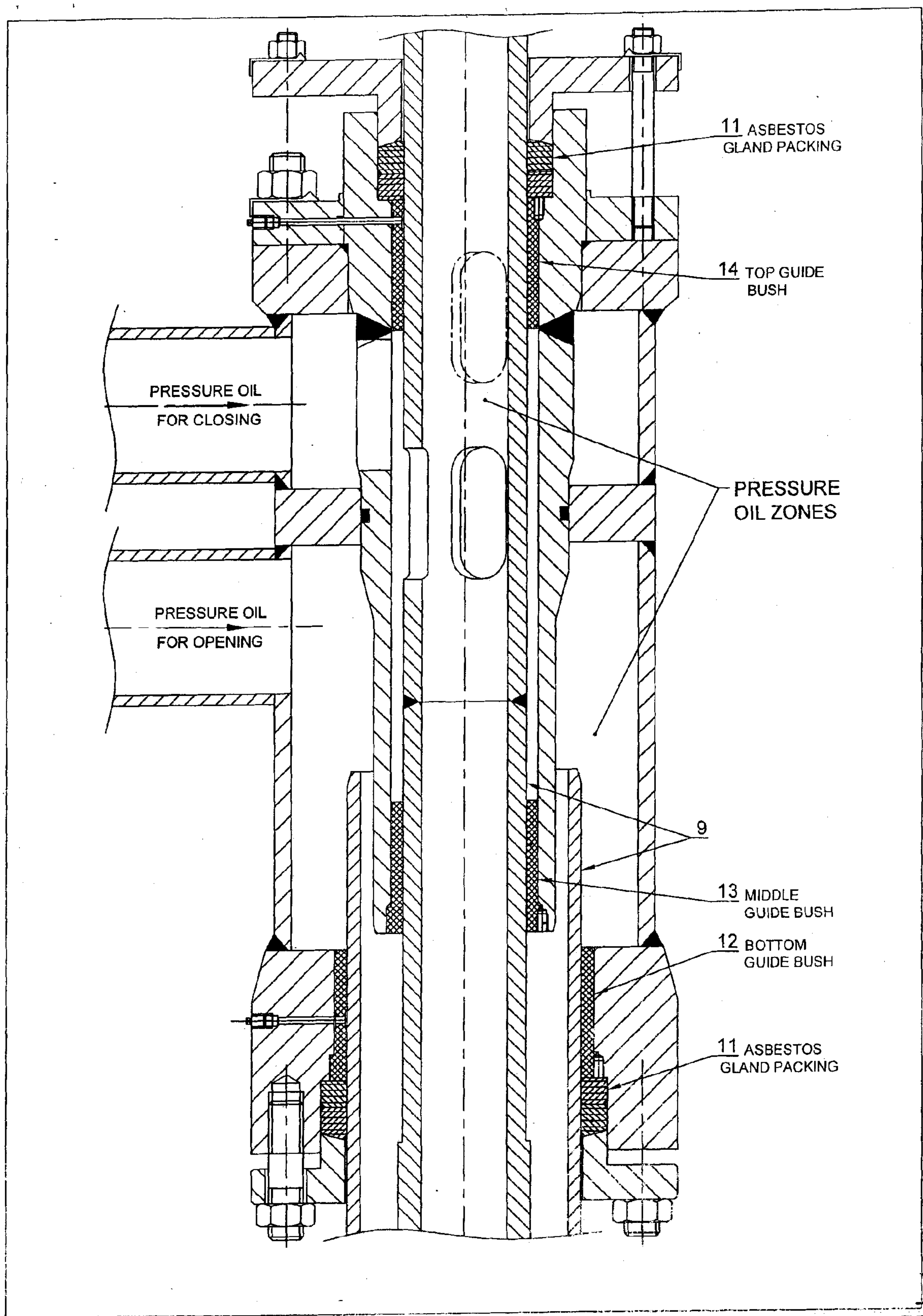

Fig - 2

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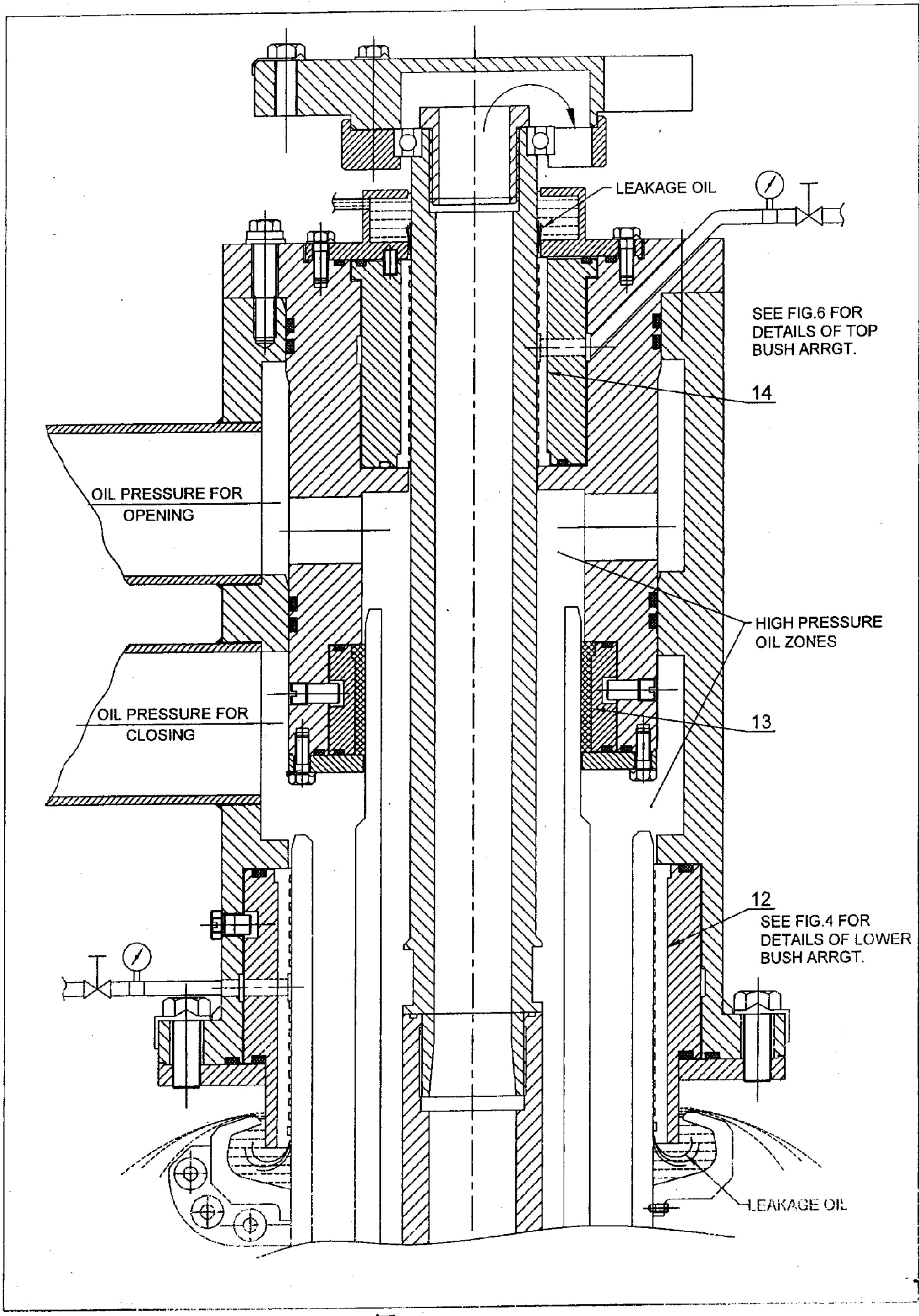

Fig - 3

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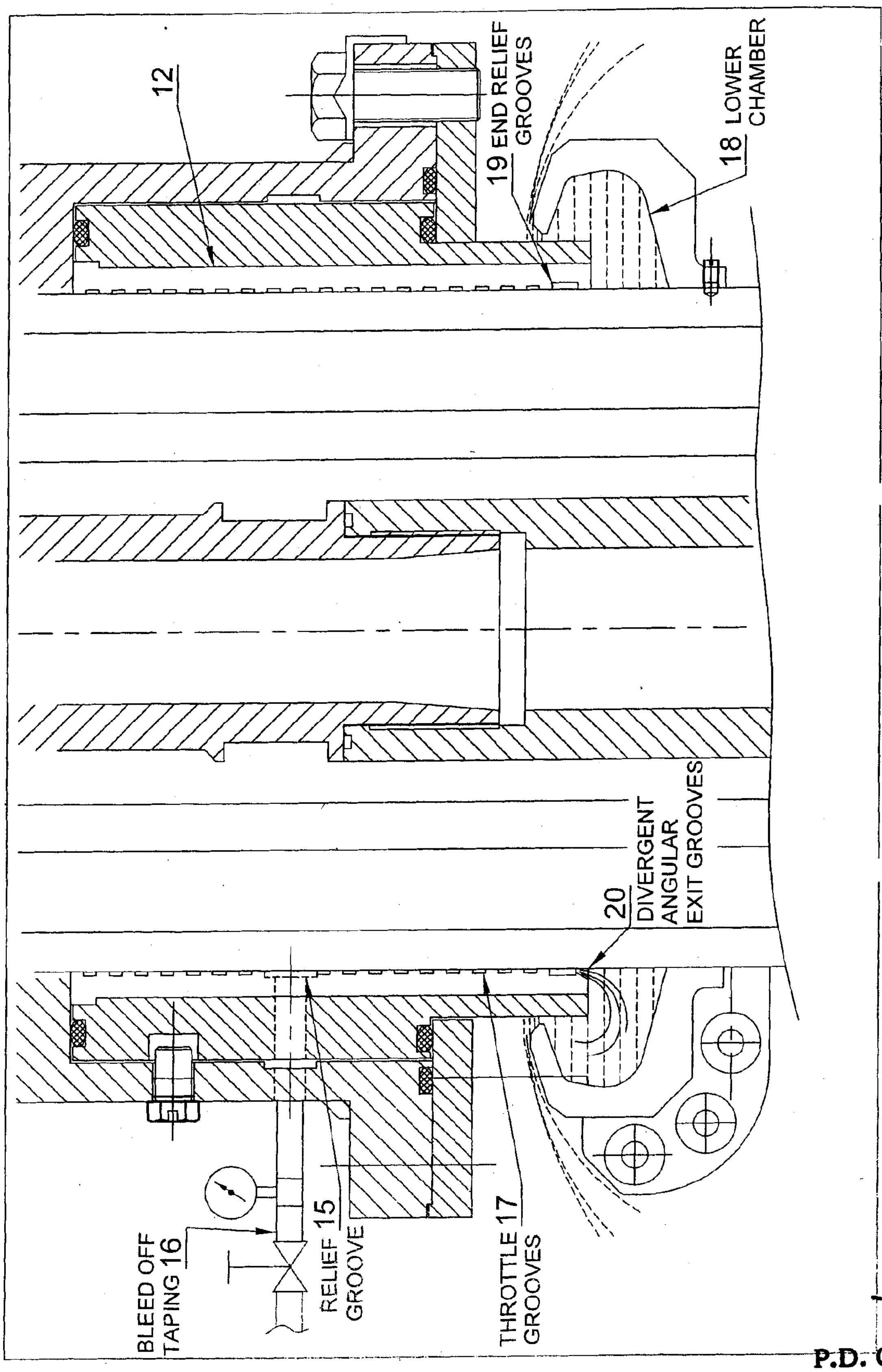

Fig-4

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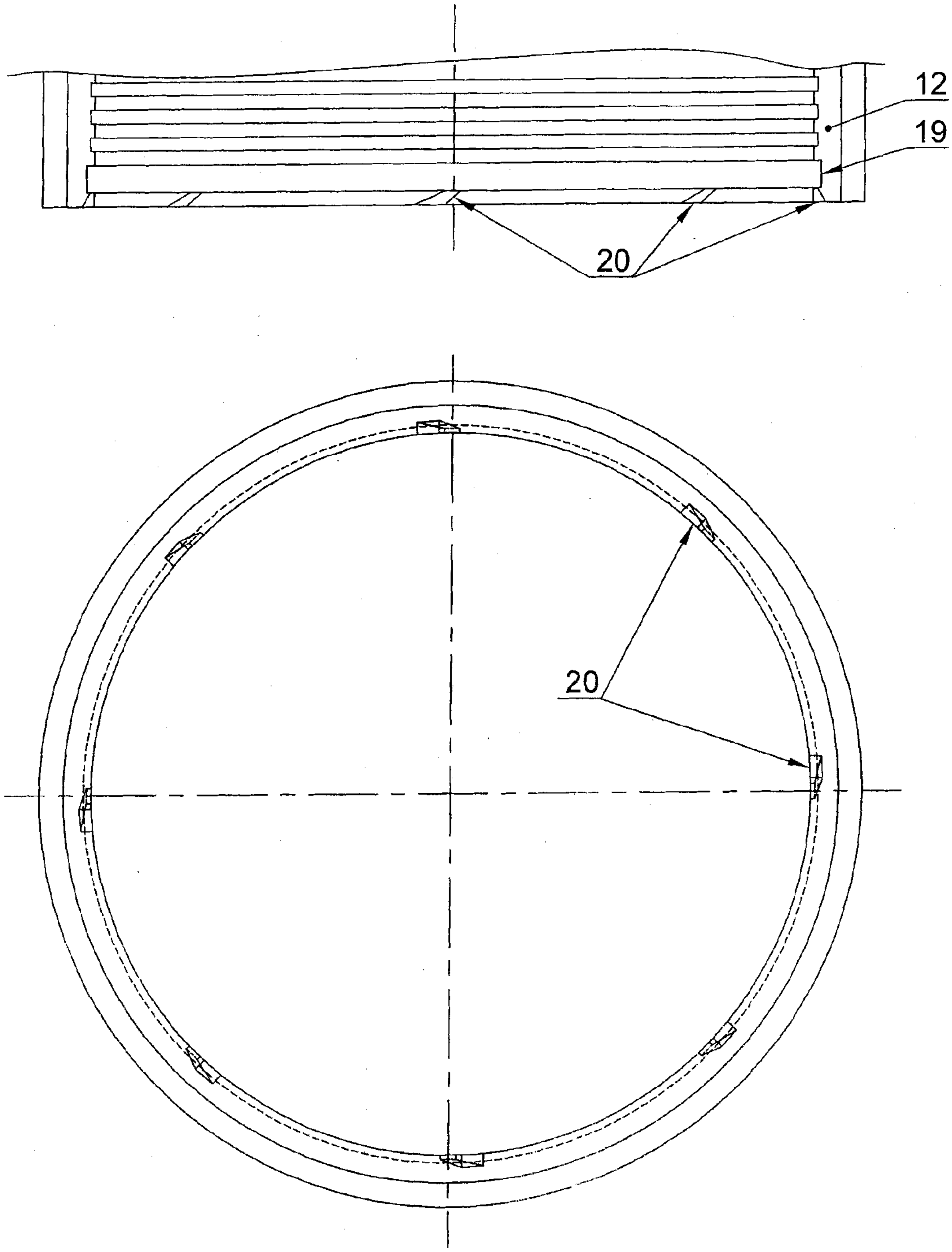

PLAN VIEW OF DIVERGENT ANGULAR EXIT GROOVES

Fig - 5

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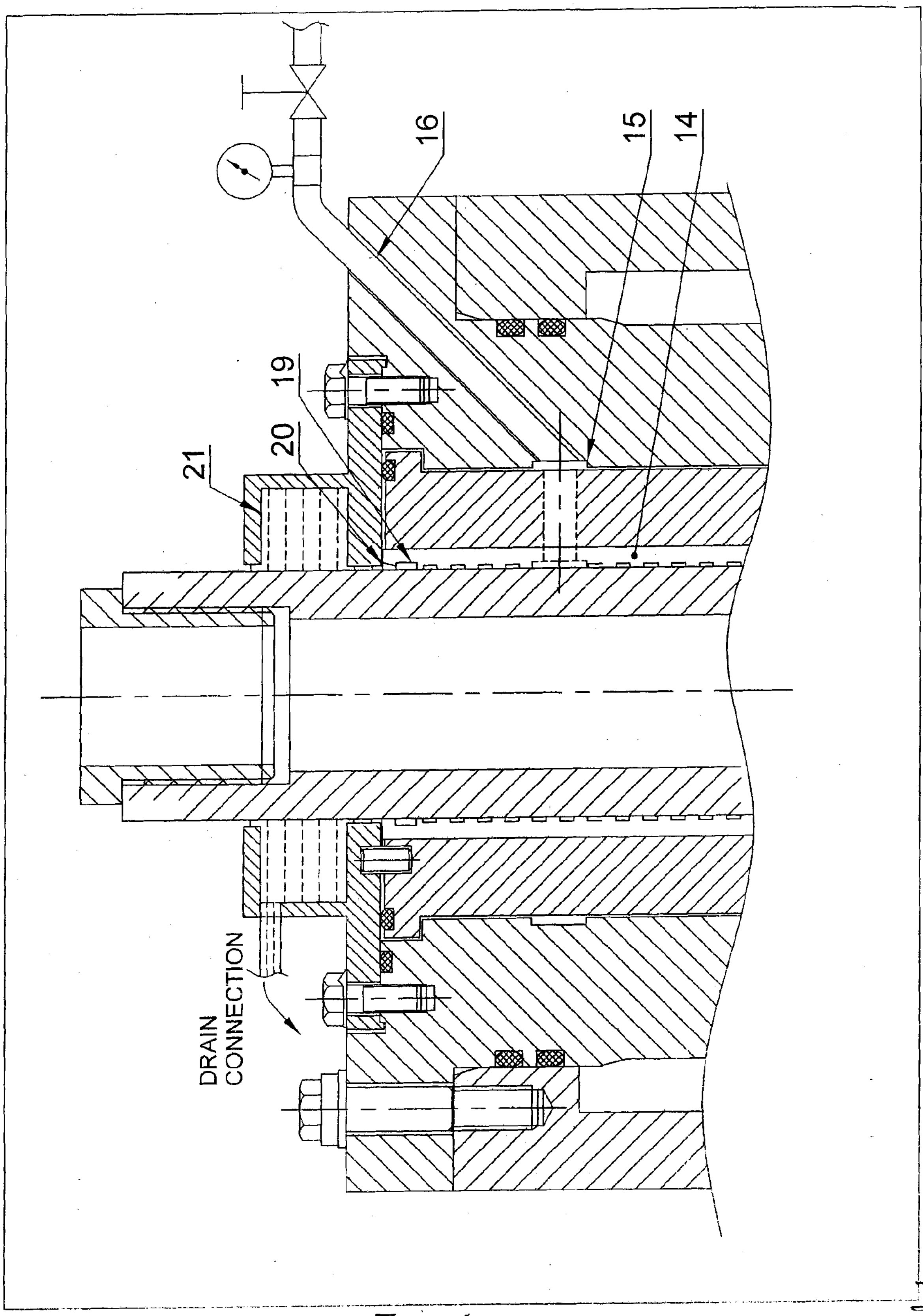

Fig-6

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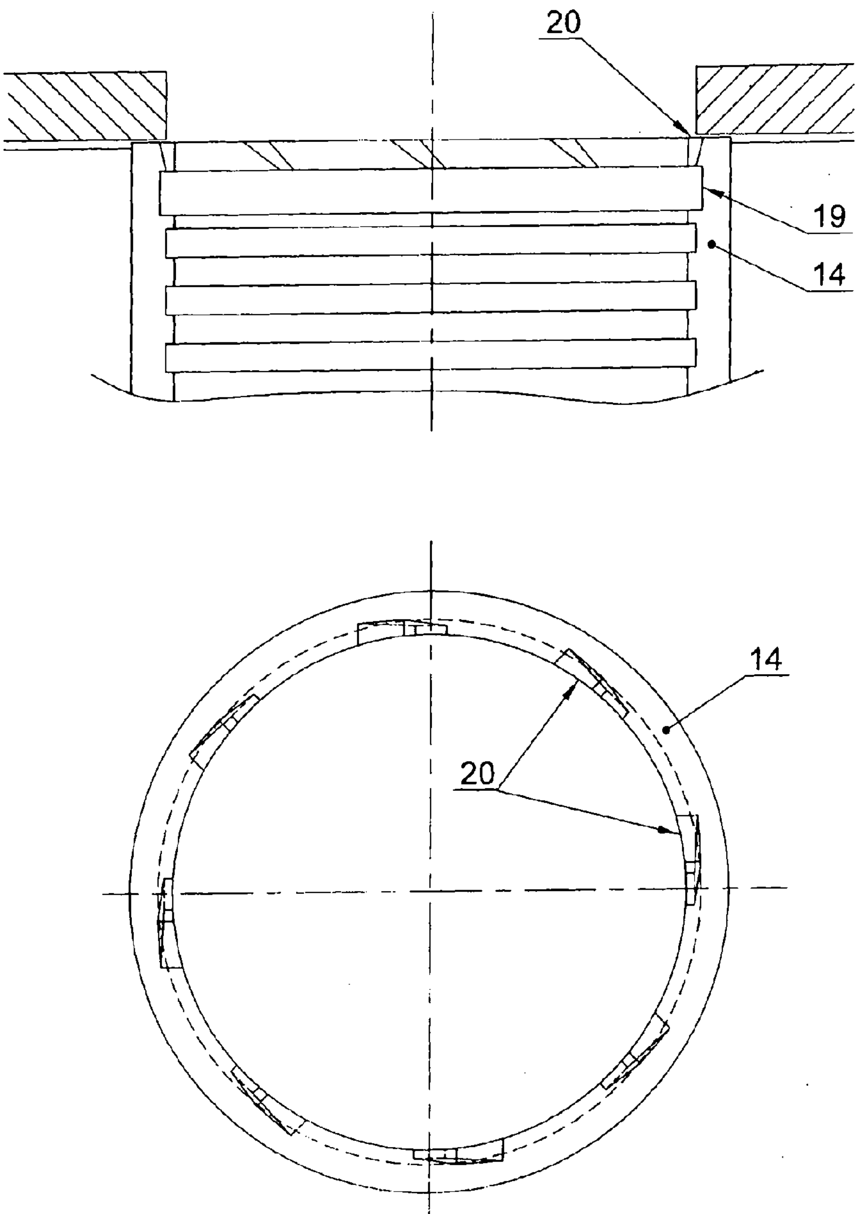

PLAN VIEW OF DIVERGENT ANGULAR EXIT GROOVES

Fig-7

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FIELD OF THE INVENTION

The invention relates to high pressure Oil Header for blade turning mechanism of Kaplan type Hydro Turbines. More particularly the invention relates to an improved high pressure Oil Header with submerged leakage oil discharge.

BACKGROUND OF THE INVENTION

Oil Header is required in Kaplan Turbines for Oil pressure supply to the Runner Servomotor (2) through concentric steel tubes (9) for oil passage. The main function of an oil header (10) is to supply high pressure oil to said tubes (9) rotating along with the runner (1) while minimizing leakage of oil which is essential for effective functioning of said blade turning mechanism. Figure 1 illustrates a known arrangement of a blade turning mechanism of Kaplan Turbines. The leakage of very high pressurized hot oil in the form of jets from the clearances between a plurality of stationary body bushes and the rotating oil tubes (9) might catch fire and hence it is necessary from safety aspects that the leaking hot oil jets do not immediately come in contact with atmospheric air.

Earlier the oil pressure system used in old Kaplan Turbines was of quite low pressure in the range of 40 to 60 kg/cm2. In such cases, asbestos rope gland sealing (11) were used to minimize the leakage of oil from the oil header (10). Figure 2 illustrates prior mechanism of oil header for such low oil pressure systems. In these cases, the fibres of asbestos ropes (11) frequently get detached in the relative zones of the interference between the bushes and the rotating oil tubes (9) which further goes into a governor oil system necessitating the use of a filter in the return oil circuit. Also the wear rate of these asbestos ropes (11) is quite high which leads to shut down of machines every two months of operation.

In order to reduce the servomotor sizes in the turbines, the prior art subsequently had adopted high pressure oil systems in the range of 40 to 60 kg/cm2. The major challenge in operating with high pressure oil systems is the safe and efficient functioning of the oil header (10) of Kaplan Turbines. Presently, the oil pressure systems operate at a pressure range of 100 to 160 kg/cm^2. In such cases, only a minimum leakage of oil may be allowed to ensure effective functioning of blade turning mechanism (3). Also for safe working, an arrangement is required to prevent leakage of hot oil in the form of fine jets and mist to atmosphere to avoid catching fire inside the Oil Header (10).

As described herein above, with the advancements in very high pressure, oil storage devices for example, nitrogen filled piston accumulators, adoption of high pressure operating systems for turbine controls in the range of 100 to 160 bar is gaining popularity on account of the advantages of compactness and economy.

Use of high oil pressure for turbine controls does not pose any such problem for Pelton and Francis type hydro turbines; however it poses a problem in Kaplan turbines on account of heavy leakages at the oil header supplying oil under pressure to a runner servomotor (2) through the rotating oil tubes. Also the leaking hot oil jets from the sealing bushes coming in contact with atmospheric air carry the risk of catching fire.

CN 201220124863 discloses an oil-supply head sealing device for an axial flow Kaplan turbine generator set. The oil-supply head sealing device comprises an oil-supply head body, sealing covers and sealing rings, wherein operation oil tube assembly holes are formed at the upper end and the lower end of the oil supply head body; an oil cavity is formed in the oil-supply head body; the sealing covers are fixed at the upper end and the lower end of the oil-supply head body; the sealing rings are positioned in the assembly holes and comprise sealing limiting sleeves; the sealing limiting sleeves are fixed on the sealing covers; the copper sleeves are movably positioned in the sealing limiting sleeves; clearances are reserved between the outlet walls of the copper sleeves and the inner walls of the sealing limiting sleeve; limiting bosses positioned in the sealing limiting sleeves are formed on the sealing covers; limiting slots of the sealing limiting sleeves; limiting bosses positioned in the sealing limiting sleeves are formed on the sealing covers; limiting slots corresponding to the limiting bosses are formed on the copper sleeves; and the outer walls of the sealing limiting sleeves are tightly attached to the inner walls of the assembly holes. The oil-supply head sealing device has the advantages of compact structure and convenience in machining and can prevent an oil-supply head from leaking oil; the use reliability is improved; on the premise of guaranteeing the displacement of the copper sleeves, the weights of the copper sleeves are reduced; the cost is reduced; the friction is reduced; and a phenomenon that operation oil tubes are locked is avoided.

CN 200810151364 teaches an oil-supply head of a Kaplan type turbine, which comprises an operating oil pipe assembly, an oil-supply head body, a front oil tank and a restoring mechanism; the oil-supply head is characterized in that the operating oil pipe assembly comprising an inner pipe, a middle pipe and an outer pipe is connected with the oil supply head body which is produced by a seamless steel pipe into a whole structure, the outer wall of the operating oil pipe assembly is sheathed with a sealing pad and a revolving ring, an oil-supply head seat is connected with the oil-supply head body, one end of the oil-supply head body is connected with the front oil-tank, the end part of the inner pipe of the operating oil pipe assembly is connected with a swing link type restoring mechanism; all pipe bodies of the operating oil pipe assembly are connected by thread heads, the joint is provided with limited blocks, the outer walls of the inner pipe and the middle pipe of the operating oil pipe assembly are fixedly provided with guide blocks and limited blocks and the oil-supply head seat is a steel plate welded structure. The oil-supply head has the advantages that the outer pipe of the operating oil pipe assembly does not need the supplement of a front-end shaft a generator, has more simplified structure, is convenient to install and can avoid oil leakage; the restoring mechanism can accurately detect the middle position of the stroke of a vane in virtue of the movement of a fork joint and a swing link, thus leading to more accurate feed back and higher sensitivity.

CN 200820142645 discloses an improved structure of an oil supply head of an axial-flow adjustable-blade water turbine. The improved structure comprises a base fixedly installed on a collector ring cover, an oil dish positioned in the base and fixedly connected with a front end shaft of a motor, an oil supply head body fixedly installed on the base, and a floating tile installed on a tile seat of the oil supply head body. The improved structure is characterized in that regulating clearances are formed on the floating tile, and the end surface and the side surface of the tile seat of the oil supply head body; and both the oil supply head body and the oil dish adopt plate welding structures. The improved structure has the advantages that the floating tile can achieve automatic position adjustment, thereby avoiding problems of tile lapping, slip, oil leakage and the like during operation of the oil supply head, which are caused by processing and installation errors of operation oil pipes, so that the operation stability of the oil supply head is ensured; besides, both the oil supply head body and the oil dish adopt the plate welding structure, so that not only the quality of the oil supply head is ensured, but also manufacture costs of the oil supply head is reduced; and furthermore, the processing cycle is shortened.

OBJECTS OF THE INVENTION

It is therefore an object of the invention to propose an improved high pressure Oil Header with submerged leakage oil discharge for blade turning mechanism of Kaplan turbines.

Another object of the invention is to propose an improved high pressure Oil Header with submerged leakage oil discharge for blade turning mechanism of Kaplan turbines which minimizes the leakage of oil at high pressures.

A further object of the invention is to propose an improved high pressure Oil Header with submerged leakage oil discharge for blade turning mechanism of Kaplan turbines which prevents possibility of fire hazards inside the oil header.

SUMMARY OF THE INVENTION

Accordingly, there is provided improved high pressure Oil Header with submerged leakage oil discharge for blade turning mechanism of Kaplan turbines. The improved oil header addresses both the prior art problems of heavy oil leakage and fire hazard. Oil leakage is minimized by providing a plurality of throttle grooves and arranging an oil bleed-off from an intermediate relief groove. The risk of fire hazard is eliminated primarily by locating oil chambers at the ends of the top and bottom oil bushes so that the leaking oil does not come in contact with air but gets submerged in oil. Additionally at end of top and bottom bushes, an end relief groove has been provided with at least six divergent angular exit grooves. These angular exit grooves are divergent radially and tangentially so that escaping oil is highly diffused and not in the form of jets. Also, the angular grooves being in a direction opposite to that of direction of rotation resulting a reverse pumping action, which further minimizes the leakage.

BRIEF DESCRIPTION OF THE ACCOMPANYING DRAWINGS

Figure 1 : Overall Arrangement of a known Kaplan Turbine

Figure 2 : Prior Art Arrangement of oil header

Figure 3 : High Pressure oil header with submerged leakage oil discharge according to the invention.

Figure 4 : Details of lower bush and lower chamber arrangement of the high pressure oil header of figure 3.

Figure 5 : Details of lower bush exit grooves of the high pressure oil header of Figure 3.

Figure 6 : Details of top bush and top chamber arrangement of the high pressure oil header of Figure 3.

Figure 7 : Details of angular exit grooves of the top bush of the high pressure oil header of Figure 3.

DETAILED DESCRIPTION OF THE INVENTION

In Kaplan Turbines of Hydro-Electric projects, an oil pressure system is required for Runner servomotor (2) for Blades turning operations. The oil chambers of these servomotors are installed inside a Runner Hub and Cone, Comprising of piping system of concentric tubes for these chambers is installed in the central bores of turbine and generator shafts. These tubes are connected to the oil servo chambers inside the Runner Hub and hence these oil tubes are rotating along with the Runner.

According to the invention, the improved oil header (10) is an arrangement of a fabricated steel structure mounted at the top of the generator for oil connections. The Oil header (10) ensures proper communication of oil through the rotating tubes (9) right from the generator top, up to the runner servo chamber inside the runner hub. It is provided with bearing and sealing arrangement for smooth running operation with ability to absorb wobbling of the generator top shaft on which the oil header (10) tubes are mounted. The main challenge of the system is to minimize the leakage corresponding to the wobbling effect of the rotating oil tubes.

For the inventive high pressure oil systems, a plurality of throttle grooves are provided in the bearing (12, 13, 14) to minimize the oil leakage. At a location of about 40% to 50% of throttle grooves, a relief chamber (15) is provided from which oil is bleed off (16) to relieve the pressure (refer Figure 3). This would thus reduce the oil pressure for the next stage of the throttle grooves and thus minimize the oil leakage.

Another major concern in high pressure oil header is that the oil which escapes through the fine bearing clearances gets heated up. Hence the most important safety aspect of the improved high pressure oil header is that the hot oil leaking in the form of fine jets might catch fire while leaking into the atmosphere. To take care of this, oil chambers (18 and 21) have been introduced at both the ends of top and bottom bushes (12, 14) so that the hot pressurized leakage oil jets are not exposed to the atmosphere but are submerged in oil.

The hot oil leakage from the bushes (12, 14) might come out to the atmosphere in the form of vertical jets. To prevent such occurrence, an end relief groove (19) is made at the end of second stage of throttle grooves and divergent angular exit grooves (20) are made in a direction opposite to the direction of rotation of the system. Refer detail of grooves in figures 5 and 7. Such divergent angular exit grooves (20) have the following functions:

a. Six to eight of such grooves are provided having a combined area, higher than the clearance area between the rotating oil tube and the bush. Thus this enlarged area of the exit grooves (20) ensures that the velocity of leaking oil drops down drastically and leaking oil does not spurt out in the form of jets or mist.

b. The grooves being at an angle, the leakage jets from the end of the bush does not escape vertically through the clearance / gap. The jets if any comes out of an angle, somewhat tangentially creating a swirl action.

c. The angular grooves (20) are divergent in the radial direction also, so that the leaking jets which are highly diffused are also at an angle to the vertical escape through a vertical gap.

d. If the angular grooves are in the same direction as that of rotation, a sucking action will generate and leakage will increase. Hence by making the angular grooves in the opposite angle from the direction of rotation, the rotation of the tubes will oppose the leakage of oil and hence the discharge of leakage oil would reduce.

Thus, the improved high pressure oil header becomes safe and effective on account of the following features:

i) Location of the Oil Chambers (18 and 21) allowing a submerged oil leakage;

ii) a plurality of throttle grooves with intermediate bleed off (16) to minimize leakage; and

iii) a plurality of divergent Angular exit grooves (20) at the end of the bushes in a direction opposite to the direction of rotation of the tubes minimizes leakage and prevent leakage oil jets from coming out vertically.

List of features of the invention

1. Runner
2. Runner servomotor
3. Blade Turning mechanism
4. Blade
5. Turbine Shaft
6. Generator Shaft
7. Generator Rotor
8. Generator Brush Gear Housing
9. Oil Tubes
10. Oil Header
11. Asbestos gland packing
12. Bottom guide bush / bearing
13. Middle guide bush / bearing
14. Top Guide bush / bearing
15. Relief Groove
16. Bleed-off tapping
17. Throttle Grooves
18. Lower chamber
19. End Relief groove
20. Divergent angular exit grooves
21. Upper Chamber