



- (51) International Patent Classification: Not classified
- (21) International Application Number: PCT/IN2014/000017
- (22) International Filing Date: 8 January 2014 (08.01.2014)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data: 236/MUM/2013 28 January 2013 (28.01.2013) IN
- (72) Inventor; and
- (71) Applicant : RANADE, Abhay, Vishwas [IN/IN]; 501 Govind, 172 Shivaji Nagar, Nagpur 440010, Maharashtra (IN).

- (81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA,

SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

- (84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

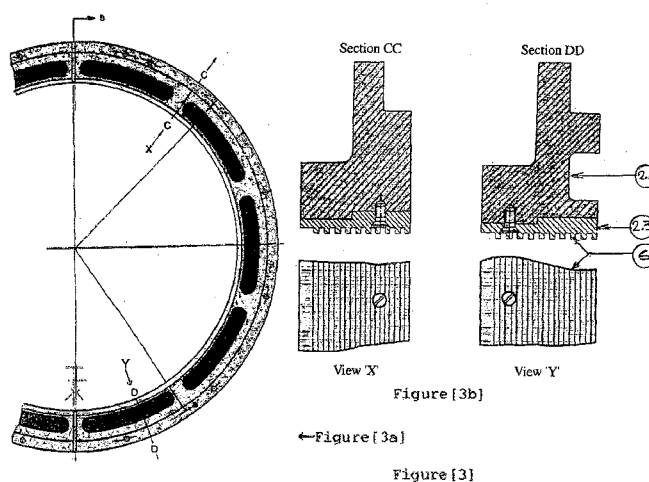
Declarations under Rule 4.17:

- as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))
- as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))
- of inventorship (Rule 4.17(iv))

Published:

- without international search report and to be republished upon receipt of that report (Rule 48.2(g))

- (54) Title: LABYRINTH SEAL WITH REPLACEABLE INNER LINER/RING



- (57) Abstract: The "LABYRINTH SEAL WITH REPLACEABLE INNER LINER/ RING", comprises totally brand new seal(2.2) comprising parts(2.3) & (2.4); Provision is made in part(2.4) to fix new Replaceable Inner Liner within item(2.4). The reconditioning of the worn out Seal is done without discarding the Seal. The reconditioning of old Seal will yield to reconditioned-new-seal. The worn Ring/s of the Seal is machined clean; item(2.1) is converted into item(2.4) to accept new Replaceable Inner Liner resulting into Seal(2.2). The New Replaceable Inner Liner is fixed inside NEW or RECONDITIONED Seal. The subsequent replacement of worn Replaceable Ring by new Replaceable Ring is easy, simple, without discarding the outer-body of Labyrinth Seal. Optionally, replaceable inner Liner is made having Helical/Inclined Ring/s. The Contact-Surface of the Ring/s facing the Surface of the Shaft, is coated with material/s with improved properties.

TITLE: LABYRINTH SEAL WITH REPLACEABLE INNER LINER/RING**Introduction:**

This Invention relates to Labyrinth Seal. "Labyrinth Seal" is a device used in "Sealing" of "gas". When the gas is air, the Seal is also termed as "Labyrinth Air Seal", or simply, "Labyrinth Seal", or "Seal".

The "Labyrinth Seal" has plurality of circumferential "Ring/s" / "Touch Point/s" arranged in series. These Rings or touch points lightly touch the rotating shaft. These circumferential Rings or touch points provide successive expansion of the gas. As the Differential Pressure across each individual restriction is small, the total leakage is minimized.

During running & use, these Rings or touch points wear. Increase in this wear leads to increase in leakage-of-air necessitating replacement of entire Labyrinth Seal.

It is known that currently conventional Labyrinth Seal is employed in certain types of Mills or Pulverizers and the like equipments employed in cement manufacturing plants, or, coal fired Thermal Power Plants, or such other plants.

Coal Mills or Pulverizers are used in Thermal Power Station/s [TPS] which is also termed as Thermal Power Plant/s [TPP]. In any TPS/TPP, coal is first pulverized, that is powdered, and then the powdered coal is used as fuel for the boiler which produces steam which rotates the turbine coupled to a generator which generates electricity.

The pulverization of coal takes place in a Coal Mill. The pulverized coal is conveyed to the boiler by hot pressurized air called Primary Air. This coal-dust-laden-hot-pressurized-air tends to leak into any area of lower pressure from any available opening. One such opening is around the shaft or the hub or the yoke which enters the Coal Mill from the Gear Box below; and this opening opens into the atmosphere around the coal mill & the gear box, and other auxiliaries, for example, electric motor and other equipments/machinery.

This leakage of the Pulverized Coal causes extensive damage to equipment, and pollution in the atmosphere. Pollution causes grave health hazards.

To minimize all bad effects caused by the worn Labyrinth Seal, the entire worn Labyrinth Seal is scrapped; and, a new Seal is installed; this is too expensive and time consuming.

With reference to above explanation, this Invention more particularly NOW provides "REPLACEABLE INNER LINER/RING". So, the worn Labyrinth Seal is now NOT required to be discarded. Thus, this NEW CONSTRUCTION achieves great economy and utility and convenience.

PRIOR ART:

Presently, in certain types of coal mills, to contain the leakage of coal dust laden hot Primary Air Labyrinth Seal is employed. The Seal is fixed or placed around the Shaft or the hub or the yoke by known methods such that the Rings-of-the-Seal lightly touch the rotating shaft. This Labyrinth Seal comprises of a number of circumferential Rings in series.

During the working of the coal mill, that is, when the shaft is rotating, the Rings of the Seal touch & rub the rotating shaft. This action wears the rings of the Seal and also produces grooves on the shaft itself. Coal dust being highly abrasive in nature hastens this wear of the rings and groove formation on the shaft. This causes the running gap between the shaft and the Labyrinth Seal to increase leading to increase in leakage of the Coal-dust-laden-Air in the atmosphere. When this leakage increases beyond certain acceptable limits, the entire, that is complete Labyrinth Seal is replaced.

The Labyrinth Seal is traditionally made out of Phosphor Bronze[PB] Alloy, Cast Iron[CI] or Aluminium[Al].

Phosphor Bronze is the most expensive of the materials but offers the best Sealing & Lubrication properties.

Cast Iron[CI] is used to save cost but CI being hard the Rings of the CI Seal cut grooves on the shaft faster when

compared to PB. Also, the Lubrication property of CI is inferior.

Aluminum[Al] is used for relative ease of mounting / & / fixing due to its lower weight; but the lubrication properties are not good. Debris get generated with the wear of the Rings. The debris, in turn, cause the groove formation faster on the shaft.

The phenomena of formation of debris is far more pronounced in case of Al; negligible in case of CI; and non-existent in case of PB.

When the Rings of the Labyrinth Seal wear, entire Seal is discarded/scrapped in TOTALITY, as if the Seal is a sacrificial component.

PATENT SEARCH:

Patent Search is conducted. Please see Table below.
None of the old/&/existing Patents, however, refer to any
"**Replaceable** Inner Liner/Ring".

Sr.No.	Patent Number	TITLE	Applicant
1.	CA2034981A1	Labyrinth Seal for steam turbines	Westinghouse Electric Corpn
2.	CA 22544158C	Integrated Labyrinth & carbon Seal . . . "double seal"	PRATT & WHITNEY Canada Corpn
3.	EP0421596B1	Labyrinth Seal support	Rolls Royce
4.	EP2182173A2	Steam turbines with thermally activated sealing device	General Electric Co
5.	EP2412933A2 EP2412933A3 US20120027575	Labyrinth Seal	Rolls Royce
6.	EP2642081A1	Labyrinth Seal for turbines . . . group of several fins forming circumferential barriers against the flow of . . .	Alstom Technology Ltd
7.	US20040096319	Rotary machine with Seal	Tatsuro Uchida

8.	US20120027575	Labyrinth Seal	Rolls Royce
9.	US4420161	Rotor stabilizing Labyrinth Seal for steam turbines	General Electric Co
10.	US5029876	Labyrinth Seal system	General Electric Co
11.	US5735667	Method & apparatus for minimizing leakage in turbine Seal	Innovative Technology LLC
12.	US5890873	Labyrinth Seal for turbine bucket cover	General Electric Co
13.	US613910	Brush Seals and combined Labyrinth and brush Seals for rotary machines	General Electric Co
14.	US6761530	Method & apparatus to facilitate reducing turbine packing leakage losses	General Electric Co
15.	WO2006111405A1	Device & method for reducing loss thru sealing gaps	Klaus Peter Priebe
16.	WO2013037841A1	Labyrinth Seal	Alstom Technology Ltd

DEFICIENCIES/DRAWBACKS of PRIOR ART:

The DEFICIENCIES/DRAWBACKS of PRIOR ART are obvious as below:

- D1] When the Rings wear-out, The Complete Labyrinth Seal is discarded / scrapped.
- D2] Totally New Seal is required to be put.
- D3] Cost of new-Seal-to-be-put-in is very high.
- D4] Replacement Time is more.
- D5] Replacement Cost is more.
- D6] The corresponding Loss in Generation of Electricity is more, with associated cumulative bad effects.

MY INVENTION:**OBJECTS of MY INVENTION:**

- O1] The main Object of my invention is to increase the UTILITY of the Labyrinth Seal,
and,
- O2] to REDUCE ON COST of new/PROPOSED Labyrinth Seal.
- O3] Yet one more Object is to allow or make-possible the reconditioning of worn-out Labyrinth Seal which hitherto is / was not possible.
- O4] Yet one another Object is to Reduce on cost of the reconditioning of worn-out Labyrinth Seal.
- O5] And, as per this Invention, the worn out Ring portion is replaced by providing either:
- a) a new Replaceable Inner Liner/Ring of Phosphor Bronze, or composite materials, or of material of user's choice, where, the new Replaceable Inner Liner/Ring is fixed on the inner face of the worn, BUT NOW properly machined/ prepared/ matched Labyrinth Seal;

or,

b) to supply the new Labyrinth Seal in Aluminium or Cast Iron or in material of the user's choice with a new Replaceable Inner Liner/Ring within, of Phosphor Bronze or composite materials, or of material of user's choice;

and/or,

c) by both (a & b).

06] To provide Replaceable inner Liner/Ring(2.3) as a separate part, easy-&-simple to install.

07] To minimize the wastage going in & as the sacrificial component.

08] Yet one more Object is to optionally offer The Sealing Ring/s in Helical/Inclined manner.

STATEMENT OF THE INVENTION:

According to this Invention therefore, The "LABYRINTH SEAL WITH REPLACEABLE INNER LINER/RING", -- as substantially explained in the accompanying drawings -- comprises

constructing the totally brand new seal(2.2) comprising parts(2.3)&(2.4); wherein provision is made in part(2.4) to fix new Replaceable Inner Liner/Ring(2.3) within item(2.4); wherein further,

the reconditioning of the worn out Seal(2.1) is done without discarding the Seal(2.1); where, the reconditioning-of-the-old-worn-out-Seal(2.1) will also yield to the-reconditioned-to-as-good-as-new-seal as (2.2); wherein further, the worn-out Ring/s(3) of the Seal(2.1) is machined clean by known methods and provision is made to convert item(2.1) into item(2.4) with the provision to accommodate/&fix new Replaceable Inner Liner/Ring/(2.3), thus old seal (2.1) gets converted into Seal(2.2);

wherein further,

the New Replaceable Inner Liner/Ring(2.3) is fixed inside of either of the above, that is, NEW Seal or RECONDITIONED Seal;

wherein further,

the Design & Construction of the Invention is so characterised that the subsequent replacement of worn Replaceable Ring(2.3) by new Replaceable Ring(2.3) is

also easy-&-simple, and without discarding the outer-body(2.4) of the Labyrinth Seal(2.2),
wherein further,
optionally, The Replaceable Inner Liner/Ring is made having Helical/Inclined Ring/s(7),
wherein further,
optionally, the Invention is so characterised & constructed that the Contact-Surface of The Touch-Points / The Ring/s(6) &/or Helical/Inclined Ring/s(7), facing and touching the Surface of the Shaft(1), is coated/covered/spurred with material/s with improved properties of Lubrication & Wear-Resistance.

DESCRIPTION WITH REFERENCE TO DRAWINGS:

This invention will now be described with the help of suitable drawing/s & figure/s, by means of explanatory numeral/s marked thereon. The drawing/s & figure/s are SCHEMATIC only. Drawing/s are not to scale. Drawing/s represent non-restrictive examples. Further, to explain & understand this Invention in a better manner, Prior Art is also explained in Drawings/figures followed by drawings of this Invention.

Figure[1] relates to Prior Art;

Figure[2] onwards explain this Invention.

Figure[3] shows a colored print/drawing of a typical Seal with a replaceable inner liner/ring.

Figure[4] shows "Helical/Inclined" Ring/s.

Referring to Drawings/&Figures, Fig[1] shows a PRIOR ART typical arrangement of a rotating shaft(1) around which the Labyrinth-Seal(2.1) is fixed to stationary-part-of-the-coal-mill/pulverizer(not shown).

"The Labyrinth-Seal(2.1)" has the purpose of the Sealing to prevent or minimize the Leakage-of-coal-dust-laden-hot-Air(4). The "flow" of Air is shown by arrows; Mill-side-space is shown by item(4.1), &, Atmosphere-side-space is shown by item(4.2).

There are provided the Rings (3.1, 3.2, 3.3, . . .) which is/are integral part/s of Seal(2.1).

The ring/s(3) comprise the plurality or succession of ring/s(3.1, 3.2, 3.3, 3.4, . . .). The Rings(3.1, 3.2, . . .) of the non-rotating stationary Seal(2.1) "just touch" the Shaft(1).

When ring/s(3) wear/s out, the gap(5) increases resulting in increase of leakage of coal-dust-laden-Air(4). Over time, the Flow(4) increases beyond acceptable/&/tolerable limits. This is what happens during running & usage. And so it is required that **"something MUST BE DONE"**. But then, **"What 'something' MUST BE DONE"??:-** The answer/ & / SOLUTION/ & /implementation is in two successive steps(a & b) as below:

(a) As the old worn out Ring(3) is integral part of THE Seal(2.1), THE entire Seal(2.1) is discarded & scrapped.

and then,

(b) NEW Seal(2.1) having Ring/s(3) of original size/s, is provided & put/installed in place.

Fig[2] shows this INVENTION in a schematic-way. There is the typical arrangement of the rotating-shaft(1), and, the stationary non-rotating "Labyrinth-Seal(2.2)". The Principle, general Construction, & Function of my newly Invented Seal(2.2) is similar to Seal(2.1) of PRIOR ART. But, the Working & Actual-Construction of The Invented Seal(2.2) differs from The Old Seal(2.1) in the following way:

The fact is NOW there is/are the ring/s(6, THAT IS, 6.1, 6.2, 6.3,) similar to item(3) of Prior art; but, these Ring/s(6) are formed/constructed on the now new & separate part(2.3) which in turn is fixed to part/item(2.4). Thus, Parts/Items(2.3) & (2.4) together form part/item/Seal(2.2) out of which item(2.3) is THE REPLACEABLE part of novel Seal(2.2). The ring/s(6) is an integral part of the Replaceable-Liner/Ring(2.3); & item(2.3) is firmly attached to the Seal(2.2) by any known methods; & one such method is shown in figure[3 and 3b].

It is to be specifically noted that:-

- {The Prior Art Ring/s(3) & Seal(2.1) is integral & non-separable};
- In the novel Seal(2.2), Seal(2.2) comprises items (2.3) & (2.4); where REPLACEABLE item(2.3) is firmly attached/&/fixed, but not permanently fixed or welded, to item(2.4);

And further,

- In constructing new Seal(2.2), adequate machining/provision/or/preparation is done/made in item(2.4) to accommodate item(2.3) having integral Ring/s/touch-points(6).

NOW, When ring/s(6) of part/item(2.3), wears out, SIMPLY & ONLY part/item(2.3) is removed; and it is then replaced by another new item(2.3); The ENTIRE Seal(2.2) is not at all required to be replaced or scrapped.

Presently, Ring/s(6)/&/item(2.3) is constructed in Phosphor Bronze; however, this Inventor foresees to construct/make the same in the material/s of user's choice, &/or, composites having better/improved lubrication properties coupled with better/improved wear-resistant & impact-resistant properties; also foresees using composites of Phosphor Bronze, PTFE[Poly-Tetra-Fluoro-Ethylene], Graphite Powder, Carbon Fibers & the like.

And,

Also presently, part/item(2.4) is made in Al due to its lower weight.

Figure[3] shows a colored print/drawing of a typical Seal with replaceable inner liner/ring.

Figure[3] comprises of Figures [3a and 3b]

Figure[4] shows typical "Helical/Inclined" Ring/s(7).

CLAIMS:**I CLAIM:**

C1]

The "LABYRINTH SEAL WITH REPLACEABLE INNER LINER/RING", -- as substantially explained in the accompanying drawings, -- comprising constructing the totally brand new seal(2.2) comprising parts(2.3) & (2.4); wherein provision is made in part(2.4) to fix new Replaceable Inner Liner/Ring(2.3) within item(2.4);

C2]

The "LABYRINTH SEAL WITH REPLACEABLE INNER LINER/RING", as claimed in Claim C1, wherein further, the reconditioning of the worn out Seal(2.1) is done without discarding the Seal(2.1); where, the reconditioning-of-the-old-worn-out-Seal(2.1) will also yield to the-reconditioned-to-as-good-as-new-seal; wherein further, the worn-out Ring/s(3) of the Seal(2.1) is machined clean by known methods and further machined to convert item(2.1) into item(2.4) with the provision to accommodate/&/fix new Replaceable Inner Liner/Ring/(2.3), thus old Seal (2.1) gets converted into Seal(2.2);

C3]

The "LABYRINTH SEAL WITH REPLACEABLE INNER LINER/RING", as claimed in Claims C1, C2,

wherein further,

the New Replaceable Inner Liner/Ring(2.3) is fixed inside of either of the above, that is, NEW Seal or RECONDITIONED Seal;

C4]

The "LABYRINTH SEAL WITH REPLACEABLE INNER LINER/RING", as claimed in Claims C1, C2, C3,

wherein further,

the Design & Construction of the Invention is so characterized that the subsequent replacement of worn Replaceable Ring(2.3) by new Replaceable Ring(2.3) is also easy-&-simple, and without discarding the outer-body(2.4) of the Labyrinth Seal(2.2).

C5]

The "LABYRINTH SEAL WITH REPLACEABLE INNER LINER/RING", as claimed in Claims C1, C2, C3, C4,

wherein further,

optionally, replaceable inner Liner is made having "Helical/Inclined" Ring/s(7).

C6]

The "LABYRINTH SEAL WITH REPLACEABLE INNER LINER/RING", as claimed in Claims C1, C2, C3, C4, C5, wherein further, optionally, the Invention is so characterized & constructed that the Contact-Surface of The Touch-Points of The Ring/s(6) or "Helical/Inclined" Rings(7), facing and touching the Surface of the Shaft(1), is coated/covered/spurred with material/s with improved properties of Lubrication & Wear-Resistance.

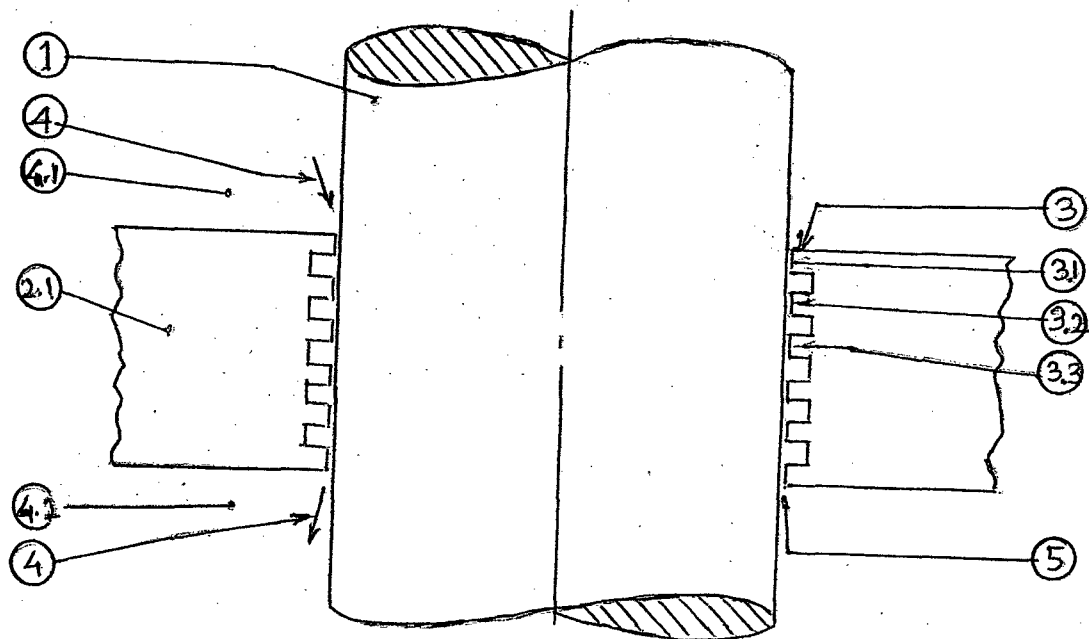


Figure [1]

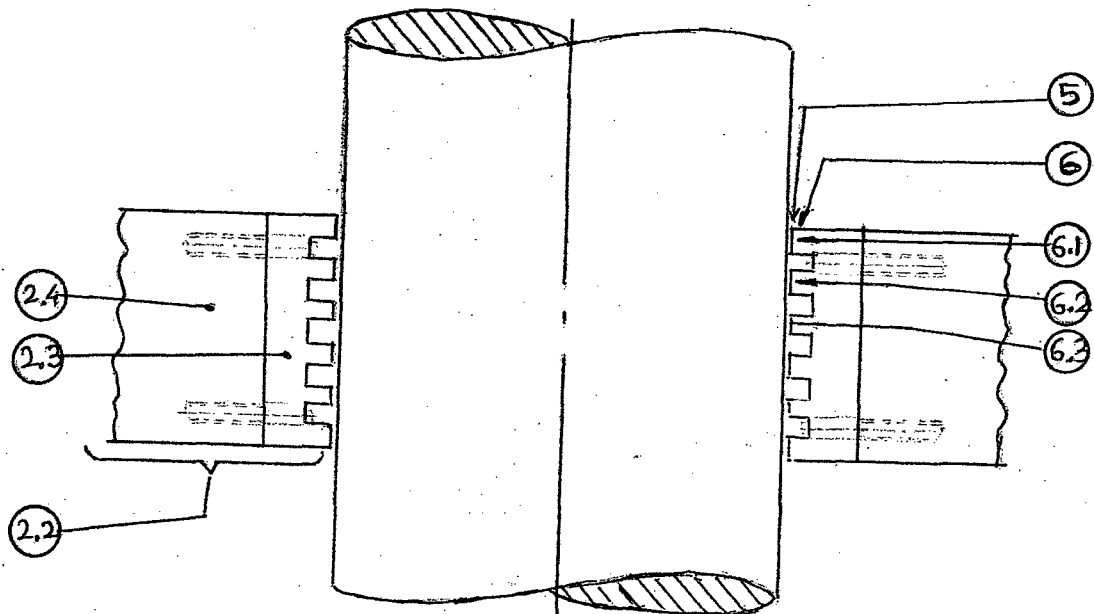
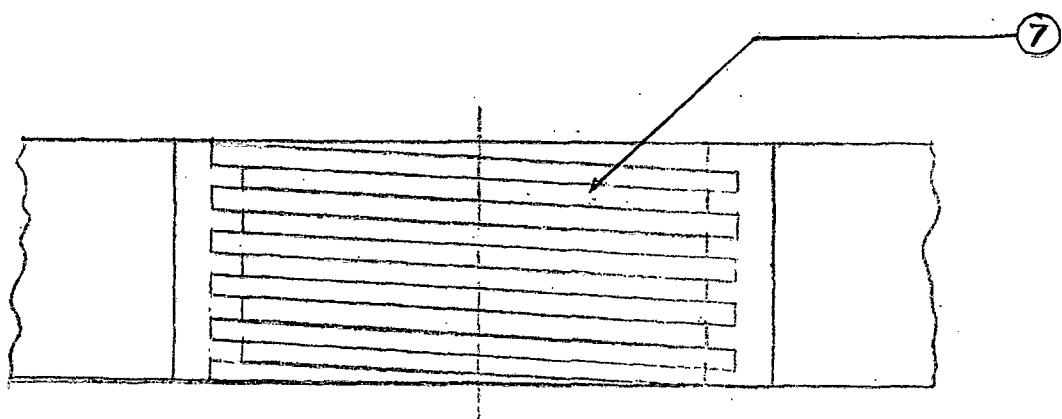
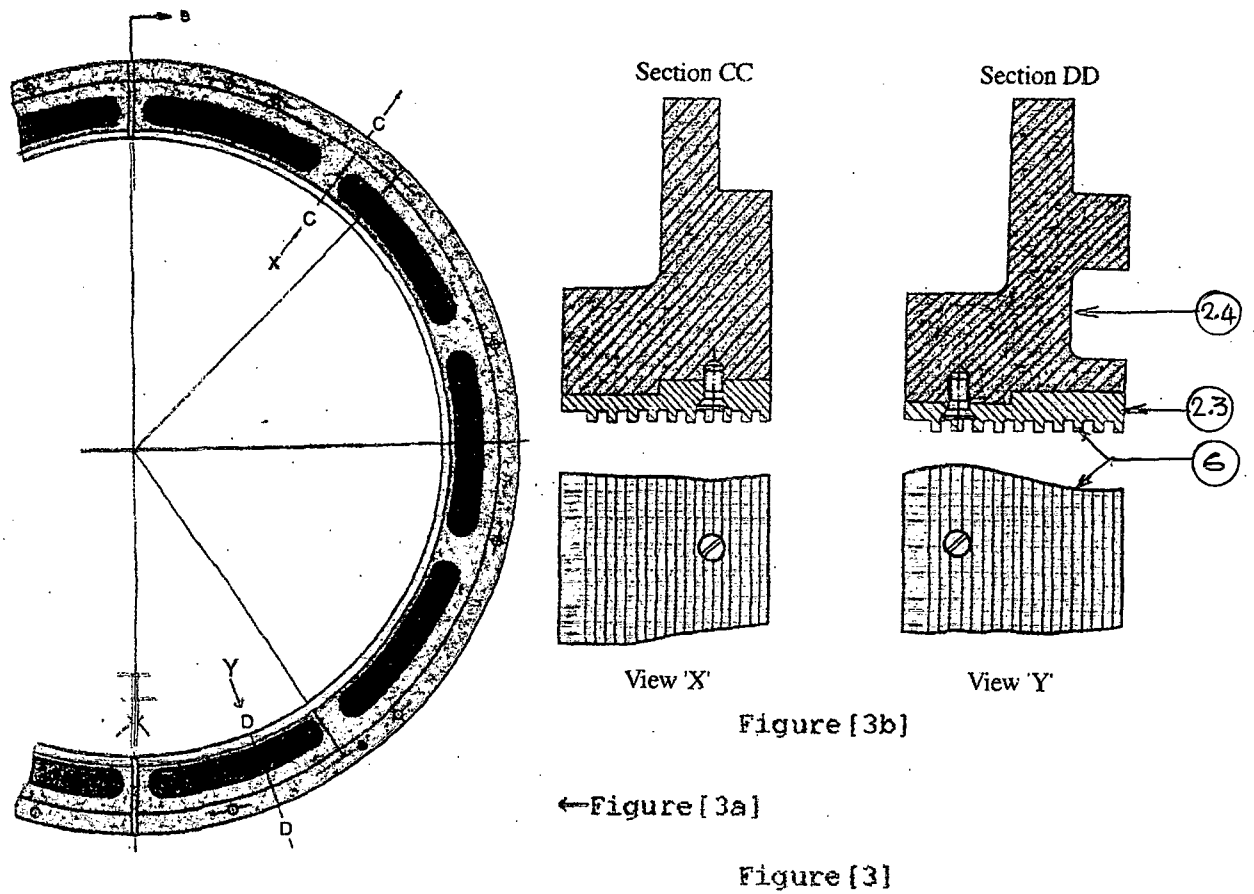


Figure [2]



Figure[4]