Nov. 7, 1961 J. O. EAMES 3,007,555

LIQUID-COOLED FRICTIONAL MECHANISM

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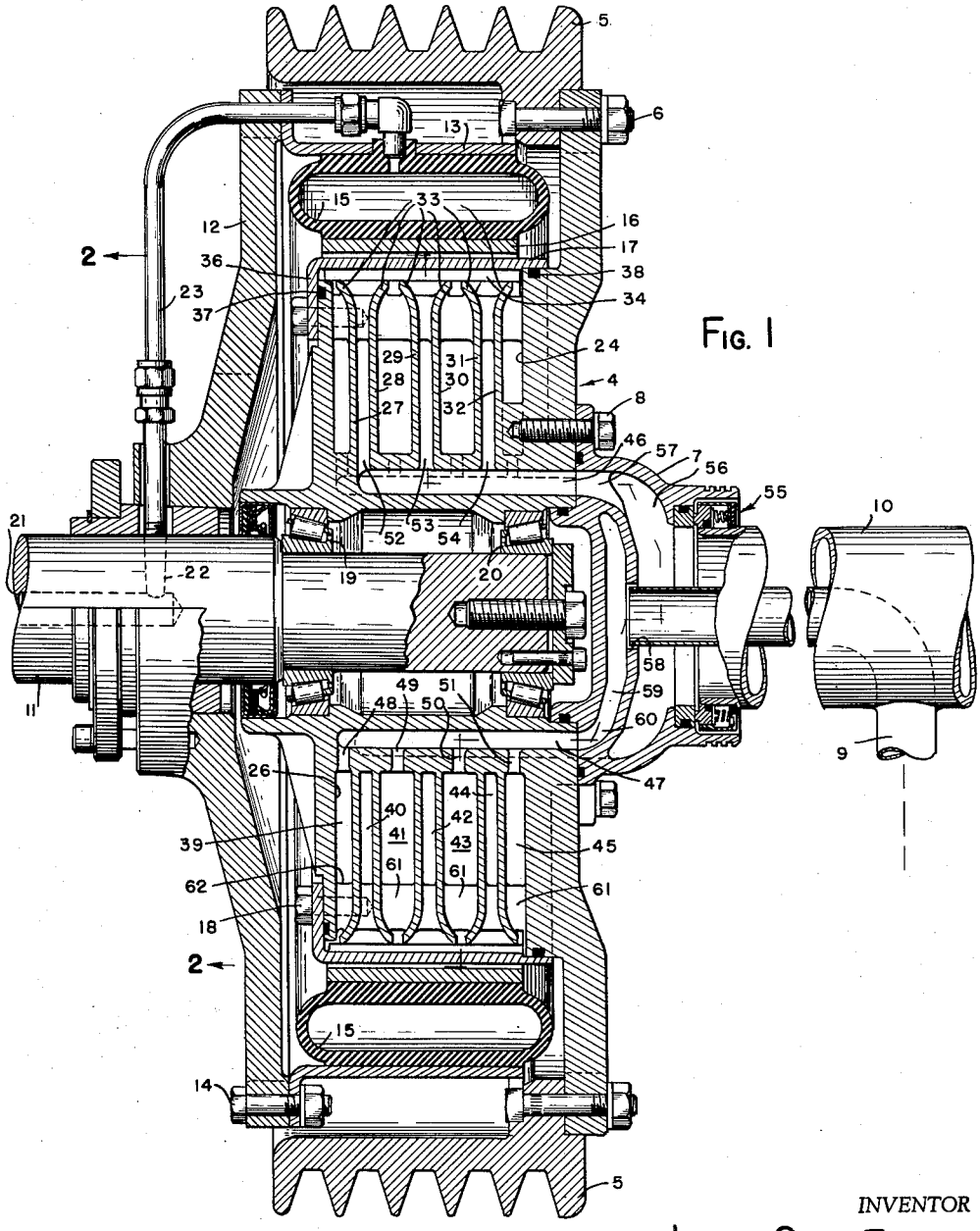


FIG. 1

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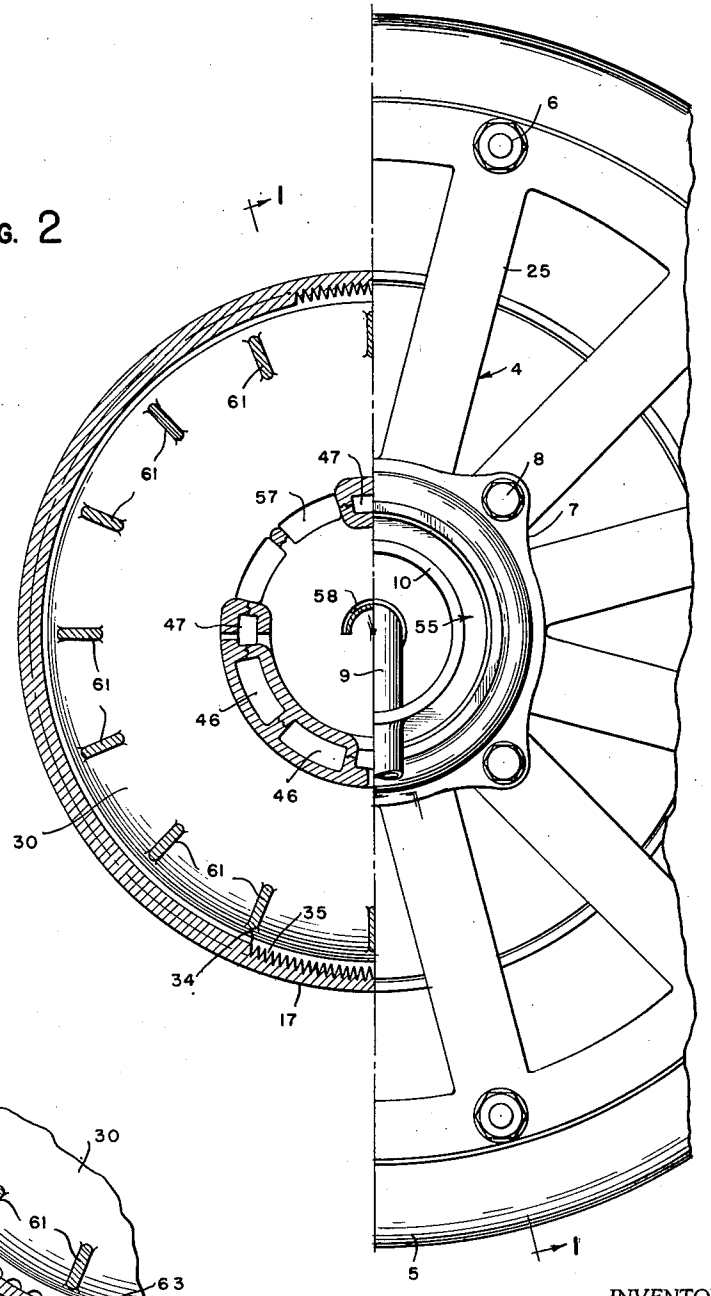
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FIG. 2



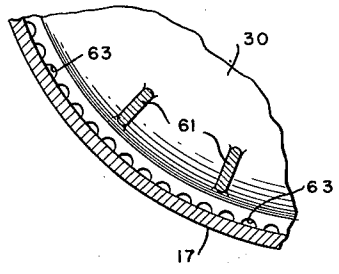


FIG. 3

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LIQUID-COOLED FRICTIONAL MECHANISM

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8 Claims. (Cl. 188—264)

This invention relates to frictional mechanisms, and more particularly to liquid cooled frictional mechanisms such as brakes and clutches.

The excessive heat developed in frictional mechanisms of this type has caused many difficulties in the past, and it is accordingly one of the objects of the invention to provide means for overcoming these difficulties.

Another object of the invention is the provision of novel cooling means for frictional mechanism of the above type.

Yet another object of the invention is to provide, in a frictional mechanism of the above type, means for automatically circulating a cooling liquid in the mechanism.

Still another object of the invention is to provide frictional mechanisms wherein the cooling liquid is forcibly maintained in intimate engagement with a surface directly opposite the friction surface.

These and other objects of the invention will be more readily apparent from the following detailed description when taken in connection with the accompanying drawings. It is to be expressly understood, however, that the description and drawings are not to be taken as defining the limits of the invention, reference being had for this purpose to the appended claims.

In the drawings:

FIG. 1 is a sectional view of a frictional mechanism constructed in accordance with the principles of the invention, the section being taken along line 1—1 of FIG. 2;

FIG. 2 is a partial sectional view of the mechanism of FIG. 1 taken along lines 2—2 of FIG. 1; and

FIG. 3 is a fragmentary sectional view of a modification of the mechanism shown in FIGS. 1 and 2.

Although the matter of liquid cooling for frictional mechanisms has received considerable attention in the past, in many cases the full potentialities of the cooling liquid have not been realized, and in the present invention, provision is made for evaporating the cooling liquid in the brake itself in order to utilize the latent heat of vaporization to the best advantage. In the event water is used for the cooling liquid, for example, a portion of the water is converted to steam during operation of the mechanism, this steam being discharged from the mechanism in a suitable manner and thus serving to dissipate large quantities of heat from the mechanism.

Referring first to FIG. 1, showing a mechanism constructed in accordance with the principles of the present invention and adapted more particularly for use as a clutch, the mechanism includes in general a drum supporting member 4 having a V belt pulley 5 secured thereto by bolts 6, an inlet and outlet member or manifold 7 secured to the member 4 by cap screws 8, a cooling inlet conduit 9, a vapor discharge conduit 10, a rotatable shaft 11 having an actuator supporting member 12 secured thereto for rotation therewith, an actuator carrier 13 secured to the member 12 by bolts 14, an expansible actuator tube 15 secured to the carrier 13 and having friction lining elements 16 suitably secured thereto as shown, and a metal friction drum or friction element 17 secured to the member 4 by cap screws 18 and adapted to be engaged on its internal cylindrical surface by cooling liquid in the member 4, and to be engaged on its external cylindrical surface by the friction lining elements 16.

As shown, the member 4 is rotatably mounted on shaft 11 by means of suitable bearings 19 and 20, and the pulley 5 and the member 4 connected thereto are adapted to be driven from a motor, not shown, by means of V belts. Thus, it will be understood that when the pulley 5 is driven as above described, the shaft 11 will be rotated with the pulley 5 and the member 4 whenever the expander tube 15 is supplied with fluid under pressure to effect engagement of the lining elements 16 with the outer surface of the drum 17. In order to effect such actuation, a fluid such as compressed air is supplied to the expander tube under the control of a suitable valve, not shown, through a passage 21 and a passage 22 in the shaft 11 and thence through a conduit 23 connected to the expander tube as shown.

The drum supporting member 4 includes an annular wall 24 having outwardly extending spokes 25 which serve to secure the member to the pulley 5 through the medium of the bolts 6, a second annular wall 26 axially spaced from the wall 24, and a plurality of spaced apart annular partitions 27, 28, 29, 30, 31 and 32, the partitions 27 and 32 being spaced respectively from the walls 26 and 24. Surfaces 33 at the outer peripheries of the partitions and the walls are cylindrical and of the same diameter, and these surfaces 33 on the partitions engage and support the ends of axial teeth 34 formed on the inner surface of the cylindrical drum 17, valleys 35 between the teeth forming axial passages for cooling liquid as will be more fully described hereinafter. The drum member 17 is cup-shaped as shown, and a flange 36 on the drum member engages the left face of the wall 26 and is sealed against leakage by means of a suitable O ring or gasket 37. At the right end of the drum member 17 the member slidably engages the outer periphery of the wall 24 and is sealed against leakage by a suitable O ring 38.

Referring again to the annular partitions, it will be noted that partitions 27 and 28 are flared outwardly in opposite directions at their outer ends, as is also true of partitions 29 and 30 and partitions 31 and 32 respectively. Thus, the partition 27 forms, in connection with the wall 26, an annular liquid passage 39 having a relatively small annular opening at the outer periphery, partitions 27 and 28 form an annular liquid passage 40 having a large annular opening at the outer periphery thereof, partitions 28 and 29 form an annular liquid passage 41 having a small annular opening at the outer periphery, partitions 29 and 30 form a liquid passage 42 having a large opening at its outer end, partitions 30 and 31 from an annular passage 43 having a small annular opening at the outer end, partitions 31 and 32 form an annular liquid passage 44 having a large annular opening at its outer end, and partition 32 and wall 24 form an annular liquid passage having a small annular opening at the outer end. Thus we have a series of adjacent annular liquid passages, alternate passages having respectively small and large annular openings at the outer ends thereof terminating directly adjacent the inner surface of the cylindrical friction drum member 17, for purposes to be described hereinafter. As shown in FIGS. 1 and 2, the central portion of the member 4 is provided with eight outlet passages 46, and four inlet passages 47. The annular passages 39, 41, 43 and 45 are connected to the inlet passages 46 by ports 48, 49, 50 and 51, while passages 40, 42 and 44 are connected to the outlet passages 46 by ports 52, 53 and 54.

In order to provide for the supplying of cooling liquid to the interior of the mechanism and to provide for the discharge of vapor or steam formed during operation of the mechanism, the conduit 10 is connected to the rotatable member 7 through a rotary seal 55, and is connected to the discharge ports 46 in the member 4 by means of a chamber 56 and ports 57 in the member 7. In like manner, the cooling liquid supply conduit 9 is connected to

the inlet passages 47 in the member 4 by means of a central port 58, a chamber 59 and ports 60 formed in the member 7.

During the operation of the frictional mechanism described, the interior of the mechanism may be partially filled with cooling liquid through the conduit 9 in any suitable manner, or a measured amount of liquid may be supplied through the conduit with the excess liquid flowing outward to a drain through the discharge conduit 10, the type of operation insofar as the supplying of the liquid is concerned depending on the liquid supply available and on the type of operation desired. The important thing, however, is to insure that sufficient liquid is in the friction mechanism at all times to fully engage and cover the inner surface of the drum member 17 to an appreciable radial depth whenever the drum member is rotating at a speed sufficient to throw the liquid outward to the outer portion of the drum due to the action of centrifugal force. In other words, it is essential that the annular passages between the partitions be at least partially filled with liquid at the outer portions thereof whenever the drum is rotating at any appreciable speed.

When the mechanism is operated to effect engagement between the rotating member 4 and the friction linings in order to rotate the shaft 11, or in the event the shaft 11 is held stationary and the linings are engaged with the drum in order to stop rotation of the member 4, large amounts of heat are generated in the friction drum 17, this heat being transmitted to the inner surface of the member and to the teeth 34, thus tending to vaporize the liquid in engagement with the inner surface. Due to the fact that the annular passages heretofore described have alternately large and small annular openings at their outer ends, it will be apparent that, considering for example the annular passages 40 and 41, a larger number of steam bubbles or vapor bubbles will be formed at the outer portion of the passage 40 than will be formed at the outer portion of the passage 41. Consequently the column of liquid extending radially inwardly in the passage 40 will contain a mixture of liquid and vapor bubbles with the vapor bubbles predominating as compared with the number of vapor bubbles in the liquid at the outer end of the passage 41. Thus the liquid in the passage 40 will tend to be lighter then that in passage 41, and the heavier liquid in the passage 41 will be thrown outwardly by centrifugal force against the inner surface of the drum member 17, while the lighter mixture of liquid and vapor in the passage 40 will tend to move inwardly toward the center of the member 4, thus setting up a continuous thermo-siphon circulation between each of the adjacent annular passages. Circulation of the liquid between the adjacent passages is of course facilitated and permitted by the passages 35 formed between the teeth 34 on the drum member 17. Thus the mechanism acts in a manner similar to a percolator to concentrate or collect a large number of steam or vapor bubbles in the passages 40, 42 and 44, and to minimize the formation of such bubbles in the passages 39, 41, 43 and 45 in order to insure an efficient thermo-siphon circulation of the liquid outwardly in the passages 39, 41, 43 and 45, and inwardly towards the center of the mechanism in the passages 40, 42 and 44. Since the vapor or steam, or combination of liquid and vapor or steam discharged from the mechanism will have a larger volume than the unvaporized liquid supplied through the conduit 9, the outlet passages 46 and the connections thereto are made appreciably larger than the inlet passages 47 and the adjacent connections, and in addition, it is found desirable to utilize more outlet passages than inlet passages in order to provide unrestricted passage for steam or vapor from the mechanism.

The annular partitions can be supported in any suitable manner, but in the embodiment shown, they are connected by web members 61 provided at their left ends with bosses 62 which serve to receive the cap screws 18 which secure the drum member 17 to the drum supporting member 4. The webs 61 are connected at their right ends to the annular wall 24 of the member 4.

Although any suitable metal can be utilized for the cylindrical friction element or drum 17, drums formed primarily of copper or silver have been found to be very advantageous, and in the event such metals are utilized, it will be understood that the teeth 34, having their apices in engagement with the outer peripheries of the annular partitions provide means for adequately supporting the ductile copper or silver drum member 17 against distortion due to the forces exerted thereon by the application of the friction lining 16. In addition, the use of copper or silver as the preferred metal insures that heat will be transmitted rapidly through the metal of the drum member and into the cooling liquid in engagement therewith.

In the event it is undesirable to provide the teeth 34 on the drum 17 due to the cost of machining or for other reasons, the drum may be provided as shown in FIG. 3 with a smooth cylindrical inner surface, and grooves 63 may be provided in the partitions 27, 28, 29, 30, 31 and 32 at their outer peripheries to provide communication for cooling liquid between all of the adjacent annular passages. Thus with either form of construction, the level of the liquid in the drum mechanism in the annular passages between the partitions can equalize in such a manner that the entire inner surface of the drum element 17 will be subjected to the action of the liquid regardless of where the cooling liquid is introduced into the drum.

Although as heretofore stated, the mechanism shown is particularly adapted for use as a clutch, it will be understood by those skilled in the art that in the event it is desired to utilize the mechanism as a brake, it is only necessary to hold the shaft 11 stationary by suitable means, not shown, and to supply fluid under pressure to the expander tube 15 to effect engagement of the lining 16 with the outer surface of the drum element 17 whenever it is desired to stop the rotation of the drum supporting member 4 and the attached pulley 5. It is important, however, when the mechanism is utilized as a brake, to have the rotating member which is to be decelerated the one which includes the annular partitions and the annular passages therebetween. In other words, the drum 17 should always be a part of the rotating portion when the mechanism is utilized as a brake.

It is well known to those skilled in the art that a large amount of heat may be dissipated by vaporizing a cooling liquid and discharging the vapor from the mechanism to be cooled, a well known example of this being the vaporization of water to form steam which is discharged from the mechanism either to atmosphere or to a suitable condenser. In the present mechanism, means have been provided to permit such vaporization of the cooling liquid and to so direct the flow of the unvaporized cooling liquid and of the vaporized cooling liquid as to insure that a fresh supply of unvaporized cooling liquid will always be available at the heated surface of the mechanism, and also to insure that the vapor or steam formed due to the heating of the liquid will be discharged from the mechanism in an orderly manner. As will be seen, the mechanism is of a simple nature which is not liable to require adjustment or repairs, and one which provides adequate and efficient cooling for the metallic friction element 17.

Although the invention has been illustrated and described herein with considerable particularity, it is to be understood that the invention is not to be considered as limited thereto, but may be embodied in other forms as may well suggest themselves to those skilled in the art. Reference will, therefore, be had to the appended claims for a definition of the limits of the invention.

What is claimed is:

1. Liquid cooled frictional mechanism including a rotatable hollow friction drum having an external friction surface adapted to be engaged by a friction shoe, an opposite internal surface, an annular radial inlet passage

in said drum for conducting cooling liquid from a central portion of the drum to said internal surface having an annular opening directly adjacent said internal surface, an annular radial outlet passage in said drum extending from a central portion of the drum toward said internal surface having an annular opening appreciably larger than the first named opening and positioned directly adjacent said first named opening and said internal surface, an axial passage connecting said two openings adjacent said internal surface and along substantially the entire circumference of said internal surface in line with said annular openings, means for supplying cooling liquid to said inlet passage at the inner end thereof, and outlet conduit means extending from the inner end of said outlet passage to a region outside of the hollow drum.

2. Liquid cooled frictional mechanism as set forth in claim 1, wherein the outlet conduit means is so dimensioned as to have a larger capacity than the inlet conduit means.

3. Liquid cooled frictional mechanism including a rotatable hollow friction drum having an external friction surface adapted to be engaged by a friction shoe, an opposite internal surface, a plurality of annular radial cooling liquid inlet passages in the drum extending outward from from the central portion thereof and having annular openings at their outer ends positioned directly adjacent said internal surface, a plurality of annular radial outlet passages in said drum extending outward from the center portion thereof and having annular openings at their outer ends appreciably larger than said first named openings positioned directly adjacent said internal surface, said first named openings and said larger openings being positioned closely adjacent each other, passages connecting said first named openings and said larger adjacent openings along substantially the entire outer peripheries of said partitions and positioned directly adjacent said internal surface, means for supplying cooling liquid to said inlet passages at the inner ends thereof, and outlet conduit means connecting the inner ends of said outlet passages to a region outside of said hollow drum.

4. Liquid cooled frictional mechanism as set forth in claim 3, wherein said radial inlet and outlet passages are formed by adjacent axially spaced annular partitions in said drum.

5. Liquid cooled frictional mechanism including a rotatable hollow friction drum member, a separate cylindrical metal friction element on the drum member having an external friction surface adapted for engagement by friction brake shoe and an opposite internal surface forming a wall of said hollow friction drum member, spaced annular partitions in said drum member forming alternate annular radial inlet and outlet passages of the drum member terminating at their outer ends closely adjacent the inner surface of said friction element in adjacent annular inlet and outlet openings, the areas of said outlet openings adjacent the inner surface of said element being appreciably greater than that areas of the inlet openings at their outer ends, means including an inlet conduit connected to the inner ends of the inlet passages for supplying cooling liquid to the inlet passages from a region outside of the hollow drum member, means including an outlet conduit connected to the inner ends of the outlet passages for connecting the latter to a region outside of said hollow drum member, and a plurality of axial passages adacent the inner surface of said friction element connecting the openings at the outer ends of adjacent inlet and outlet passages along substantially the entire outer peripheries of said partitions.

6. Liquid cooled frictional mechanism as set forth in claim 5, wherein the means for connecting the outlet passages with a region outside of the hollow drum member is of larger cross-sectional area than the means for connecting the inlet passages with a region outside of the hollow drum.

7. Liquid cooled frictional mechanism including a rotatable hollow friction drum member, a separate cylindrical metal friction element on the drum member having an external friction surface adapted for engagement by a friction brake shoe and an opposite internal surface forming a wall of said hollow friction friction drum member, said internal surface having generally axial teeth formed thereon, spaced annular partitions in said drum member forming alternate annular radial inlet and outlet passages in the drum member terminating at their outer ends closely adjacent the inner surface of said friction element, the peaks of said teeth being in engagement with the outer peripheries of said partitions for supporting the friction element and the valleys between the teeth forming axial passages connecting the outer ends of said annular inlet and outlet passages, the area of said outlet passages adjacent the inner surface of said element being appreciably greater than the areas of said inlet passages at their outer ends, means including an inlet conduit connected to the inlet passages for supplying cooling liquid to the inlet passages from a region outside of the hollow drum member, and means including an outlet conduit connected to the outlet passages for connecting the letter to a region outside of said hollow drum member.

8. Liquid cooled frictional mechanism including a rotatable hollow drum member, a separate cylindrical metal friction element on the drum member having an external friction surface adapted for engagement by a friction brake shoe and an opposite internal surface forming a wall of said hollow friction drum member, spaced annular partitions in said drum member forming alternate annular inlet and outlet passages in the drum member terminating at their outer ends closely adjacent the inner surface of said friction element, said inner surface being in supporting engagement with the outer peripheries of said annular partitions, the areas of said outlet passages adjacent the inner surface of said element being appreciably greater than the areas of said inlet passages at their outer ends, means including an inlet conduit connected to the inlet passages for supplying cooling liquid to the inlet passages from a region outside of the hollow drum member, means including an outlet conduit connected to the outlet passages for connecting the latter to a region outside of said hollow drum member, and a plurality of axial passages adjacent the inner surface of said friction element connecting the outer ends of adjacent inlet and outlet passages, said axial passages being formed in the outer peripheral portions of said annular partitions adjacent the internal surface of said friction element.

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