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(54) **Insulation in a low-pressure turbine plant.**

(57) Insulation in a low-pressure turbine plant in order to reduce power losses caused by heat transport from hot inner surfaces to cooler outer surfaces of walls in the turbine and associated equipment. The walls are insulated externally against a surrounding vacuum space (7) with an elastomeric sheeting (1). The sheeting is fixed with sheet elements or rivet-like means.

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INSULATION IN A LOW-PRESSURE TURBINE PLANT

The invention relates to an insulation in a low-pressure turbine plant according to the precharacterising part of claim 1.

Power plants for generation of energy comprise, inter alia, low-pressure turbines with a condenser connected thereto. The low-pressure turbine with connecting conduits is surrounded by an outer turbine housing. Around the entire low-pressure turbine, between its inner housing and its outer housing, there is a space which is in direct communication with the condenser. Throughout the remainder of this description, this space is considered to form part of the condenser. The low-pressure turbine with those portions of the associated connecting conduits which are located inside the outer turbine housing can then be considered to be enclosed in the condenser. In the condenser and consequently also in the space between the inner turbine housing and the outer turbine housing, a pressure prevails which is near vacuum. The connected spaces mentioned are designated "vacuum space". Hot gas or steam, originating from the steam generator of the power plant, flows, under expansion, through the turbine and from there into the vacuum space in the surroun ding condenser. In the vacuum space a considerably lower pressure and temperature of the steam prevail. Since the temperature difference between the interior of the inner turbine housing with associated connecting conduits, which are traversed by hot steam, on the one hand, and the vacuum space on the other hand may be great, a not-insignificant heat transport in the form of thermal conduction through the walls of the inner turbine housing occurs. This results in heat losses in the turbine, which cause a reduction of the power thereof. Besides this power loss, the heat transfer to the condenser from the turbine results in a reduction of the temperature of the steam, which is discharged from the turbine for different purposes through steam extraction conduits. Thus the moisture content of the steam is increased, and this entails problems with material wear in the turbine equipment because of erosion and corrosion.

To reduce the power losses in connection with the above-mentioned heat transfer, it is desirable, inside the vacuum space, to insulate the walls of the turbine and associated equipment externally around spaces which enclose hot steam.

Such insulation has been carried out only to a small extent in the past. The problems of applying insulation on turbine housing walls and connecting conduits are considerable. The surfaces which are to be insulated are subjected to vibrations, high temperature, constant presence of water steam and condensed water. The spaces are not accessible for service and inspection other than at normal inspection intervals.

In view of the above difficulties, it is common for the hot surfaces to be left uninsulated.

One method of insulation which is used to a certain extent is based on providing the hot turbine surfaces inside the outer turbine housing with a casing of sheet metal. Between the sheet metal casing and the inner turbine housing walls there are insulating air spaces, which are in contact with the surroundings only through ventilator slots. An insulation designed in this way functions well, but has disadvantages. The design is very costly. Because of vibrations, sheets may loosen, fall down and damage underlying condenser conduits. Thus, the insulating sheets may cause interruption of the operation and downtime for the plant. The downtimes can be exceedingly costly in power plants in which this type of turbine plants are utilized.

The invention aims at designing an insulation in a low-pressure turbine plant which considerably reduces the above-mentioned heat transfer from the turbine to the condenser without causing any hazards for uninterrupted normal operation of the turbine plant.

To achieve this aim the invention suggests an insulation in a low-pressure turbine plant according to the introductory part of claim 1, which is characterized by the features of the characterizing part of claim 1.

Further developments of the invention are characterized by the features of the additional claims.

As mentioned above, those turbine plant parts whose surfaces are to be insulated are surrounded by the vacuum space of the condenser. This means that these surfaces are in an atmosphere of water steam. Oxygen and other aggressive gases occur in very small contents. Thus, the environment is quite different from that in ordinary air. This makes it possible to use in the insulating materials which are not broken down to any mentionable degree in the uniform environment.

As insulation there is used an elastomeric sheeting, which is applied on the surfaces to be insulated. The insulating sheeting may, for example, have a thickness of 3-10 mm, depending on the heat transfer parameters of parts in the turbine equipment. As elastomeric material in the insulating sheeting, rubber or rubber reinforced with fabric may be used. This rubber or the material used must possess certain properties. The insulating power must be good. The material must endure the high temperatures and the moist environment for a long period of time.

The environment is characterized by vacuum with a typical pressure of 0.004 MPa, moist steam and a high velocity of flow of moist steam towards the surfaces which are contacted. The quality of the elastomer should preferably be such that the insulating sheeting is able to withstand the erosion to which it is subjected when contacted by the flow of moist steam, the velocity of which may amount to 200 m/s. The insulation is to withstand internal stresses and thermal expansion, which stresses and expansion in the present invention occur in vacuum environment.

A number of different methods may be used for fixing the insulating sheetings to the surfaces to be insulated. The insulating sheetings may be fastened with a number of thin plates which are fixed, screwed or welded at even intervals. Straps of sheet metals or some other material may be passed around the insulating sheetings, when these surround cylindrical surfaces. The insulating sheetings may be glued, or possibly sprayed, in position even during the manufacturing stage. Another suitable methòd for fastening is to use short tubular collared elements, which are passed through holes provided in the insulating sheetings and which are internally welded to the surfaces to be insulated. The collar on top of the collared element presses the sheeting in place against the surfaces to be insulated.

The insulating sheeting makes contact with surfaces in a space with vacuum atmosphere. This entails a certain risk of the sheeting being sucked loose from the insulated surfaces, since the pressure in the surroundings may become lower than between the insulating sheeting and the surface to be insulated. To prevent this, the sheeting may be provided with a number of small through-holes which equalize the pressure between the inner and outer sides of the insulating sheeting.

An advantage with the use of the insulation according to the invention manifests itself if local damage to the insulation should arise. Pieces of the sheeting which may loosen and fall down into the condenser may hardly cause any damage because of their low specific weight and may be cleaned away from the bottom of the condenser during the next service inspection.

By way of example, the invention will now be described in greater detail with reference to the accompanying drawings showing in

Figure 1 a section through the turbine housing and turbine connections with insulated walls and the surrounding outer turbine housing, as well as a condenser,

Figure 2 the principle of fastening an insulating sheeting around the surface of a inner turbine housing between two bulkheads,

Figure 3 the design of a fixing plate intended to keep the insulation in place around cylindrical surfaces,

Figure 4 a fastening element for fixing the insulating sheeting through holes provided therein.

Figure 1 shows a low-pressure turbine plant with the parts onto which, according to the invention, an elastomeric insulation 1 is to be fixed. These parts consists of a low-pressure inner turbine housing 2 with extraction chambers 3, steam extraction conduits 4 and preheaters 5. All of these items are insulated with the intended insulation 1 only on surfaces which are enclosed within the casing of the outer turbine housing 6 and which face outwards towards the vacuum space 7 inside the outer turbine housing 6. The condenser 8 is connected to the outer turbine housing 6 such that the condenser 8 and the outer turbine housing 6 together form the common vacuum space 7.

As insulating material according to the invention there has been chosen a sheeting 1 of rubber with a preferred thickness of 7 mm and a preferred rubber quality designated 4896 - SBR, a styrene rubber from Trelleborg AB.

For the attachment of the rubber sheeting two preferred methods are used, depending on whether the underlying surface is curved or plane.

The curved surfaces which are to be insulated are largely cylindrical and divided by a number of bulkheads 9. Between these bulkheads 9 a number of fixing plates 10 are located at regular peripheral intervals parallel to the longitudinal axis of said cylindrical surface and in parallel with one another around the entire periphery of the cylindrical surface. These fixing plates 10 are provided along their longitudinal edges with sheet folds 11 for longitudinal stiffening. Each end of the fixing plates 10 is provided with a pair of projecting extensions which are bent into transverse sheet folds 12, which make an obtuse angle with the longitudinal axis of the fixing plate 10 (see Figure 3). The fixing plates 10 are pressed down in place between two bulkheads 9 for retaining the rubber sheeting 1. In addition, the trans verse sheet folds 12 at the ends of each fixing plate 10 are welded to the respective bulkhead 9 with a weld joint at the upper edge of the transverse sheet folds 12. This solution allows the fixing plates 10 to absorb thermal movements in the joined members.

Where no projecting bulkheads occur, or if the surfaces to be insulated are plane, the rubber sheeting 1 is fastened with tubular, collared elements, so-called tubular rivets 14, which are welded to the underlying surface. Tubular rivets 14 are placed in holes provided in the rubber sheeting 1, whereafter each tubular rivet 14 is fixed with a weld joint internally to the insulated sheet metal surface with which the rubber sheeting 1 makes contact. The collar 15 on each tubular rivet 14 presses down the rubber sheeting 1 against the insulated metal surface. The collar 15 may be made internally threaded, permitting it to be threaded onto the rivet body 16, which is then provided with corresponding threads, after mounting of the rubber sheeting 1.

Claims

1. Insulation in a low-pressure turbine plant comprising a low-pressure turbine with a low-pressure inner turbine housing (2), extraction chambers (3), steam extraction conduits (4), and preheaters (5) enclosed within the vacuum space (7) form by an outer turbine housing (6), **characterized** in that at least the inner turbine housing (2) with the extraction chambers (3) enclosed in the outer turbine housing (6) are externally insulated by a sheeting (1) of elastomeric material against the vacuum space (7).

2. Insulation according to claim 1, **characterized** in that those sections of the steam extraction conduits (4) and the preheater (5), which are enclosed in the outer turbine housing (6), are insulated by a sheeting (1) of elastomeric material against the vacuum space (7).

3. Insulation according to claim 1 or 2, **characterized** in that the sheeting (1) is fastened with sheet metal holders (10) pressed down between bulkheads (9) and attached at each end to the bulkheads (9), suitably by welding.

4. Insulation according to any of the preceding claims, **characterized** in that the sheeting (1) is fastened with tubular, collared elements (14), fitted through holes in the sheeting (1) and internally welded to the insulated metal surface.

5. Insulation according to claim 4, **characterized** in that the collar (15) and the neck of said tubular, collared elements (14) are provided with corresponding threads enabling the collar to be threaded to the neck of the cylindrical body (16) of the elements (14).

6. Insulation according to any of the preceding claims, **characterized** in that straps of sheet metals or some other material are passed around the insulating sheetings which surround cylindrical surfaces.

7. Insulation according to any of claims 1-3 **characterized** in that the insulating sheetings are glued or sprayed to the surfaces to be insulated.

8. Insulation according to any of the preceding claims, **characterized** in that the sheeting (1) is provided with through-holes for equalizing any pressure differences between both sides of the sheeting.

FIG. 1

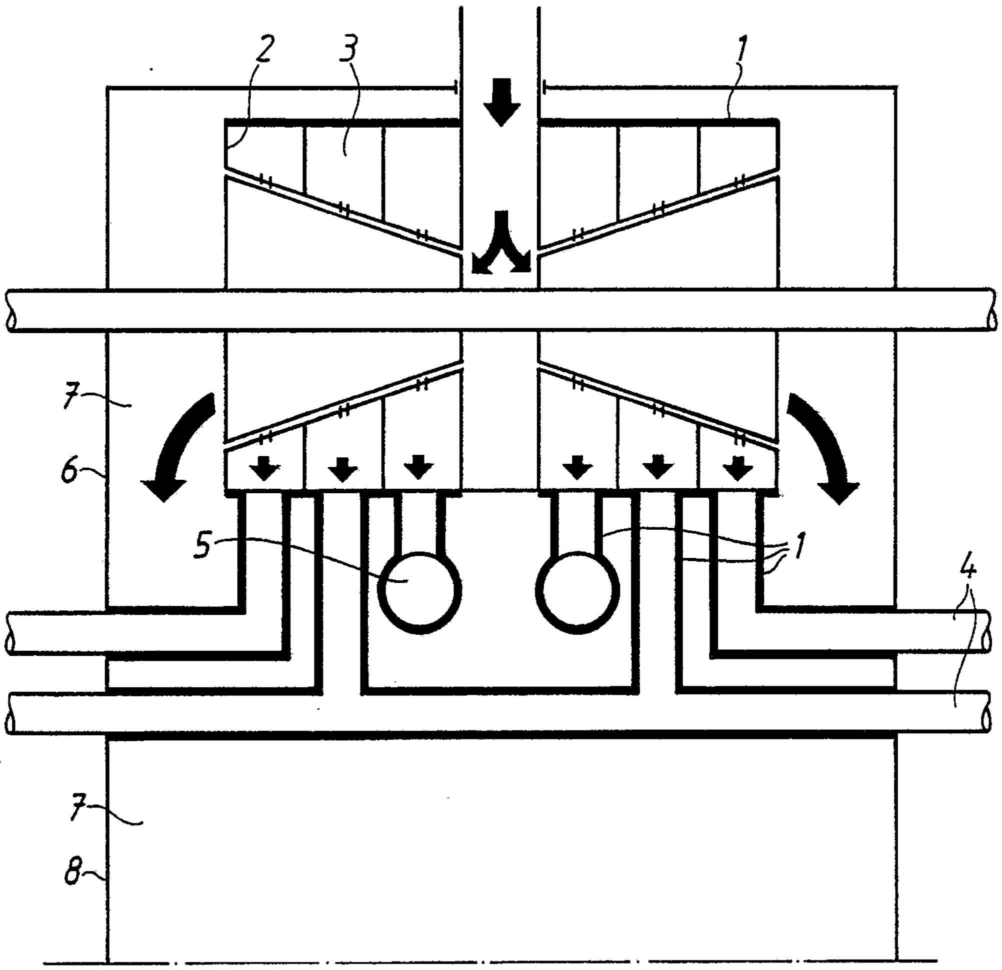


FIG. 2

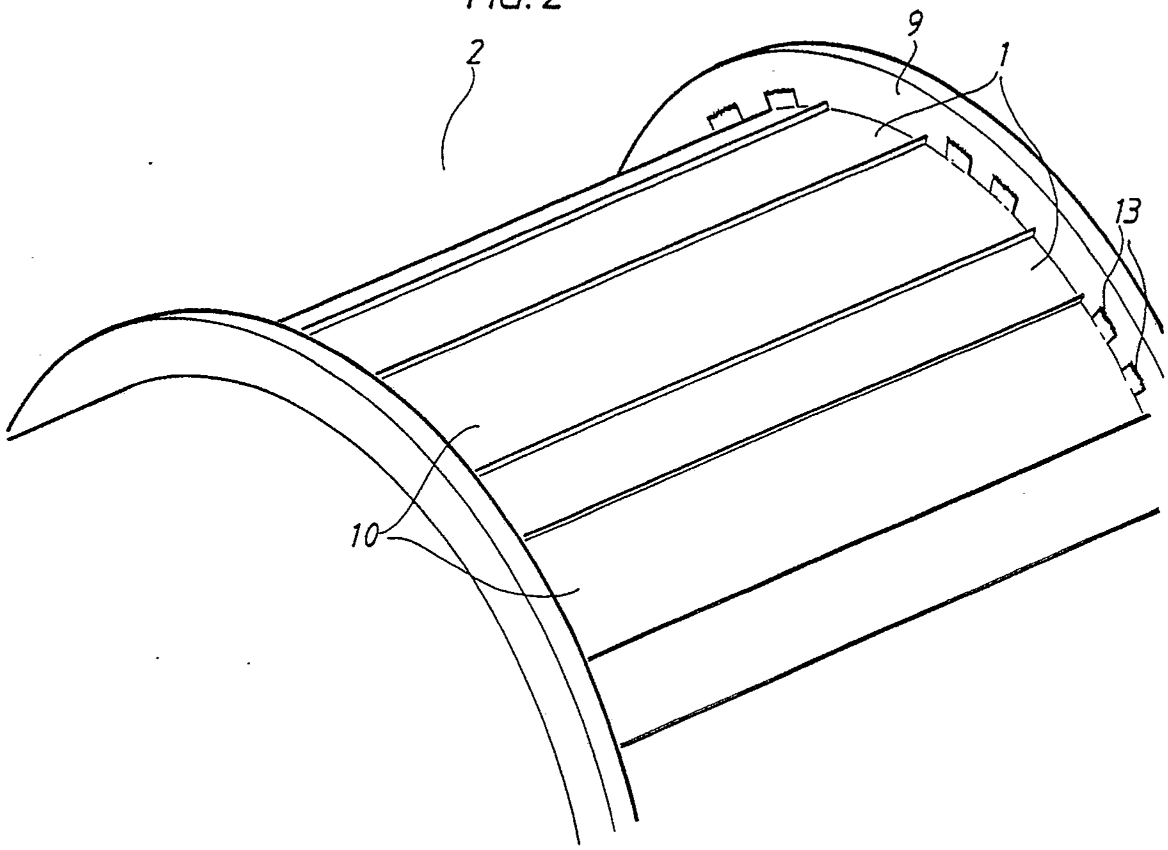


FIG.3

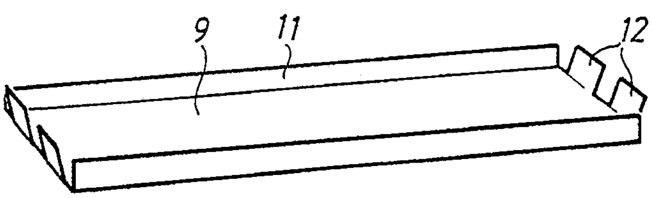
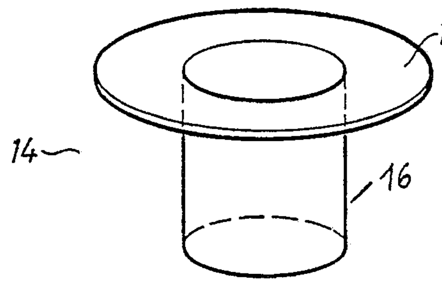


FIG. 4



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EUROPEAN SEARCH REPORT

Application number
EP90118639.5

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int Cl 5)
A	US-A-4 102 598 (ALVIN L. STOCK ET AL) 25 July 1978		F 01 D 25/08 F 01 K 11/02 F 16 L 59/02
A	GB-A-1 360 146 (KRAFTWERK UNION AG) 17 July 1974		
A	DE-A-2 006 536 (WESTINGHOUSE ELECTRIC CORP.) 10 September 1970		

TECHNICAL FIELDS SEARCHED (Int Cl 5)
F 01 D F 01 K F 16 L

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
STOCKHOLM	18-11-1990	WARNBO P-O

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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E : earlier patent document, but published on, or after the filing date
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