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Cilles

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[54] **MINING MACHINE WITH APPARATUS FOR CONVEYING PRESSURIZED FLUID BETWEEN MOVABLE FRAMES**

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[52] **U.S. Cl.** **299/75**; 285/62; 285/302; 299/64

[51] **Int. Cl.** **E21c 27/24**

[58] **Field of Search**........ 285/137 R, 163, 165, 302; 60/177, 184; 299/59–62, 71–76; 173/27

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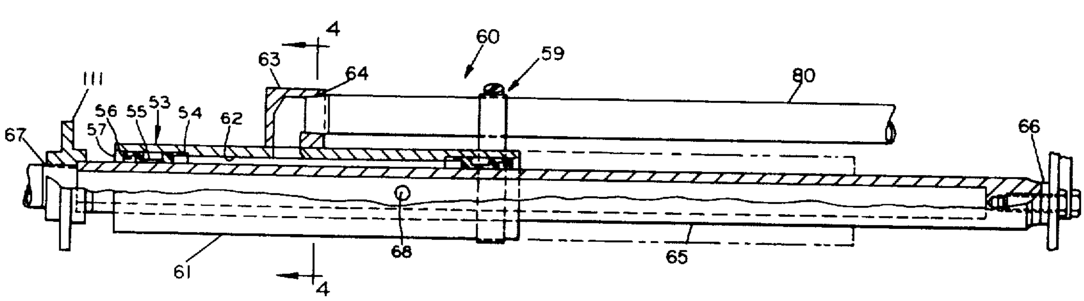
[57] **ABSTRACT**

A sliding fluid joint for transfer of hydraulic fluid described in relation to a mining machine. The mining machine has a main frame with drive means for propelling the machine. A second frame, or sump frame, extends forwardly from the main frame. A rotary drum for cutting and breaking material out of a mine face is pivotally mounted on the front end of the sump frame. The sump frame is slidably mounted on the main frame so the propelling means may be locked and the rotary drum advanced into the mine face by moving the sump frame forward away from the main frame. The main frame carries an electric motor driving a hydraulic pump for supply of fluid under pressure to fluid activated devices such as cylinders and hydraulic motors which are mounted on the main frame and on the sump frame. To connect the hydraulic pump on the main frame to fluid activated devices on the movable sump frame, sliding fluid joints are provided which eliminate the need for long flexible hose. The joints permit the frames to move relative to each other while maintaining a constant flow of fluid between the devices on the main frame and those on the sump frame. The sliding fluid joint comprises a cylinder and a longer hollow rod which passes longitudinally through the cylinder. Fluid flows into the rod and passes through holes in the rod into the cavity formed between the rod and the cylinder. From there the fluid flows out of an opening in the cylinder sidewall to the fluid activated devices on the second frame. This structure allows the rod and cylinder to move relative to each other without affecting the flow of fluids between the main frame and sump frame.

6 Claims, 7 Drawing Figures



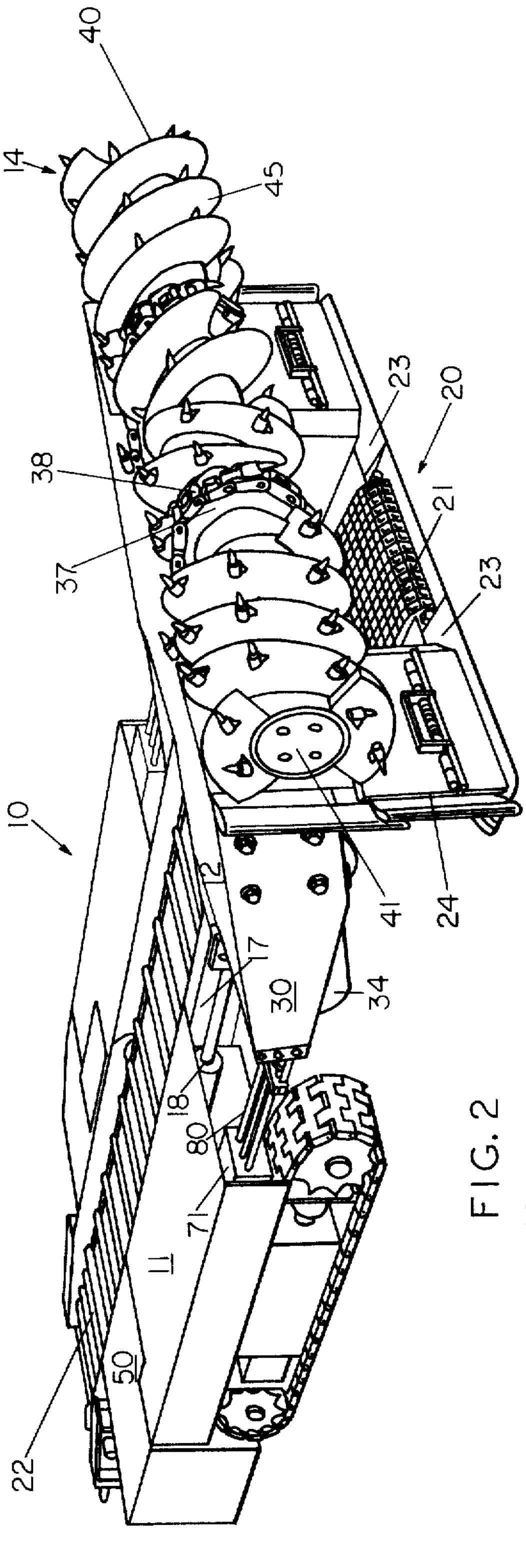

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FIG. 2

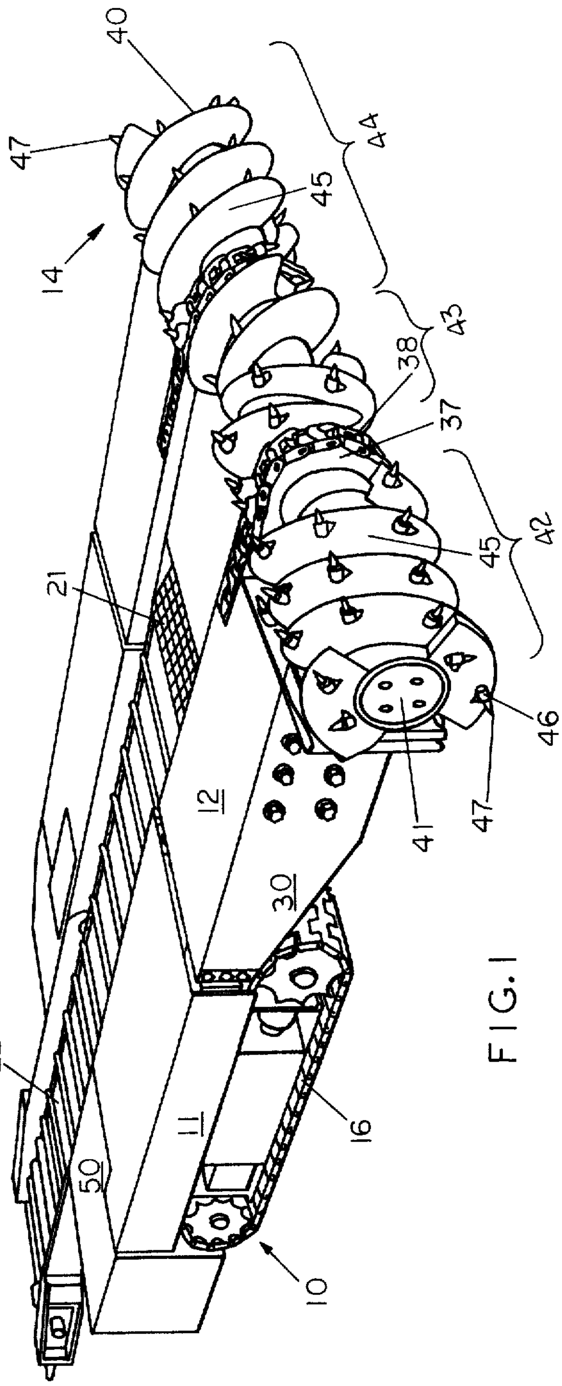
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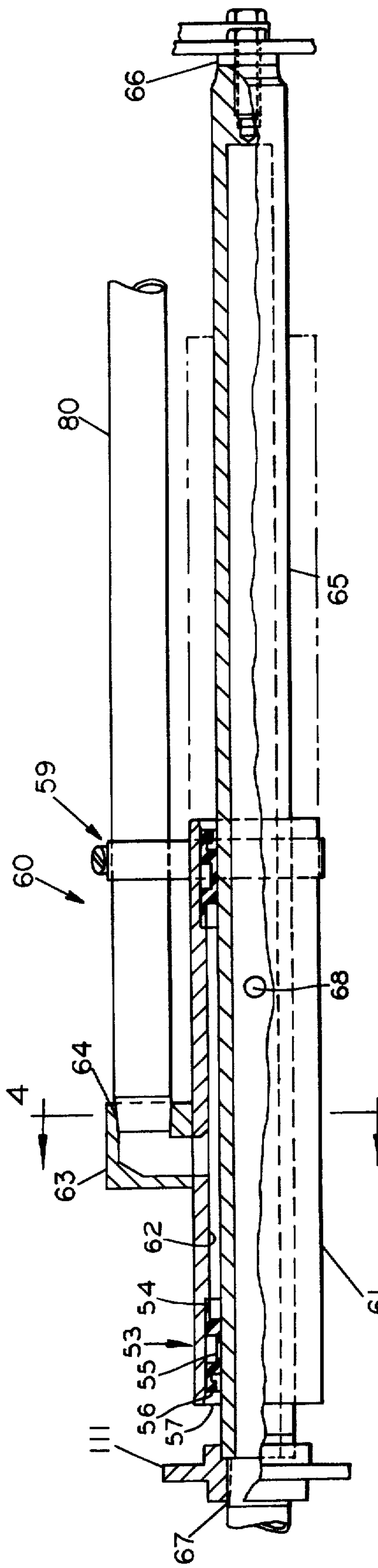
FIG. 1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65
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61
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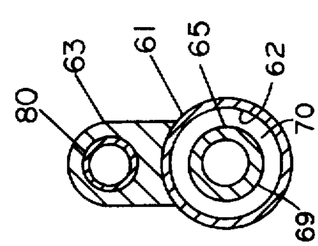
FIG. 3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63
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65
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FIG. 4

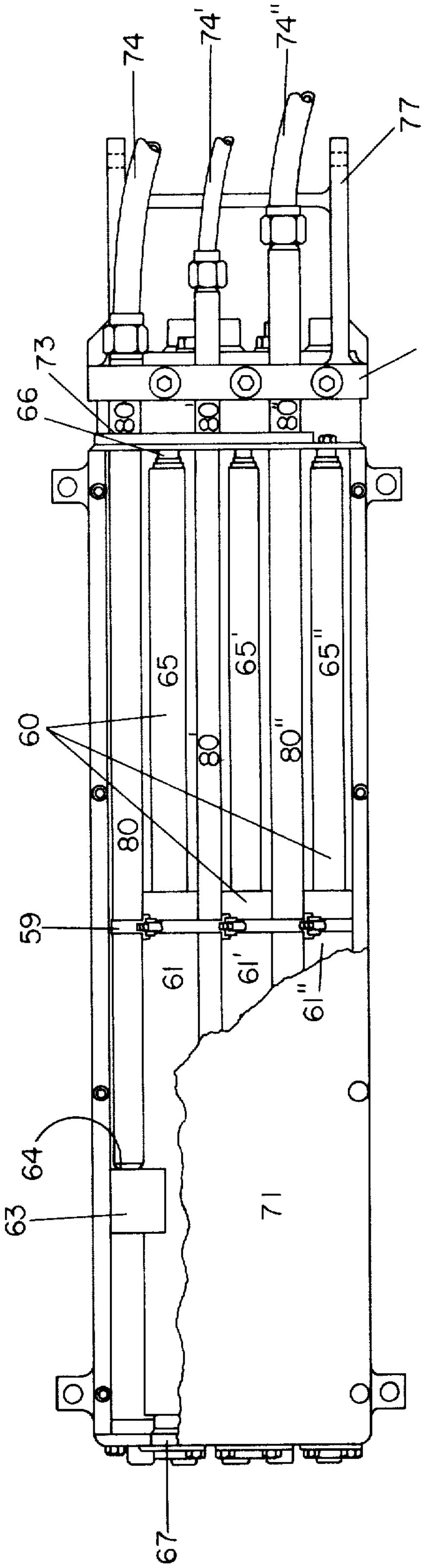

FIG. 5

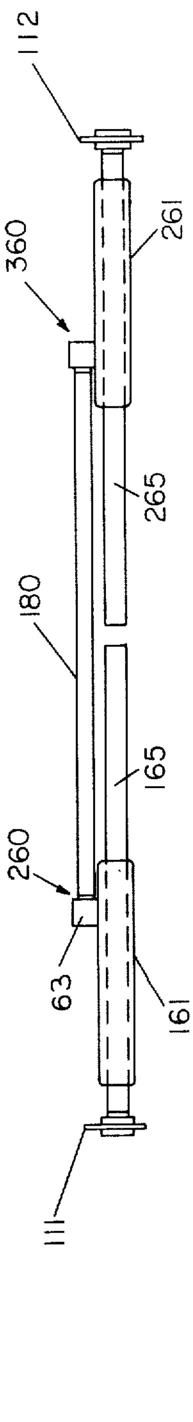

FIG. 6

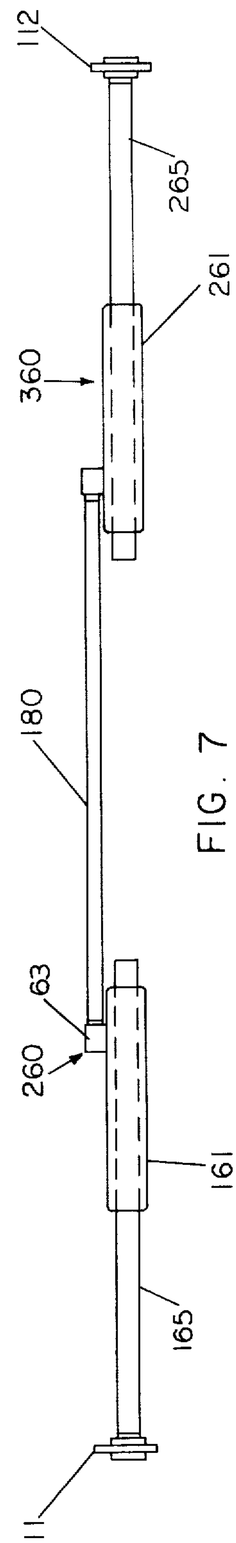

FIG. 7

MINING MACHINE WITH APPARATUS FOR CONVEYING PRESSURIZED FLUID BETWEEN MOVABLE FRAMES

BACKGROUND OF THE INVENTION

This invention relates to mining machines and particularly to mining machines having two or more major components that move relative to each other. Hydraulic devices are used extensively on large heavy duty movable equipment such as mining machines or mine conveyors. The hydraulic devices may include either cylinders or hydraulic motors which act to lift, move or propel certain parts of the machine. Usually the machine has one electric motor that drives the hydraulic pump. The pump, in turn, supplies fluid under pressure to the fluid activated devices such as the cylinders or hydraulic motors. The fluid activated devices are conventionally connected to the pump by hydraulic hoses. Usually the pump and fluid activated devices are stationary relative to each other, and the connecting hoses are likewise stationary. However, it is sometimes necessary for the frame on which the fluid activated devices are located to move relative to the frame on which the pump is mounted. In such instances the prior art has conventionally used the usual hydraulic hose. The hoses are simply made longer and are allowed to flex as the frames move relative to each other.

For small diameter hoses in clean environments, this flexing is not particularly harmful to the hose. However, for ¾ inch diameter hose or larger the periodic flexing is detrimental to the hose. Continued flexing of the large hose leads to its eventual early failure. Then there is the usual equipment and operation downtime attendant with such a failure.

Furthermore, in harsh environments such as mines, there is the additional problem that the free hanging hose is exposed to falling ore or other debris. Typically, to avoid this problem a large enclosure is built around the hose.

For most heavy weight mining machines, the rotary cutting drum is advanced or sumped into the mine face by simply propelling the total machine forward on its crawlers. However, the coefficient of friction for moving crawlers is substantially less than that for non-moving crawlers. Therefore, for lighter weight, low seam mining machines it would be advantageous to be able to lock the crawlers and advance the rotary drum by means of a connecting but movable sump frame. Since hydraulic devices are mounted on both the crawler frame and on the movable sump frame which carries the rotary drum, some provision must be made for transfer of hydraulic fluid between the movable frames. Conventionally, the fluid transfer means has been a long flexible hose encased in a large protective enclosure. Such protective enclosures take up a considerable amount of space.

SUMMARY OF THE INVENTION

In view of these considerations, it is an object of the present invention to provide improved apparatus for transfer of pressurized fluid between two frames that move relative to each other.

A further object of the invention is to provide a hydraulic fluid transfer device which has a constant volume of fluid and metal components in the system so that there is no change in the compression of the fluid flowing through the device.

Another object of the invention is to provide a sliding fluid joint for transfer of hydraulic fluid that is more reliable and maintenance free than the conventional hydraulic hose because it eliminates the need for flexing of the hose.

Still another object of the invention is to provide a mining machine with an improved fluid transfer means for supplying pressurized hydraulic fluid from a hydraulic pump on a main frame to fluid activated devices on a front sump frame that moves relative to the main frame.

The present invention accomplishes the above objectives by providing a cylinder in combination with a hollow rod which passes longitudinally through the cylinder in fluid transfer relationship. The hollow rod is smaller in diameter than the cylinder and about twice the length. A seal is disposed near each end of the cylinder to form a closed cavity between the outer surface of the rod and the inner surface of the cylinders. The seals also allow the rod to slide easily back and forth through the cylinder. One end of the rod is closed and the other end is connected to a source of hydraulic fluid. The rod also has an opening at its center region to allow flow of fluid from the rod into the cavity between the rod's outer surface and the cylinder's inner surface. The cylinder also has an opening in its sidewall for connection to the fluid activated device disposed on a separate frame.

In operation, the invention provides the following reversible fluid connection between a pump attached to one frame and fluid activated devices mounted on a second frame. The fluid from the pump flows into the rod and out of the holes in the center region of the rod into the cavity between the rod and the cylinder. From there it flows out the opening in the sidewall of the cylinder to the fluid activated devices on the second frame.

Since the cylinder and rod are able to move relative to each other, the system is able to accommodate similar relative motion between the two frames. As the rod moves relative to the cylinder, the volume of fluid in the system does not change. The volume of fluid in the hollow rod remains constant. And the volume of fluid in the cavity between the rod and the cylinder remains constant. Also, the volume of metal in the rod and cylinder system remains constant and is not changed by the relative motion of the rod and cylinder.

The present invention was initially developed for and is of particular utility to small, low seam mining machines. As such, it is described herein in its relationship to such mining machines. However, it has application to other fields where similar problems of fluid transfer between moving parts exist.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a mining machine having a movable front sump frame incorporating the sliding fluid joints of the present invention.

FIG. 2 is another perspective view of the mining machine shown in FIG. 1, with the movable front frame, the sliding fluid joints in the extended position and the auger in the raised position.

FIG. 3 is an enlarged side elevational view partially in cross section of a single sliding fluid joint of the present invention with the full extended position of the joint shown in broken lines.

FIG. 4 is a cross sectional view taken substantially along line 4—4 of FIG. 3.

FIG. 5 is a top plan view of a plurality of the sliding fluid joints mounted in tandem.

FIG. 6 is a side elevational view of another embodiment of the invention wherein two of the sliding fluid joints are placed end to end.

FIG. 7 is a side elevational view of the sliding fluid joints of FIG. 6 with both joints in the extended position.

DESCRIPTION OF THE PREFERRED EMBODIMENT

A continuous mining machine **10** shown in FIGS. **1** and **2** of the drawings has a mining head **14** with a rotary drum **40** for cutting and breaking material from a mine face. Endless crawler tractor treads **16**, disposed one on each side of the main frame, propel the machine. A second frame or sump frame **12** is mounted on top of the main frame **11**. The sump frame is connected to the main frame by means of a tongue **17** and groove (not shown) arrangement which enables the sump frame to be moved horizontally away from the main frame. The sump frame **12** is moved forward and backward by a pair of hydraulic cylinders **18** located on opposite sides of the machine one of which is visible in FIG. **2**. Each hydraulic cylinder **18** is connected at one end to the main frame **11** and at the other end to the sump frame **12**. By activating the hydraulic cylinders, the rotary drum **40** is advanced or sumped into a mine face.

Because the chassis of the mining machine is configured with a central sliding sump frame, it permits the crawlers **16** to remain locked while advancing or sumping the rotary drum or augers **40** into a mine face. This design takes advantage of the fact that the static coefficient of friction between the fixed crawlers and the floor is approximately 50 percent greater than the dynamic coefficient of friction between moving crawlers and the floor. The hydraulic cylinders **18** act to move the sliding sump frame **12** forward. The sliding sump frame **12** carries the rotary drum head **40**, gathering head **20** and conveyor assemblies **21** and **22** in its forward and rearward movement.

The mining head **14** has a boom **30** that extends forwardly to support the rotary drum **40** at the front end of the sump frame **12** of the mining machine **10**. The boom **30** is connected by a pivot structure **31** to the sump frame.

The mining head **14** is pivotally mounted on the pivot structure **31** and is moved upwardly and downwardly by a pair of hydraulic cylinders (not shown) located on opposite sides of the sump frame **12**. Each of these hydraulic cylinders is pivotally connected at one end to the sump frame **12** and at the other end to the boom **30**.

The rotary drum **40** is driven by a pair of electric motors **34**, one of which is shown in FIG. **2**, that are disposed at opposite sides of the sump frame **12**. The motors **34** drive motor gear transmissions and a clutch and brake mechanism (not shown). Each of the clutches is connected by means of a drive sprocket (not shown) to a drive chain **38** that delivers drive by means of a second sprocket wheel **37** to the rotary drum **40**.

The forward sprocket wheel **37** is fixed to a shaft **41** which extends transversely to the frame **12**. Fixed to the shaft are three auger cutting sections **42, 43** and **44**. Each auger section comprises a pair of helical blades **45** having their inner peripheries fixed securely to the adjacent portion of the casing **48** of the shaft **41** and the outer peripheries of a substantial constant radial extent. The pitch of the blades **45** of each section **42, 43, 44** is such that when rotated they will serve to convey material inwardly toward the forward end of the centrally disposed gathering conveyor **21**.

The outer periphery of each helical blade **45** of each auger section **42, 43, 44** has secured thereto a plurality of spaced bit holders **46** arranged to receive bits **47** of conventional structure that extend outwardly from the periphery of the blades **45**. The bits on each blade are spaced apart equally in a longitudinal or axial direction.

There is a gathering head **20** at the front of the mining machine **10** below the boom **30**. The gathering head **20** has an apron or deck **23**, with its leading edge at the floor. A vertical hinged dozer blade **24** extends along the back edge of the apron **23** to provide a surface against which the helical auger may move the coal. A small mat conveyor **21** extends toward the front of the apron **23**. This small conveyor **21** operates in conjunction with the spiral augers **42, 43, 44** and the vertical dozer blade **24** to move the mined material back to a discharge conveyor **22**. The discharge conveyor **22** moves the mined material from the forward end of the mining machine to its rear end, at which it is discharged to other conveying apparatus (not shown) for removing the mined material from the mining place.

A third electric motor (not shown) is located in an enclosure **50** on the main frame **11**. Driving connections from this motor drive hydraulic pumps, (not shown) also located in the enclosure **50**, which provide hydraulic fluid with a pressure of about 2,000 psi. This fluid is used to operate the hydraulic cylinders for the mining heads **14**, the hydraulic cylinders for the gathering head **20**, the hydraulic cylinders (not shown) for the discharge conveyor boom and the hydraulic motors (not shown) which run the mat conveyor **21** and the conveyor **22** and the hydraulic cylinders **18** which move the sump fram.

Some of the fluid activated devices such as cylinder **18** which are powered by the pressurized fluid from the pump are located on the main frame **11**. These devices are connected to the hydraulic pump by conventional hydraulic pipes or hose lines (not shown). However, some of the fluid activated devices such as the hydraulic cylinders for the mining head **14** and the hydraulic motors for the conveyors **21** and **22** are located on the movable sump frame **12**. To accommodate the movement of the sump frame **12** relative to the main frame **11**, special fluid transfer devices or sliding fluid joints **60** are provided for maintaining a constant flow of hydraulic fluid from the pump **51** to the fluid activated devices on the sump frame **12**. An enclosure **71, 72** is provided on either side of the main frame to house the sliding joints **60**.

FIG. **3** illustrates a single sliding fluid joint **60** for transfer of fluid between the hydraulic pump on the main frame **11** and the fluid activated devices on the sump frame **12**. The sliding fluid joint **60** comprises a cylinder **61** having a hollow rod **65** passing longitudinally therethrough. The inner wall surface **62** of the cylinder **61** is spaced away from the outer surface **69** of the rod **65** to allow free flow of fluid in the space **70** therebetween. To close off the open ends between the cylinder **61** and the rod **65**, conventional sleeve bushings **53** are disposed in grooves **58, 59** at either end of the cylinder. The sleeve bushings **53, 153** include static seals **54, 154** which rest against the inner surface **62** of the cylinder, and dynamic seals **55, 155** which allow movement of the rod **65** through the interior of the cylinder **61.** All of the seals are made of conventional type sealing material. Also near the outer end of each seal there is a conventional rod wiper **56, 156.** Finally, retaining rings **57, 157** are inserted in the grooves **58, 158** at either end of the cylinder to hold the sleeve bushing **53, 153** in place.

The hollow rod **65** extends through the cylinder **61** and is free to travel back and forth relative to the outer cylinder **61.** The hollow rod is closed at one end **66** and is threaded at the other end **67** for connection to the supply of hydraulic fluid (not shown). Cross holes **68** are made in the center region of the rod **65** to allow free flow of fluid between the interior of the rod and the space between the cylinder and rod.

The cylinder **61** has a threaded opening **64** in its wall to which a right angle fixture **63** is affixed for connection to a hose, pipe or similar fluid conveying means **74,** thus completing the fluid connection between the pump on the main frame **11** and fluid activated devices on the sump frame **12.**

In operation, fluid under pressure is supplied from the hydraulic pump (not shown) to the interior of the rod **65.** The fluid fills the rod and flows through the cross holes **68** in the center region of the rod filling the space **70** between the outer surface **69** of the rod and the inner surface **62** of the cylinder. The fluid then exits through the opening **64** in the sidewall of the cylinder to be conveyed to the hydraulic devices. It can be seen that by means of this invention a continuous uninterrupted path is available for the pressurized fluid to travel from the pump to the fluid activated devices.

The opening **67** into the rod, the cross openings **68** in the center region of the rod and the exit opening **64** in the cylinder wall are approximately all equal in cross sectional area. In addition, the cross sectional area of the space **70** shown in FIG. **4** between the outer surface **69** of the rod and the inner surface **62** of the cylinder also approximates the cross sectional area of the other openings **67, 68,** and **64.** All of these openings are about equal in total cross sectional area so that the resistance to fluid flow through the system is constant.

This rod and cylinder sliding fluid joint **60** performs no work. Theoretically there is no horsepower loss caused by the relative movement of the rod **65** and the cylinder **61.** The only force which must be overcome to move the rod relative to the cylinder is the frictional force between the outer surface **69** of the rod and the surface of the seals **55, 155** and wiper blades **56.**

It is noteworthy that there is no change in fluid volume or in the volume of metal in the system. Whether the cylinder, **61** is in the retracted position as shown in FIG. **3** or whether it is in its extended position as shown by the broken lines **90** in FIG. **3,** the volume of fluid in the system remains constant, as does the volume of metal. Thus there is no compression of fluid as the cylinder **61** moves relative to the rod **65.**

The flow of fluid through the sliding joint may be in either direction. The fluid flow may be from the rod **65** into the cylinder **61** or the flow may be from the cylinder **61** into the rod **65.** Thus, the slip joint **60** may be used for hydraulic motors, wherein the flow may be in either direction depending on the operation of the motor.

FIG. **5** shows the arrangement of a bank of sliding joints **60** installed for a mining machine operation. Because of the harsh nature of the mining environment, the sliding joint assemblies are enclosed in a metal box **71.** Except for their position in the box **71,** the individual joint assemblies **60** are identical and the parts of each are identified by the same reference numerals, with the addition of a prime or a double prime. The hollow rods **65** are attached securely at either end to the box **71** which is then bolted to the main frame **11.** Right angle pipe elbows **63** are attached to each of the threaded cylinder openings **64.** Pipes **80** are then connected to each of the outlets of the elbows **63.** It is important that since the pipes **80** are rigid and move with the cylinder **61** relative to the rod **65,** that the pipes **80** be exactly parallel to their corresponding rods **65.** This parallel configuration minimizes binding of the rods **65** against the seals **55** in the cylinder **61.**

Since the cylinders always move together in parallel fashion, they are hooked together by a bar **59** which gives added stability to the system. In a similar manner another stabilizing bar **159** holds the exiting pipes **80** together.

The ends of the box enclosure **71** are closed off except for the openings **73** which accommodate the movement of the connecting pipes **80** therethrough. The openings **73** are lined with sealing material (not shown) to make the box **71** substantially airtight. A slight differential in pressure is created when the sump frame **12** is extended moving the pipe **80** out of the box **71.** Therefore, dust or other foreign material would be drawn into the box were it not airtight.

The present invention may be used in most machines where flexing of hydraulic hose would be encountered. The only restriction is that room must be provided for the long rod **65** whose length must necessarily be twice the amount of the desired extension. This length limitation results because the seals **55** of the cylinder **61** cannot be allowed to cover the cross holes **68** in the center of the rod. The cross holes in the rod must always open into the space **70** formed between the rod and cylinder to assure a continuous uninterrupted flow between the two frames. As long as the rod and cylinder are adequately supported, the assembly may be made to any practical length allowed by the particular machine.

In the case of the mining machine **10** described herein, the sump frame moves about eighteen inches away from the main frame thus sliding joints are made to accommodate slightly more than eighteen inches of movement to assure the cross holes are never covered. Accordingly, the overall length of the retracted sliding joint assembly is approximately (40 inches and the extended length is about 68 inches **40** inches plus the 18 inch extension).

Rather than make one long sliding joint assembly, it may be more feasible or desirable to combine two joint assemblies end to end. FIGS. **6 & 7** show schematically how this might be done. A sliding joint assembly **260,** 360 is secured to each frame **111, 112** so that the rods **165, 265** and cylinders **161, 261** are placed end to end and connected by a pipe **180.** The cylinders and rods move relative to each other as previously described, and at their full extension have the configuration shown in FIG. **7.**

In the mining machine application, the main frame **11** and sump frame **12** are rigidly held so that the only relative movement is a straight horizontal movement.

Thus, the end of the rod **65** and cylinder **61** may be rigidly held without danger of binding or otherwise damaging the sliding joint assembly **60**. However, for other applications it may be desirable to allow for some movement or play of the pieces of the assembly. This may be done by connecting the rod and cylinders to flexible hoses rather than to rigid pipes. In conjunction with the substitution of the flexible hoses, it may be advantageous to pivot the sliding joint assembly to enable the second frame to turn relative to the main frame as well as move away from or towards it.

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 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. A mining machine, comprising:

a main frame having a hydraulic pump mounted thereon for supply of hydraulic fluid under pressure;

a sump frame slidably mounted on the main frame to allow movement of the sump frame relative to the main frame, the sump frame having fluid activated devices mounted thereon;

a sliding fluid joint for transfer of hydraulic fluid from the pump on the main frame to the fluid activated devices on the sump frame, comprising:

a hollow longitudinal rod having an opening near one end for connection to fluid conveying means on one of the frames, the rod also having an opening in its sidewall near the center of the rod;

a hollow cylinder having an opening in each end for passage of the rod therethrough, the inner surface of the cylinder walls being spaced a sufficient distance from the outer surface of the rod sidewalls to allow flow of fluid in the space formed therebetween, the cylinder also having another opening in its sidewall for connection to fluid conveying means on the other frame; and

means allowing movement of the rod relative to the cylinder while maintaining the opening in the rod sidewall in communication with the space between the cylinder and rod, such that the hydraulic fluid can flow at a constant rate and pressure through the sliding joint notwithstanding movement of the sump frame relative to the main frame.

2. A mining machine as recited in claim **1**, wherein the rod is at least twice the length of the cylinder.

3. A mining machine as recited in claim **1**, wherein the cross sectional area of the end opening in the rod, the area of the side opening in the rod, the area of the cylinder opening, and the cross sectional area of the space between the rod and the cylinder are approximately equal.

4. A mining machine as recited in claim **1**, wherein the connections of the rod and the cylinder to their respective frames are flexible mounts.

5. In a mining machine comprising a main frame having hydraulic fluid supply means mounted thereon, a sump frame supporting a mining head and mounted on the main frame in a manner allowing movement of the sump frame relative to the main frame for sumping the mining head into a mine face, and fluid actuated means mounted on the sump frame, wherein the improvement comprises:

means for conveying hydraulic fluid from the supply means to the fluid actuated means without any change in pressure or flow rate regardless of position or movement of the sump frame relative to the main frame, including:

a first rigid tube mounted on one of the frames and having an opening at one end connected to the fluid means on said one frame;

a second larger tube mounted on the other frame in sliding concentric spaced relationship about the first tube, the second tube being shorter than the first tube and having an opening in its sidewall connected to the fluid means on said other frame;

sliding fluid seals between the tubes at each end of the second tube forming the ends of an annular fluid transfer zone between the tubes, the first tube further having an opening in its sidewall in communication with the fluid transfer zone, said tubes being adapted to slide relative to each other when the sump frame moves relative to the main frame such that the opening in the sidewall of the first tube always remains in communication with the fluid transfer zone, and fluid under pressure can flow steadily through one tube, the fluid transfer zone, and the other tube at all times.

6. In a mining machine as recited in claim **5**, the further improvement wherein the area of each of the openings in said tubes and the area of the cross section of the annular fluid transfer zone between said tubes are approximately equal such that there is no change in the pressure or flow rate of fluid flowing through the fluid conveying means.

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