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OIL SEAL

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The present invention pertains to oil seals for preventing the leakage of lubricant along the portion of a shaft projecting outward from a lubricant housing or the like.

The general aim of the present invention is to afford a solution to the particularly vexatious problem of oil leakage along a shaft which not only rotates but also reciprocates or vibrates axially in the course of its operation.

The particular use for which the present oil seal was originated, although it may have utility in other fields, was for the shafts of the vibrating ink drums commonly employed in high speed rotary printing presses. For an example of such a press reference may be made to Curtis S. Crafts Patent No. 2,085,185, issued June 29, 1937. The press illustrated in that patent embodies axially vibrating rotary ink drums, one of which is shown in the upper portion of Fig. 19 of the patent. As there appears, such drum is carried on a shaft which is journaled in a suitable sleeve bearing and is vibrated axially in such bearing by a mechanism including a power actuated bell crank. Lubricant supplied to the bearing through the passage which leads downwardly to the central portion of the bearing, and to the drive mechanism housed on the outer side of the press frame, tends to creep along the shaft. In actual practice, it has been found that an objectionable amount will pass a conventional seal like that shown at the inboard end of the bearing. As the shaft vibrates endwise a small amount of oil is carried by it past the inboard seal, regardless of the tension in the latter, and is wiped off on the return stroke of the shaft. This leakage oil then falls to the reel room floor beneath the press or is slung off the shaft, splattering surrounding portions of the press. Despite repeated efforts at improvement in the years which have passed since the filing of the application for said Crafts patent (1933), oil seals of the type herein disclosed are, so far as I am aware, the first effectual solution of this leakage problem.

Further objects and advantages of the invention will become apparent as the following description proceeds, taken in connection with the accompanying drawings in which:

Figure 1 is a fragmentary vertical sectional view of the end portion of a vibrating ink drum and its supporting shaft with an oil seal, embodying the present invention, applied to such shaft.

Fig. 2 is an enlarged transverse sectional view of the oil seal shown in Fig. 1 taken substantially along the line 2-2 in the latter figure.

Fig. 3 is a longitudinal sectional view through the seal taken substantially along the line 3-3 in Fig. 2.

Fig. 4 is a horizontal sectional view through

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the seal taken substantially along the line 4-4 in Fig. 3 and constituting in effect a plan view of the lower half of the seal with the upper half removed.

Fig. 5 is a vertical sectional view generally similar to Fig. 1, but on a somewhat larger scale, showing the vibrating ink drum shaft equipped with a modified form of oil seal also embodying the present invention.

Fig. 6 is a more or less schematic plan view of the ink drum and its supporting bearings indicating the lead of the oil seal grooves at opposite ends of the drum in reference to the direction of drum rotation when employing seals like that shown in Fig. 5.

While the invention is susceptible of various modifications and alternative constructions, I have shown in the drawings and will herein describe in detail certain preferred embodiments, but it is to be understood that I do not thereby intend to limit the invention to the specific forms disclosed, but intend to cover all modifications and alternative constructions falling within the spirit and scope of the invention as expressed in the appended claims.

Referring more particularly to the drawings, the invention has been illustrated in Fig. 1 as embodied in an oil seal designated generally as 10. Such oil seal is there shown as applied to a shaft 216 fixed to one end of a vibratory ink drum indicated fragmentarily at 215. The shaft is journaled for rotary and axial sliding movement in a bearing 236 fixed in a press side frame indicated at 8. The drum 215 is rotated by suitable power means (not shown) and is simultaneously vibrated axially through the distance A indicated in Fig. 1. For details of a suitable mechanism for imparting such motions to the drum, see Crafts Patent No. 2,085,185 referred to above. Lubricant is supplied to the bearing 236 through a passage 362 from a chamber 361 from suitable supply connections (not shown) and which may, for example, also be of the form disclosed in said Crafts patent. It will be appreciated that the outer or righthand end of the shaft 216 is also likely to be bathed in lubricant cascading down over the actuating connections to it.

The function of the oil seal 10 is to prevent lubricating oil from creeping along the shaft 216 and escaping within the press. As heretofore noted, the problem of accomplishing effectual sealing in such an installation is enhanced to no small degree by the fact that the shaft 216 not only rotates at a high speed but also has axial vibration of substantial magnitude and speed.

Of the structure of the oil seal 10 itself, it will be observed that it is here shown as fashioned in the form of a cast metal sleeve made, for example, of bronze. The sleeve is split horizontally as in-

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dictated by the parting line 11 to facilitate assembly, the two halves of the sleeve being secured together by screws 10c. A reduced inner end portion 10a of the sleeve is dimensioned for insertion in the press frame bore 236a which receives the bearing 236, the inboard end of the seal being spaced from the adjacent end of the bearing. For securing the seal in place it is equipped with an integral external mounting flange 10b adapted to be bolted to the inner face of the press side frame 8.

The interior of the oil seal sleeve presents a spiral grooving 12 defined by a spiral ribbing or threads 14. In the present instance the ribs 14, and grooves 12 defined between them, are divided into two axially spaced sections spiraled in opposite directions, one being righthand and the other lefthand. The purpose of this opposite spiraling is to accommodate the seal for shaft rotation in either direction as will appear in more detail below.

In the illustrated arrangement the ribs 14 are substantially square in cross section and are dimensioned to have a close running fit with the shaft 216. The clearance may, for example, be 0.002 inch. Moreover, the ribs or threads 14 preferably have a multiple lead, being shown as quadruple in the present instance (see Fig. 2). By way of example as to size, if the shaft be $2\frac{3}{4}$ inches in diameter the grooves 12 may be $\frac{3}{32}$ of an inch wide and $\frac{3}{64}$ of an inch deep, the ribs being quadruple and having a $\frac{1}{2}$ inch lead.

Of particular note is the fact that the outboard end of the interior of the seal sleeve (lefthand end as viewed in Figs. 1 and 3) is tapered or flared outward at an angle α . This taper may be formed in the sleeve prior to threading. The result of the taper is that the internal diameter of the ribs or threads 14 is progressively enlarged toward the outboard end of the sleeve. By virtue of such an arrangement, if any oil does escape along the shaft during a leftward stroke of the shaft 216, it will run back into the seal on the return stroke instead of being sheared off as would be the case if the ribbing were of uniform internal diameter all of the way to the end of the sleeve. In the particular construction shown the taper is such that the ribbing diminishes in interior diameter progressively from the outboard end so that it does not reach minimum size until about the fourth convolution. Consequently, any shearing of oil from the shaft 216 upon a return or rightward stroke of the latter would not take place ahead of this fourth convolution. And oil sheared off at that point is in position to fall into the grooves 14 located outwardly of such convolution and thence return to the drain channel described below.

Provision is made for gravity drainage of oil stripped from the shaft 216 by the seal 10. For that purpose a longitudinally extending drain passage 15 is provided in the lower portion of the sleeve, communicating at its inner end with a downwardly inclined passage 366' in the press frame 8. Oil passes through the latter to the enclosed space on the outer side of the press frame in which the actuating mechanism (not shown) for the shaft, etc., is housed. Communication is established from the lower sides of the grooves 12 to the passage 13 through holes 16.

It is also to be observed that an annular recess 17 is formed in the seal sleeve (see Figs. 3 and 4) and communicates through an opening 18 in its lower side with the passage 15. The ribs 14 terminate abruptly in the straight sides of this groove 17 so that any lubricant on the surface of

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the intermediate portion of the shaft 216 tends to be sheared off by these side walls and flows downward by gravity through the opening 18.

As to the overall operation of the oil seal 10 described above, let it be assumed first of all that the shaft 216 is rotating counterclockwise as viewed from the inboard or righthand end of the seal (see arrow in Fig. 1). In such case, as the shaft vibrates, coincident with its rotation, any film of oil tending to creep along the shaft is sheared off by the edges of the ribs 14 and falls into the grooves 12. The outboard group or section of ribbing (left group as viewed in Fig. 3) is spiraled in a righthand direction and consequently acts, with the direction of rotation assumed, to return the oil sheared from the shaft toward the central passage 17. The oil sheared from the shaft by the other or inboard group of ribs directs the oil in the opposite direction but it is trapped at the central chamber 17 or, in any event, finally sheared off by the outboard group of ribs. The lubricant sheared from the shaft by the ribbing drains down through the grooves into the openings 16 and 18 and thence into the passage 15.

In the opposite direction of rotation the oil seal 10 also effectually prevents emergence of oil tending to creep along the shaft. In such instance, the inboard section of ribbing 14 shears the oil from the shaft, such ribbing being arranged with a lefthand spiral so that it tends to return the oil to the right to the space between the inner end of the seal and the bearing and thence into the passage 366'.

For either direction of rotation of the shaft 216 if any film of oil should somehow escape being trapped in the seal and be carried on the shaft in a leftward stroke of the latter, the tapered mouth form of the outboard end of the seal assures, as heretofore noted, that the oil film will not be sheared off at the extreme end of the seal sleeve on the return stroke of the shaft but will instead be carried back into the confines of the seal before it is sheared.

From the foregoing it will be perceived that a rugged, low-cost seal has been provided for axially vibrating rotary shafts. Moreover, the construction is such as to operate effectually with either direction of shaft rotation so that it is well-suited for use in connection with reversible shafts as, for example, in a reversible printing press unit.

In Fig. 5 is shown a modified form of oil seal 20 also embodying the present invention. The seal 20 is of somewhat simpler form than the seal 10 previously described but is more limited in its uses since it is adapted only for shafts which are unidirectional as to rotation rather than reversible.

As in the case of the seal 10, the seal 20 of Fig. 5 has been shown as applied to an end supporting shaft 216 of an axially vibrating rotary ink drum 215, the shaft being journaled in a bearing 236 in a press side frame 8. Also as before, the seal 20 serves to strip any lubricant from the shaft 216 which tends to creep along it and return the same to the gravity drain passage 366' in the press frame.

The seal 20, like the seal 10, is fashioned in the form of a cast metal sleeve made, for example, of bronze, and is split horizontally as indicated by the parting line 21. The inner end portion 20a is dimensioned to enter the press frame bore 236a which receives the bearing 236, being spaced a distance from the end of such bearing. A mount-

ing flange 20b on the sleeve is gripped by adapted shoes 366 which clamp the flange in place against the inner face of the press frame.

The interior of the seal 20 has spiral grooving 22 defined by spiral ribs 24 which may be of the same shape and size as the ribs 14 in the seal 10 previously described. Here, however, the grooving is all spiraled in only one direction. The direction of the spiraling must, however, be related to the direction of shaft rotation. As indicated in Fig. 6, the ribbing is spiraled in a direction opposite to the direction of rotation of the shaft as viewed from the inboard end of each seal (i. e. the end adjacent the press side frame). With the ink drum adapted to rotate in the direction of the arrow 215a, the ribbing or threads in the righthand one of the seals 20 (as viewed in Fig. 6) have a lefthand spiral, while those in the other seal 20 at the opposite end have a righthand spiral.

As in the case of the seal 10, the mouth of the seal 20 is tapered or flared at an angle α to prevent shearing off, outside the seal, of any lubricant which may emerge from the same, all as previously described.

I claim as my invention:

1. An oil seal for an axially vibrating rotary shaft, comprising a sleeve having an internal spiral groove therein defined by spiral ribbing dimensioned to embrace the shaft, said sleeve having a gravity drain opening in its lower portion intersecting the root of said groove, and the outboard end of the interior of said sleeve being flared outwardly to progressively enlarge the internal diameter of the ribbing toward such end, said flare extending inwardly in intersecting relation with the ribbing a distance which is at least as great as the space occupied by the first spiral convolution of the groove so that oil sheared from the shaft upon axial inward movement of the latter is substantially completely deposited for drainage in said groove.

2. An oil seal for an axially vibrating rotary shaft, comprising a transversely split sleeve having an internal spiral groove therein defined by helical ribbing dimensioned to embrace the shaft and having walls engaging said shaft at substantially a right angle, said sleeve having a gravity drain opening in its lower portion communicating with said groove, and the outboard end of the interior of said sleeve being flared outwardly to progressively enlarge the internal diameter of the ribbing toward such end, said flaring intersecting at least two adjacent convolutions of said ribbing so that the oil film clinging to said shaft is successively removed by said ribbing convolutions and deposited substantially completely in said groove.

3. An oil seal for an axially vibrating rotary shaft, comprising a sleeve having internal spiral grooves in multiple therein defined by spiral ribbing dimensioned to embrace the shaft, the portion of said ribbing at one end of said sleeve being spiraled in one direction and the portion of the ribbing at the other end being spiraled in an opposite direction, the outboard end of the interior of said sleeve being flared outwardly, the flare intersecting at least one convolution of said ribbing to prevent the shearing off of oil film externally of said sleeve, and said sleeve having a gravity drain passage in its lower portion communicating with individual ones of said grooves.

4. An oil seal for an axially vibrating shaft

having unidirectional rotation, comprising a sleeve having an internal spiral groove therein extending substantially the full length of said sleeve and defined by spiral ribbing dimensioned to embrace the shaft, said sleeve having a gravity drain opening in its lower portion communicating with the root of said groove, said ribbing being spiraled in a direction opposite to the direction of rotation of said shaft as viewed from the inboard end of said sleeve, and the outboard end of the interior of said sleeve being flared outwardly to progressively enlarge the internal diameter of the ribbing toward such end.

5. An oil seal for an axially vibrating rotary shaft comprising a sleeve having an internal spiral groove therein defined by spiral ribbing dimensioned to embrace the shaft, said ribbing presenting shearing edges to the peripheral surface of said shaft for stripping off excessive oil clinging to said shaft, said sleeve having gravity drain openings in its lower portion in communication with successive convolutions respectively of said groove so that the oil forced into said groove upon relative movement of said shaft is effectively drained at successive points along the length of said groove.

6. An oil seal for an axially vibrating rotary shaft comprising a sleeve having internal spiral grooves in multiple therein defined by spiral ribbing dimensioned to embrace the shaft, said sleeve having gravity drain openings in its lower portion in communication with individual ones of said grooves so that the oil forced into said grooves upon relative movement of said shaft is effectively drained at successive points along the length of said grooves, said sleeve having an internal flared portion extending axially inward a sufficient distance to intersect more than one of said grooves.

7. An oil seal for an axially vibrating rotary shaft having unidirectional rotation comprising a sleeve having an internal spiral groove therein defined by spiral ribbing extending substantially the full length of said sleeve, said ribbing being dimensioned to embrace the shaft and presenting shearing edges which are substantially perpendicular to the surface of the shaft for stripping off excessive oil clinging thereto, said sleeve having a gravity drain opening in its lower portion intersecting the root of said groove intermediate the ends thereof and leading downwardly therefrom to enable oil to be withdrawn from the groove as it is deposited therein upon vibration of the shaft, the spiralling of said ribbing being in a direction opposite to the direction of rotation of the shaft as viewed from the inboard end of said sleeve.

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