

[54] **MINING MACHINE WITH APPARATUS FOR SUPPLYING DUST SUPPRESSION LIQUID TO ROTATING CUTTING HEAD**

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[52] U.S. Cl. .... **299/81; 277/162; 277/165; 277/DIG. 8; 285/190**

[51] Int. Cl. .... **E21c 35/22**

[58] Field of Search ..... **299/81, 76; 175/393, 339, 175/340; 277/162, 165, DIG. 8; 285/190**

[56] **References Cited**  
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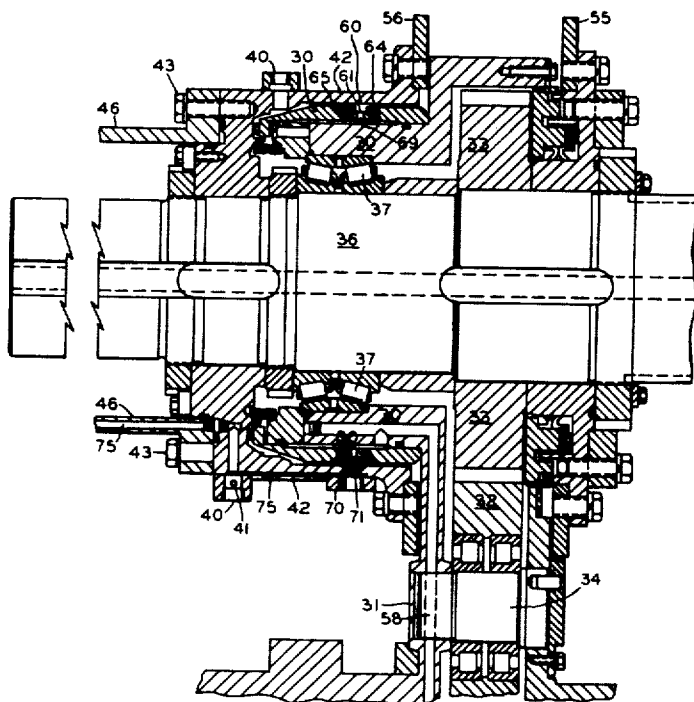
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Primary Examiner—Ernest R. Purser  
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[57] **ABSTRACT**

Apparatus for transfer of dust suppression liquid from the stationary frame of a mining machine to the peripheral cutting surface of a rotatable mining head. A stationary housing has an outer annular surface that forms an annular interface with an inner surface of the rotatable mining head. The outer surface of the stationary housing has a groove formed therein that circumscribes the housing. Floating split sealing rings are disposed in parallel relationship at either side of the groove. The rings partially fill the space between the two surfaces. Each ring tends to expand gently outwardly against the inner surface of the rotatable mining head. An annular cavity common to the housing and the head is formed between the two surfaces and the sealing rings. As liquid pressure enters the cavity between the rings, the pressure of the liquid moves the rings into a sealing position. The rings are moved radially outwardly against the inner surface of the rotatable head and they are moved axially away from each other against the sides of the groove to form a substantially liquid tight seal.

**3 Claims, 11 Drawing Figures**



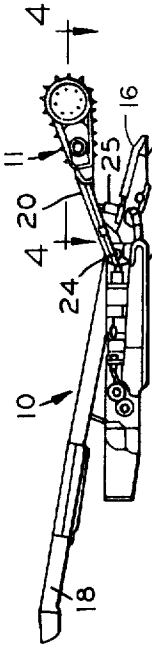
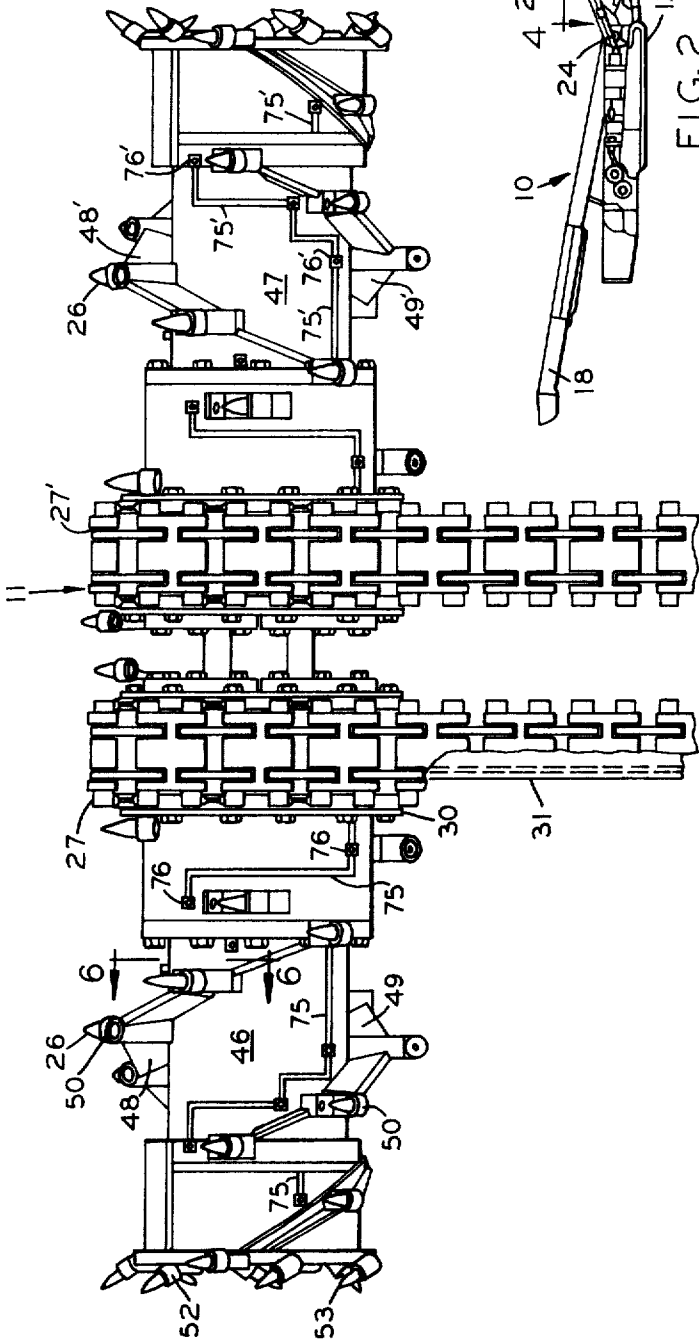


FIG. 2

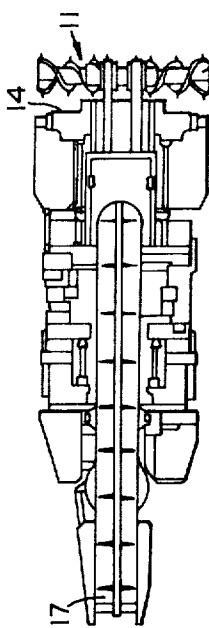


FIG. 1

FIG. 3

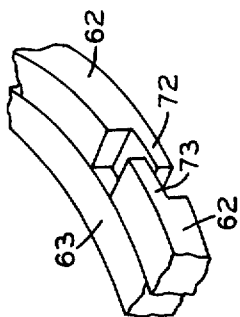
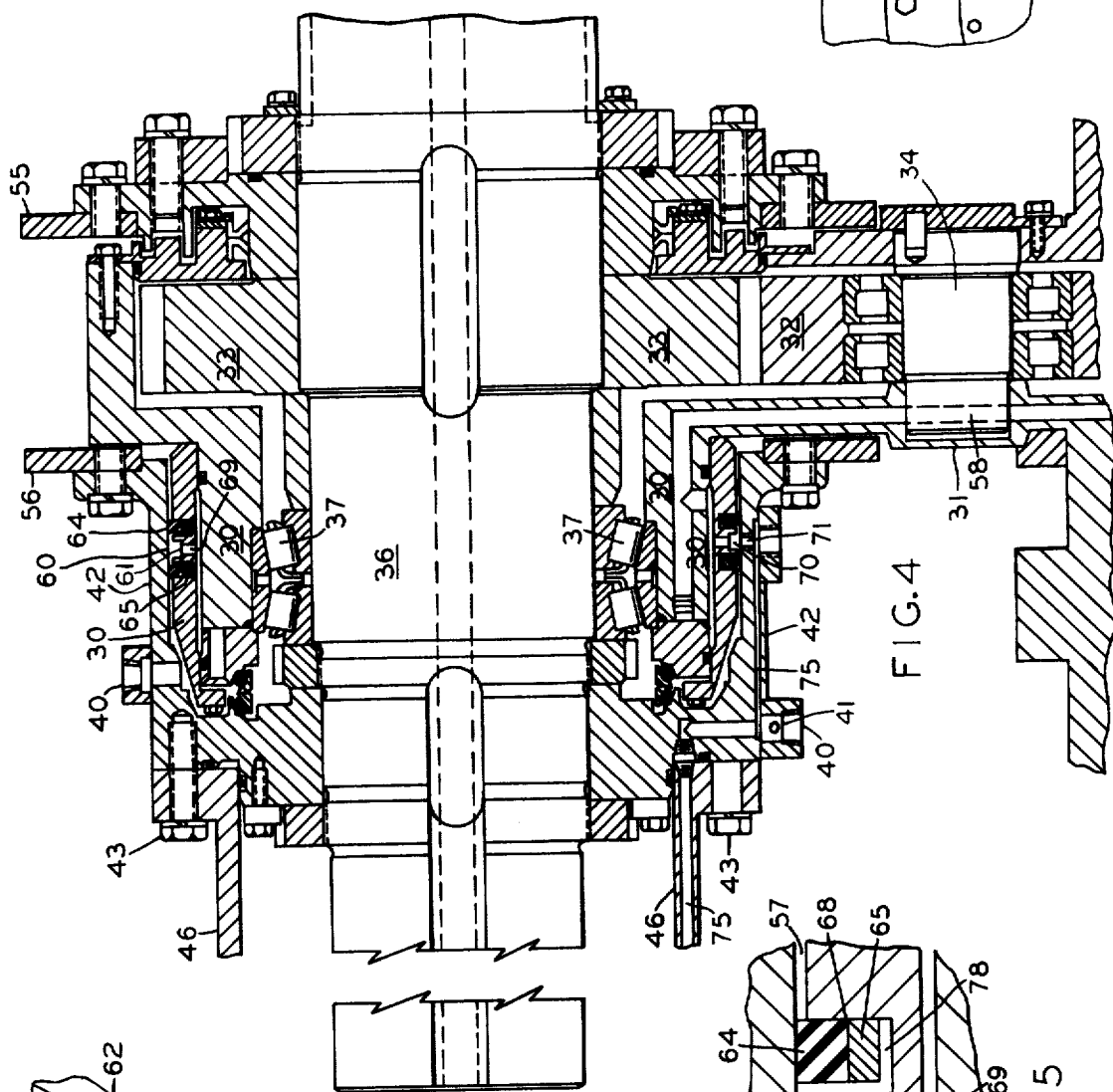


FIG. 11

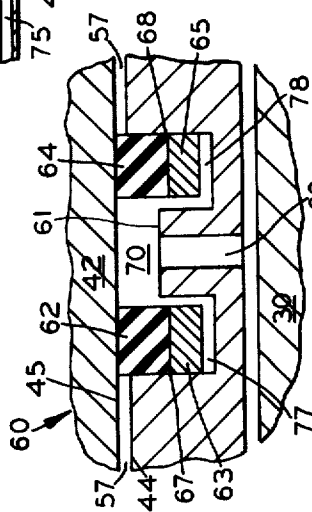


FIG. 5

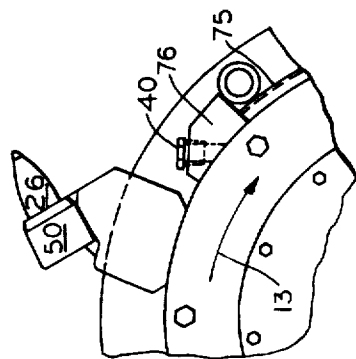


FIG. 6

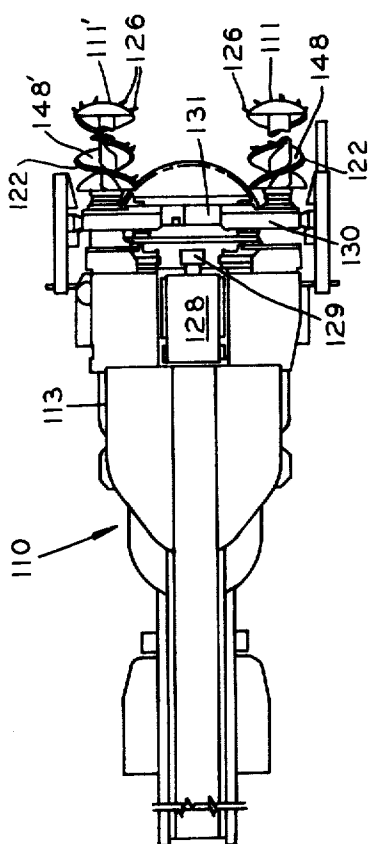


FIG. 7

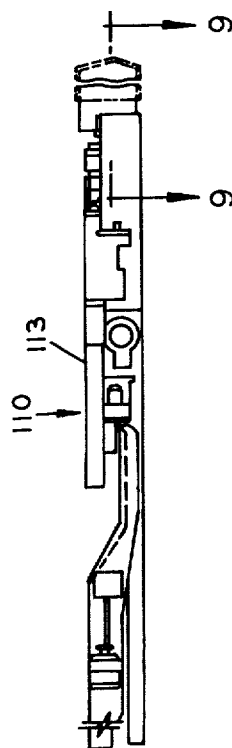


FIG. 8

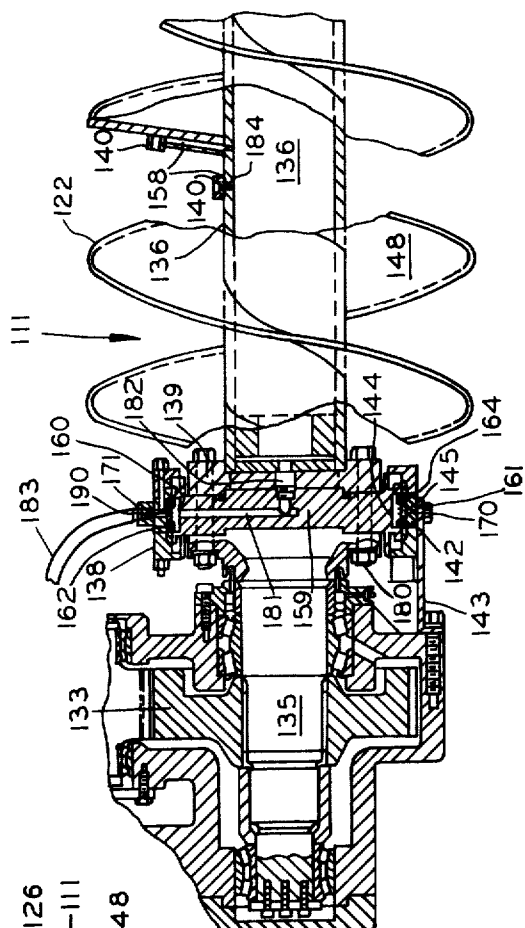


FIG. 9

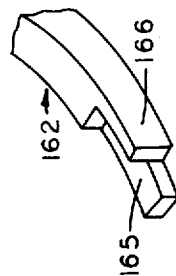


FIG. 10

## MINING MACHINE WITH APPARATUS FOR SUPPLYING DUST SUPPRESSION LIQUID TO ROTATING CUTTING HEAD

### BACKGROUND OF THE INVENTION

This invention relates generally to mining machines and more specifically to apparatus for suppressing the dust which typically arises during the operation of a mining machine. In particular the invention relates to cutters which are provided with means for feeding dust suppression fluid into the cutting zone.

During the operation of continuous miners large amounts of dust are inherently generated. This dust, unless suppressed, collected or removed, may present a hazard to the health and safety of the personnel in the mine. Conventionally, means such as large vacuum devices or banks of water spray nozzles mounted behind the rotary cutting devices have been used. However, more recent work has been directed at mounting the spray nozzles on the rotating cutter heads or augers. Such machines are generally called "wet head" or "wet auger" mining machines. These wet auger machines are effective at dust suppression. The reason evidently is because the water is directed more closely to the cutting zone and suppresses the dust before it becomes airborne. Thus the water is more efficiently used. However, the success of the wet auger system is yet to be proven as far as operating life and maintenance requirements are concerned.

Irrespective of the machine type, model or seam height being mined, the wet auger method of dust control has presented one distinct design problem. That is to provide an efficient means for conveying water from the stationary mining machine to the nozzles mounted on the rotating auger head.

In particular, the water transfer system from mining machine to rotating auger head must not leak appreciably. It must be expected that the water supply to the auger may be interrupted. Therefore the seal element must be able to operate dry without experiencing accelerated wear. Also the seal mechanism must have the capability to operate in varied mine waters that may be contaminated. In addition, the seal should be self-adjusting to wear and easily field installed when it must be replaced. Furthermore, the seal should generally require minimum maintenance to avoid interruptions of the mining process. Another desirable feature of an effective liquid transfer system is that it be easily added to existing non-wet head miners.

### SUMMARY OF THE INVENTION

Accordingly, it is the object of the present invention to provide an improved means for transferring water between a stationary mining machine frame and a rotating cutter head.

Another object of the invention is to provide an improved sealing means to aid in supply of dust suppression fluid to nozzles located on a rotating cutter head of a mining machine.

A further object of the invention is to provide a long life seal element which is self-adjusting to wear.

Still another object of the invention is the provision of a rotary seal element for a wet auger mining machine that is able to operate with contaminated mine water or without any water.

Yet another object of the invention is to provide a means for easily converting conventional rotary head mining machines to wet auger miners.

The invention accomplishes the above and other objectives by providing a rotary sealing apparatus that moves into sealing position as liquid is supplied under pressure to the annular cavity.

In one embodiment, a major groove circumscribes the outer surface of a stationary support housing of a mining machine. A portion of a rotatable mining head overlaps the grooved portion of the support housing. This overlap forms an annular interface between the stationary support and the rotatable mining head. A pair of split sealing rings is disposed in the groove. The rings are parallel and spaced apart at either side of the groove. Thus, an annular cavity is formed between the outer surface of the stationary support, the inner surface of rotatable support and the two seals. The seals only partially fill the space between the inner and outer surface. Also, each seal ring is split and each has a tendency to expand gently outwardly against the inner surface of the rotatable member. As the seal ring expands outwardly, a small gap is formed between the inner surface of the seal and the outer surface of the groove. When the dust suppression liquid is supplied under pressure, it occupies the gap and tends to push the ring into the sealing position against the inner surfaces of the rotatable mining head. The liquid pressure also pushes the rings apart axially into sealing position against the sidewalls of the groove formed in the outer surface of the support housing. Whenever the liquid is present, it acts to lubricate and cool the seals. However, when the liquid is absent the rings relax and move away from the sealing position. If the seals did not have this tendency to relax or float when liquid pressure is absent, the seals would experience accelerated wear.

### DESCRIPTION OF THE DRAWINGS

FIG. 1 is a plan view of a mining machine incorporating the dust suppression apparatus of this invention.

FIG. 2 is a side elevational view of the mining machine illustrated in FIG. 1.

FIG. 3 is an enlarged plan view with parts in section of a portion of the mining machine shown in FIG. 1.

FIG. 4 is a sectional view taken substantially along line 4—4 of FIG. 2.

FIG. 5 is an enlarged sectional view of a portion of the structure shown in FIG. 4.

FIG. 6 is a sectional view taken substantially along line 6—6 of FIG. 3.

FIG. 7 is a plan view of another mining machine incorporating the dust suppression apparatus of the present invention.

FIG. 8 is a side elevational view of the mining machine shown in FIG. 7.

FIG. 9 is a sectional view taken substantially along the line 9—9 of FIG. 8.

FIG. 10 is a perspective view of one end of a sealing ring.

FIG. 11 is a perspective view of the overlap, notched portion of a sealing ring.

### DESCRIPTION OF THE PREFERRED EMBODIMENTS

A continuous mining machine 10 with the improved dust suppression system and rotary seal structure of this invention is illustrated in FIGS. 1 and 2 of the drawings.

The mining machine is a continuous type in which the mining head 11 is disposed at the forward end thereof to be advanced into a mine face for cutting and breaking material out of a mine face. The mining machine 10 is supported on endless traction treads 12, one of which is shown in FIG. 2, disposed one at each side of the machine and suitably driven for propelling the mining machine.

The mining head 11 has a boom 20 that extends forwardly to support the rotary cutting and breaking drum 22 at the front end of the mining machine. The boom 22 extends rearwardly to the pivot structure 24 and is supported on the latter. As shown in the enlarged view in FIG. 3, the mining head has a plurality of spirally arranged cutter bits 26 and cutting chains 27 for cutting and breaking from the mine face. A plurality of liquid spray nozzles 40 are mounted on the rotating mining drum 11. Where possible the nozzles are mounted in a plane perpendicular to the drum axis and in front of a cutter bit 26 and pointed to spray dust suppression liquid in the plane of rotation of a bit. The direction of rotation is indicated by the arrow 13 of FIG. 6.

The mining head is driven by electric motors (not shown) which are on opposite sides of the main frame. The drive from the motors is delivered to transmissions (not shown) and then to universal shafts (not shown). Each universal shaft is connected to a drive shaft (not shown) which is rotatably mounted in the drive housing and main support 30 as seen in FIG. 4.

The mining head 11 is moved upwardly and downwardly by hydraulic cylinders 25 pivotally attached at their lower ends to clevises on the main frame 10 and their upper ends to the boom 20.

The gathering structure 14 is at the forward end of the mining machine 10 beneath the mining head 11 and is pivotally supported at the pivot structure 24. Two gathering arms 16 on the gathering head 14 gather the mine materials and sweep the material in toward the center of the gathering head onto an endless chain and flight conveyor 17.

The endless chain and flight conveyor 17 extends longitudinally through the mining machine 10 from the gathering head 14 to the rear end of a discharge conveyor boom 18 which is pivotally supported on the pivot structure 24.

FIGS. 3, 4, and 5 illustrate the details of the structure which conveys dust suppression liquid from the main frame 10 to the rotating mining head or drum 22. This structure is the same on each side of the mining machine except that the elements are oppositely disposed. Therefore, this description will proceed with respect to the liquid transfer structure on one side only of the mining machine with the understanding that the description applies equally to the liquid transfer structure on the other side of the mining machine.

The main support has a forward housing extension and support member 30. Within the central portions of the housing a reach gear 32 engages the drive from the motor and is rotatably mounted in the housing 30 on the shaft 34. The reach gear 32 in turn engages a driven gear 33. The driven gear 33 is secured to a rotatable shaft 36 that has its axis disposed transversely with respect to the longitudinal center line of the mining machine. The shaft 36 is supported by the forward housing extension and support member 30 and is rotatable with respect to the latter on a bearing 37. The driven gear 33 connects the drive means to the shaft 36.

The rotatable shaft 36 supports the cutting and breaking means of the mining head 11. At the outer side of the support member 30 there is a circular flange member 42 which is disposed closely adjacent to the support member 30. The circular flange extends from the shaft 36 to overlap the support section 30 to provide a rotating surface which cuts a path for the stationary housing support section 30. The circular flange member 42 is mounted at one end by a bolt 43 or other means to the shaft 36 whereby the circular flange 42 is rotatable with the shaft.

A cylindrical shell 46, 47 is also supported on the shaft 36 with the circular flange member 42. The cylindrical shell 46 extends outwardly from the circular flange member 42 along the shaft 36 and supports a portion of the outer cutting and breaking means comprise two spiral flights 48, 49 which are secured to the cylindrical shell 46. A plurality of bit holders 50 are secured to the peripheral edges of the spiral flights 48, 49 at spaced positions. And a bit 26 is secured in each bit holder 50.

At the outer end of the cylindrical shell there are a plurality of bit holders 52 and bits 53 which extend somewhat beyond the end of the cylindrical shell 46. These bit holders 52 and bits 53 are disposed in groups at spaced circumferential positions of which there may be four groups.

By reason of the support member 30 on which the shaft 36 and the rotary cutting and breaking means is supported and in which the drive connection is affected to the shaft on its transverse axis, there is a gap between the two cylindrical shells 46, 47. Such gap is filled by an auxiliary or secondary cutting and breaking means comprising and endless flexible chain 27 which is adapted to operate on a support member and is of such lateral width as to fill the gap. The chain is driven at its forward end by sprocket wheels 56 which are secured to the circular flange 42.

The overlap between the rotatable circular flange 42 and the stationary housing and support 30 presents an annular interface 57 between the stationary and rotating members. The liquid transfer structure is disposed at this interface.

Liquid is supplied to the interface 57 from a liquid source (not shown) and conveyed by appropriate hose means (not shown) to the miner 10. From the miner 10 the liquid is conveyed along a channel 58 which is formed in the wall of the stationary gear case, 31.

The liquid channel extends along the gear case 31 and outwardly along a path within the housing and support structure 30 to a fluid transfer apparatus 60 at the interface 57 between the housing 30 and the flange 42. The transfer apparatus 60 comprises a groove 61 circumscribing the structure and having two pairs of spaced apart rotary seals 62, 63, 64, 65 at either side of the groove 61. FIG. 5 shows the rotary seal mechanism in greater detail. The annular support structure or housing 30 is spaced from the concentric rotating flange 42 about one quarter inch to provide an adequate space or clearance 70 between the stationary and rotating members.

The stationary support 30 has a major center groove 61 circumscribing its outer surface. The major center groove 61 is bounded on either side by secondary grooves 67, 68. An inner seal ring 63, 65 and an outer seal ring 62, 64 are disposed within each of grooves 67, 68. The secondary grooves are narrower than the major

groove but are deeper so that they act to hold the seals in their relative positions at opposite sides of the major groove 61. Each inner seal 63, 65 is split or segmented and tends to spring outwardly against the outer ring 62, 64. Each outer ring 62, 64 is a split piston type ring made of a low friction material such as bronze impregnated polytetrafluoroethylene more commonly known by its tradename Teflon. Other low friction materials such as carbon or glass impregnated Teflon may also be used.

The ends of the outer sealing rings 62, 64 are cut to form notched-end portions 72, 73 as shown in FIG. 11. The notches 72, 73 overlap to form a continuous surface. The inner rings 63, 65 also are split and may be made of spring steel or plastic. Their main purpose is to help hold the outer ring in place and to cover the overlapped portions 72, 73. A retainer pin (not shown) holds inner and outer rings in their relative position to assure that the split portions of the outer and inner rings do not match up causing extra leakage of the liquid past the seal.

The combined width of each pair of inner and outer rings is such that each pair nearly fills its groove 67, or 68 and the space 70 formed between the rotating flange 42 and the inner support housing 30. The sealing rings 62, 63 and 64, 65 tend to expand gently outwardly against the inner surface 45 of the flange 42. When no liquid pressure is present in the system, outer rings 62, 64 ride gently against the inner surface 45 of the flange 42 in a neutral or floating position. Since the seals tend to expand outwardly and since they only partially fill the secondary grooves 67 and 68, a small gap or space 77, 78 is formed between the rings and the outer surface of the housing 30.

When liquid is supplied under pressure through the inlet 69 to the space 70, the seals are moved both axially and radially. The pressure of the liquid pushes on the rings to move them apart axially against the side walls of the groove 6. Also the liquid enters the smaller gaps 77, 78 and pushes the rings out radially against the inner surface of the flange 42.

In operation, water enters the space 70 under pressure and acts to push the seals against the inner surface of the rotatable flange 42 and against the sidewalls of the groove 6 in the non-moving housing 30. The liquid exerts a pressure of over 100 psi which holds the rings firmly in sealing position. Without the liquid pressure there is little load on the seals 62, 63, 64, 65. The only load that holds the outer seal rings 62, 64 in place is provided by the backup spring rings 63, 65 and this pressure amounts only to about 4 psi. Accordingly, if there is a loss of liquid pressure, the pressure of the seals against any moving parts is correspondingly reduced. Thus wear on the seals is reduced when the lubricating qualities of the liquid are absent.

The seals present a geometry which when combined with the on-off liquid pressure creates an automatic and self-closing seal. The seals exhibit a floating action; they relax when the liquid pressure is reduced and they move into a sealing position when the liquid pressure is present. Also because the outer seal rings are flexible, they will accommodate their own wear and the wear of the flange 42 or housing surface 30.

To minimize the leakage through the seal the clearances between the rings and the grooves should be as small as possible. However, for the floating ring seal feature of this invention to be effective both rings must

be able to move freely within the groove. Thus some allowance must be made to be sure that the rings do not bind in the groove due to heat expansion of the rings or corrosion of the groove walls and particulate matter carried by the fluid.

From the annular cavity formed 70 by the seals 62, 64 the housing surface 30 and the auger flange surface 42, the water is conveyed over the surface of the auger shell 46 by a series of channels 75. A plurality of low profile spray nozzles 40 are interconnected by the channels 75.

Each nozzle 40 is located behind a projecting nozzle block 76 to prevent direct impingement of dust or other foreign matter on nozzle orifice 41. Also, the nozzle spray orifice 41 is pointed in a direction opposite to that of the direction of rotation. Where possible the nozzles 40 are placed in the plane formed by the rotation of a bit just in front of the bit. In this position the nozzles 40 present a liquid spray which flushes the bits 26 and wets the immediately adjacent mine face.

The overlapping nature of the notched end portions 72, 73 of the outer rings 62, 64 allows the necessary expansion and contraction of the rings. Yet because of the overlap, the notched portions 72, 73 press against each other under the influence of the liquid pressure to form a continuous sealed surface. The inner spring rings 63, 65 aid in urging the outer sealing rings 62, 64 into position. Also the inner rings 62, 65 are positioned to overlap the notched portions 72, 73 of the outer seal rings 62, 64 thus helping to reduce leakage there-through. These functions of outward movement and covering of the notched portions of the outer rings 62, 64 may be accomplished by other seal ring configurations. For example, all of the functions of the outer seal ring and inner seal ring may be obtained by a single ring in which the notched portions are connected by a tongue and groove or dovetail arrangement. Such joints would allow expansion and contraction of the ring but would aid in reducing water leakage through the overlap portion.

The purpose of the secondary grooves 67, 68 is to maintain the seal rings 62, 63, 64, 65 at either side of the major groove 61. Means other than the grooves 67, 68 could be provided which could perform a similar function. For example, small annular walls could be attached to the outer wall surface 44 of the stationary extension 30. Alternately at either side of the major groove 61 expandable bridge elements or springs could be inserted between the two sets of seals 62, 63, and 64, 65 at selected points about the circumference of the stationary extension. However secondary grooves are shown in this embodiment because of their ease of fabrication, their strength and their permanence.

To improve the dust suppression efficiency of conventional mining machines similar to the one shown in FIGS. 1 and 2, it is desirable to be able to convert such conventional mining machines to wet head machines. Because a mining machine is large and because the downtime of such a production machine should be kept to a minimum, it is also desirable that the conversion process occur as quickly as possible. The present invention lends itself to such a conversion. A few straight forward changes in the described embodiment can make the invention applicable to conventional mining machines. First, a supply of liquid is already available on conventional machines to supply liquid for the bank of nozzles located behind the cutter drum. Second, most

of the channels 58, 75 that convey liquid from the supply to the cutting drum do not have to be formed within the gear case 31, the shell 46 or the flange 42. Instead a satisfactory channel may be welded to their outside surfaces. The liquid transfer apparatus 60 may be formed in any piece of the housing 30 that is overlapped by the flange 42. However, for ease of conversion, it is desirable that the liquid transfer apparatus be formed in a separate piece of the housing 30 that is easily removed. This would allow a conventional piece of the housing to be replaced with a grooved substitute.

FIG. 7 and 8 illustrate another type of mining machine 110 having liquid spray nozzles mounted on its rotary cutter head 111 and incorporating the rotary seals liquid transfer means 160 of the present invention. The mining machine 110 comprises a main frame 113 on which the various elements of the mining machine are operatively supported. Within the main frame 113 there is provided a motor 128 for operating the mining apparatus and having its armature shaft 129 longitudinally disposed. A main gear case 131 is secured to the front of the main frame 113 adjacent to the front of the motor. The main drive (not shown) of the mining mechanism is mounted within the gear case 131.

The motor armature shaft 129 extends forwardly from the motor in a longitudinal direction into the main gear case 131. The armature 129 is in engagement with a right gear train and a left gear train (not shown) which are disposed at opposite sides of the armature and extend in opposite lateral directions from the armature to the left and right sides respectively of the main gear case 131. The right and left gear trains extend in opposite directions and are drivenly connected to the auger shafts 136.

The right supporting arm and housing 130 extends laterally from the main gear case 131. The right supporting arm 130 is pivotally connected to the main gear case 131. Within the supporting arm housing 130 there is rotatably mounted a gear 133 which is secured to a shaft 135 and drivenly connected to the motor shaft 129 by the right gear train (not shown). The forward end of the shaft 135 projects forwardly from the supporting arm 130 and is formed with a mounting flange 138.

The supporting arm 130 supports a mining mechanism 111 in the form of a longitudinally extending auger 122 to which there is secured a mounting flange 139 that abuts a liquid transfer apparatus 160 which is interposed between the auger mounting flange 139 and the support arm flange 138. The two flanges 138, 139 and the internal structure of the liquid transfer apparatus 160 is secured together by a plurality of bolts 180 or the like whereby the auger 122 is rotated by the shaft 135. At the left side of the mining machine 110 there is provided another mining mechanism 111 comprising an auger 122 as seen in FIG. 7. The right and left augers are identical in all material aspects with the exception that they are oppositely formed thus, each of the augers is formed with the helical flights 148 and these are formed in opposite directions on the respective augers. When the augers are operating in a seam of material the auger 122 is rotated in a clockwise direction as viewed in FIG. 7 and the material which is cut and broken out of the seam is removed from the seam by the helical flights 148 which moves the mined material

rearward towards the main frame 113 of the mining machine 110.

At regularly spaced intervals along the periphery of the helical flights 148, there is provided a plurality of radially directed cutting bit holders 150 and at the front of each of the holders 150 there is provided a forwardly directed cutting bit 126 by which the material is cut and broken out of the mine seam.

A plurality of liquid spray nozzles 140 are mounted along the shaft 136 and at selected positions on the auger flights 148. Channels 158, 184 connect each of the spray nozzles with the interior of the hollow shaft 136. Dust suppression liquid is transferred from the mining machine frame 113 to the interior of the rotating shaft 136 by the liquid transfer apparatus 160.

The liquid transfer apparatus 160 comprises a rotating annular hub 159 interposed between the mounting flanges 138, 139. An annular housing 142 extends around the inner hub 159 and is prevented from rotating with the hub 159 by a bracket 143 which secures it to the support housing 130. The housing 142 encircles the hub 159 to form a seal housing or interface between the inner surface 145 of the stationary housing 142 and the outer surface 144 of the rotatable hub 159. The rotatable hub 159 has a major center groove 161 circumscribing its outer surface 144. The sealing rings 162, 164 are disposed around the rotatable hub 159 at opposite sides of the groove 161. Springs 190 are interposed between the seals 162, 164 to gently hold the seals in their relative parallel positions at opposite sides of the groove 161. Each sealing ring 162, 164 is split and tends to spring outwardly against the stationary housing 142. FIG. 10 illustrates one end of the portion which comprises a double notched portion providing an overlap 165 to retard flow axially and an overlap portion 166 to retard flow in the radial direction. This joint allows expansion and contraction of the ring but is less prone to leakage of the liquid than a single overlap portion would be.

The combination of the outer surface 144 of the hub 159 the inner surface 145 of the stationary housing 142 and the oppositely disposed seals 162, 164 forms an annular cavity 170 about the rotating hub 159. Dust suppression liquid is supplied to the annular space 170 from a source (not shown) by a hose 183 secured to the inlet passage 171. Radial bores 181 extend from the annular space inwardly to the center of the inner hub 159 where they coincide with an axial bore facing 182 which communicates with the hollow auger drum shaft 136.

Water system pressure enters the small annular space 170 under pressure and acts to push the seals 162, 164 outwardly against the inner surface 145 of the housing 142 and away from each other against the sidewalls of the groove 161 in the rotating hub 159. The liquid then flows from the annular space 170 through the radial bore 181 to the center of the hub 182 where flow is directed to the bore of the hollow auger drum shaft 136. Exit is then from the drum shaft 136 through channels 158, to spray nozzles 140 on the outer perimeter of the shaft 136 or to channel extensions 184 which direct the flow to nozzle positions 140 located at appropriate positions on the peripheral area of the auger scrolls 148.

Having thus described the invention, those skilled in the art will recognize various uses for and changes in the details and arrangement of parts without departing from the scope of the invention as it is defined by the

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appended claims. It is therefore respectfully requested that this invention be interpreted as broadly as possible according to the provisions of the patent statutes and limited only by the scope of the appended claims.

I claim:

1. In a mining machine including a frame; a mining head mounted for rotation on said frame and having cutter bits and liquid spray means mounted thereon; a stationary member attached to the frame and having a cylindrical surface concentric with a cylindrical surface of the rotatable mining head to form an annular interface between the stationary and rotatable members; means in the stationary member for conveying liquid to the interface; and means in the rotatable member for conveying liquid from the interface to the liquid spray means; and further including an improved means for conveying the liquid from the stationary member across the annular space to the rotating member comprising:

a pair of spaced parallel annular grooves in the surface of one of the members;

fluid activated seals disposed in each groove to form an annular space between said seals, said rotating member and said stationary member, said annular

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space being in communication with the fluid conveying means at both members, each of the seals comprising a split outer ring of low friction material and having overlapping stepped ends allowing expansion and contraction of the ring and a split inner ring of resilient material adapted to push radially outwardly against the outer ring to hold the outer ring in gentle sliding contact with the surface of the other member;

said grooves being sufficiently deep to provide an annular space under the seals such that when liquid flows in the annular space the pressure of the seals against the surface of the other member is increased.

2. In a mining machine as recited in claim 1 the further improvement wherein the split region of the inner seal ring is radially displaced from the split region of the outer seal ring and the rings are held in such relative position.

3. In a mining machine as recited in claim 1 the further improvement wherein the inner ring is made of polytetrafluoroethylene impregnated with a low friction material.

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