March 5, 1968 J. L. NEWMAN 3,371,730

MECHANICAL DRILLING JAR

Filed Sept. 20, 1965 3 Sheets-Sheet 1

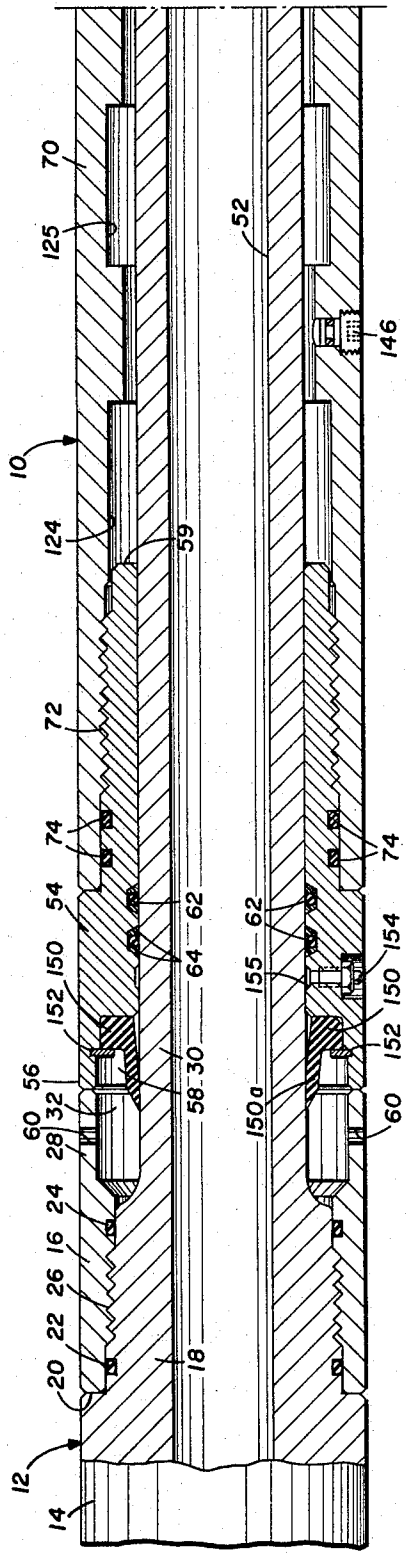

FIG. 1a

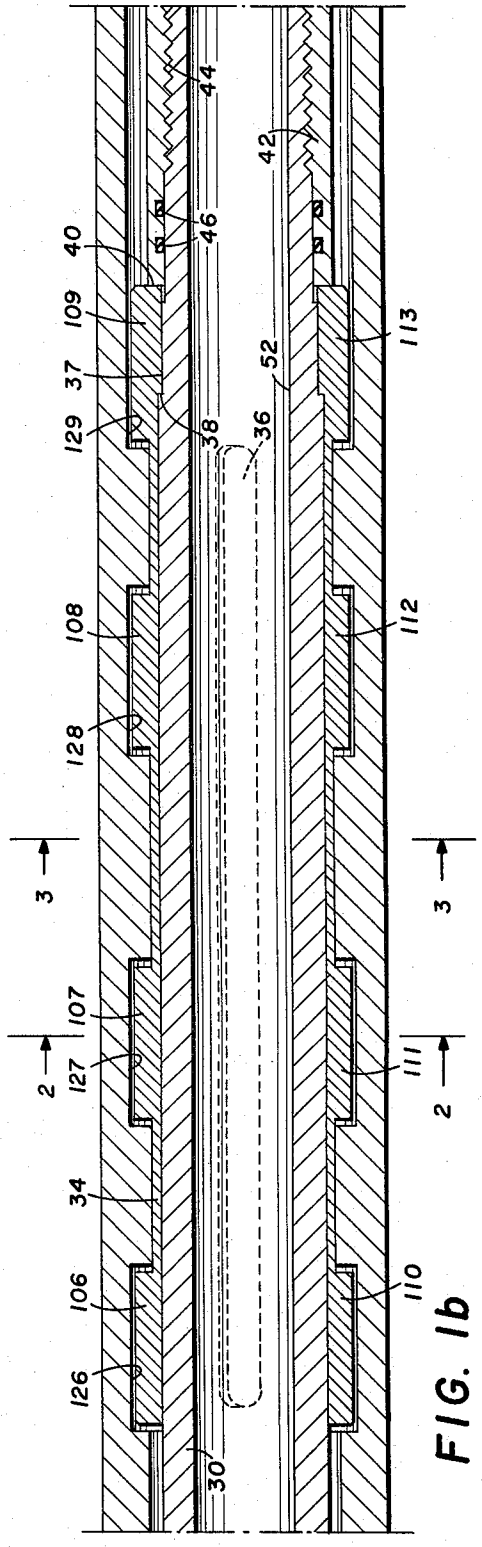

FIG. 1b

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MECHANICAL DRILLING JAR

Filed Sept. 20, 1965 3 Sheets-Sheet 2

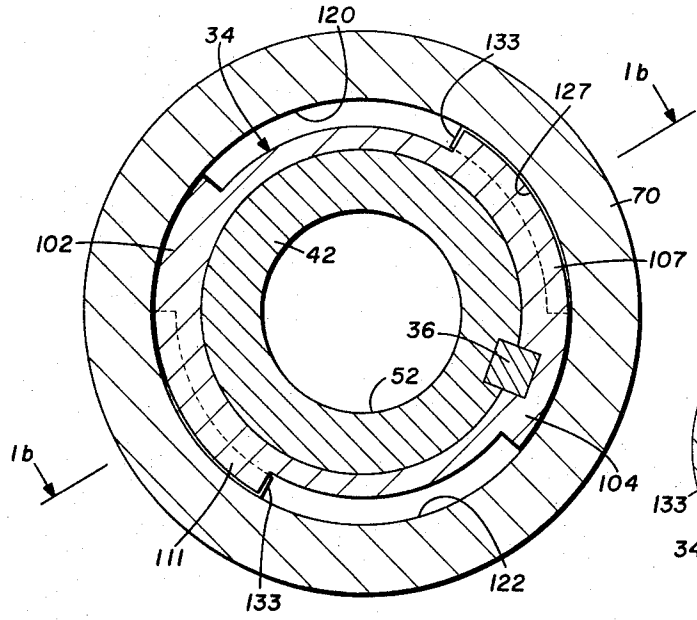

FIG. 2

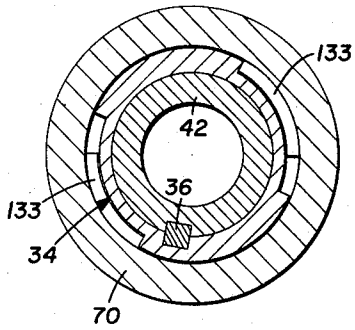

FIG. 5

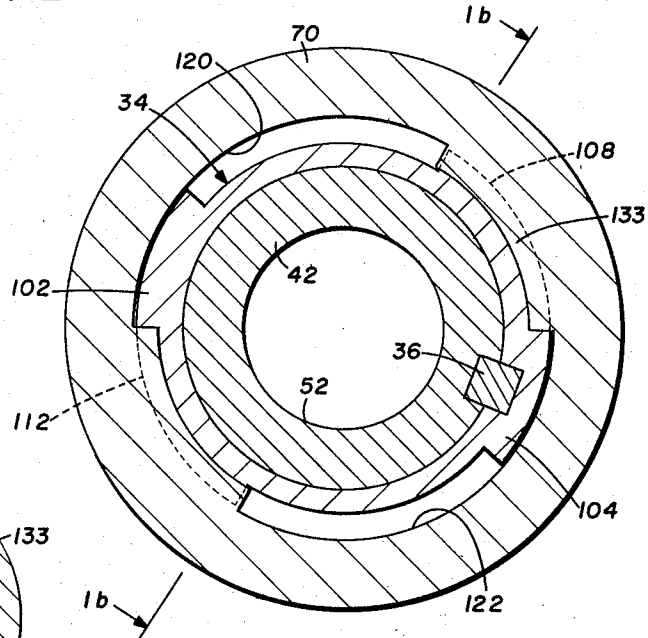

FIG. 3

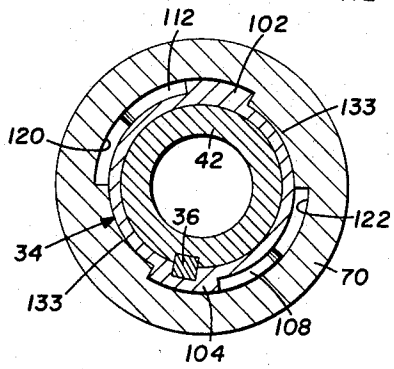

FIG. 6

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MECHANICAL DRILLING JAR

Filed Sept. 20, 1965 3 Sheets-Sheet 3

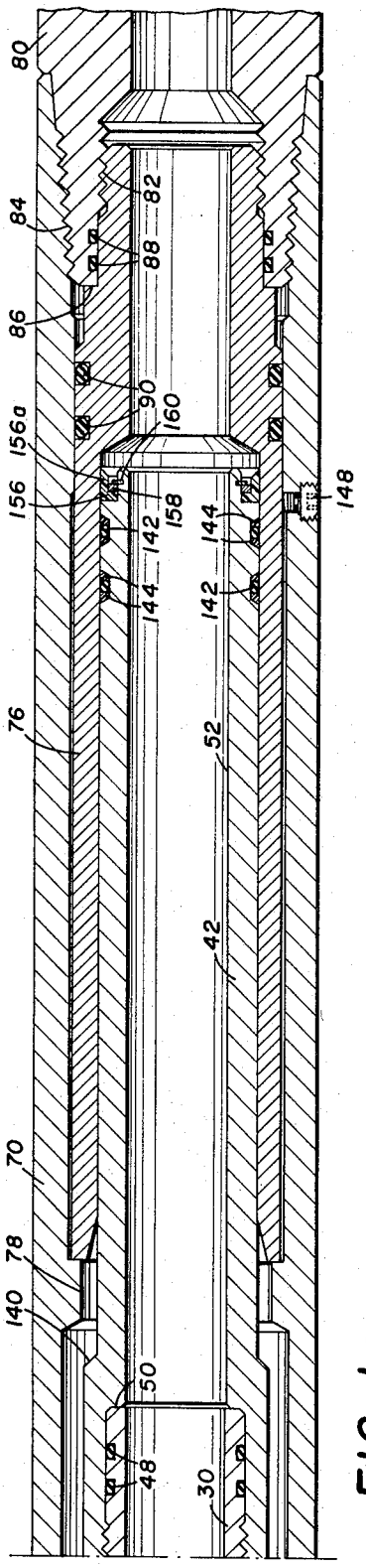

FIG. 1c

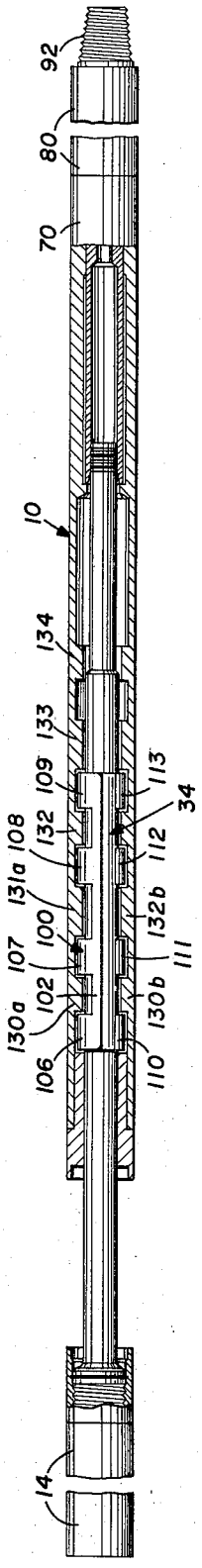

FIG. 4

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3,371,730

MECHANICAL DRILLING JAR

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Filed Sept. 20, 1965, Ser. No. 488,333
11 Claims. (Cl. 175—300)

ABSTRACT OF THE DISCLOSURE

A drilling jar having a mandrel with a tool joint at the upper end, a knocker shoulder formed at the lower end of the tool joint, a cylindrical sealing surface extending downwardly from the knocker shoulder, a mandrel sleeve having lugs disposed around the mandrel body and retained in place by a wash pipe threaded into the mandrel body, and an O-ring seal around the bottom end of the wash pipe. A sealing collar is disposed around the cylindrical sealing surface of the mandrel and has an upwardly facing knocker shoulder at the upper end and O-ring seals slidably engaging the cylindrical sealing surface of the mandrel. The housing body is threaded onto the sealing collar and contains lug means cooperatively engaging the lug means on the mandrel. A replaceable wash pipe sleeve having a cylindrical interior sealing surface cooperatively receiving the O-ring seal on the wash pipe is held in place in the housing body by a tool joint sub threaded into the lower end of the housing body.

This invention relates generally to the art of earth boring, and more particularly relates to an improved mechanical jar for connection in a rotary drill string of the type used to drill oil and gas wells to increase bit life, produce a straighter hole, and free the string in the event it becomes stuck in the hole.

In conventional rotary drilling, the bit is driven by a drill stem comprised of a number of threaded interconnected joints of drill pipe and drill collars. A special mud is usually pumped downwardly through the drill string and through the bit and recirculated upwardly through the annulus to carry the cuttings from the borehole and contain subsurface pressures. The bit is customarily loaded with a portion of the weight of the drill stem to increase the rate of penetration. The drill collars, which are of uniform maximum diameter, usually provide this weight and also stiffen the stem immediately above the bit to produce a straighter hole. As a result of the smooth and uniform surface, the drill collars sometimes stick to the wall of the borehole. The drill pipe on the other hand has a substantially reduced outside diameter except for the interconnecting tool joints which are of the same diameter as the drill collars and is not subject to sticking. However, when a portion of the weight of the pipe is applied to the drill collars, the pipe tends to bend sometimes causing the hole to be crooked.

Drilling jars have been used to some extent to deliver an impact force directed either upwardly or downwardly on the drill string to free stuck drill collars or other downhole tools. Such drilling jars are of two general types, mechanical and hydraulic. Each type is customarily comprised of a tubular housing which is connected to the bottom of the string of drill pipe and a tubular mandrel which is reciprocally disposed within the housing and connected to the upper end of the drill collars.

In the mechanical jars, interacting lug means on the mandrel and body transmit torque to the bit during normal drilling operations, but do not transmit longitudinal force, within the limit of the stroke of the mandrel within the body. However, by lowering the mandrel into the body and rotating the mandrel in the opposite direction, the lug means is engaged so that when the drill

string is pulled upwardly, the drill pipe is stretched and a substantial tension force exerted on the jar. When the drill pipe is rotated in the forward direction once again, the lug means is released and the tension in the drill pipe rapidly moves the housing upwardly until the limit of the stroke is reached, thereby delivering a longitudinally directed impact force to the string of drill collars. In some mechanical jars a downwardly directed impact force can be applied to drill collars by raising the housing to its upper limit of travel with respect to the mandrel, rotating it in the direction opposite to that normally used for drilling, applying the weight of the drill pipe to the housing, and then rotating the housing in the forward direction to release the lug means and permit the loaded housing to travel downwardly the length of its stroke and impact the mandrel and drill collars.

The hydraulic jars transmit torque from the housing to the mandrel by means of a spline which permits free vertical movement. However, a longitudinal impact force can be applied only in one direction, usually upwardly. For example, the force is normally applied by rapidly placing tension on the drill string. Initial movement of the housing is retarded by the dash pot action of a piston acting in a close fitting hydraulic cylinder so that the string of drill pipe may be tensioned and stretched. However, after the piston has traveled a pretdetermined distance, it leaves the cloes fitting cylinder and the housing travels very rapidly until it impacts the mandrel at the upper end of its stroke.

Drilling jars also function as bumper subs when used during normal drilling operations in that the weight of the drill pipe is isolated from the drill collars. Since the drill pipe is under tension, it does not flex and cannot cause a crooked hole, and the uniform weight of the drill collars produces a longer bit life at maximum penetration rates. However, before a drilling jar can be used during normal drilling operations, it is very important that the high pressure drilling fluid being pumped downwardly through the drill string must be sealed from the lower pressure fluid in the annulus by an effective seal at the sliding joint between the housing and mandrel. If this seal should begin to leak, the highly abrasive drilling fluid will quickly erode a large hole through the housing until it is so weakened as to separate. This necessitates an expensive fishing operation which if unsuccessful may even reuslt in the abandonment of the hole. Due to the propensity of existing drilling jars to fail in this manner, drilling jars are not used extensively during normal drilling operations, but are used primarily during fishing operations. As a result, the advantage of being able to immeidately free a stuck drill string by the jar, as well as the advantages obtained by controlling the weight applied to the drill bit, is largely lost. Another difficulty with existing drilling jars, particularly the mechanical type, is that the drilling fluid enters the housing and the abrasive sands tend to very quickly wear the operative parts and the sliding seals, thus enhancing the possibility of a separation failure and shortening the useful life of the jar.

The object of the present invention is to provide an improved mechanical drilling jar which may be safely used during normal drilling operations so as to control the weight applied to the bit and also provide a means for immediately applying either an upwardly or downwardly directed impact force to the drill collars should they stick in the borehole.

Another object is to provide a mechanical drilling jar having an improved seal between the mandrel and body which substantially eliminates the possibility of a separation due to washout.

A further object is to provide a mechanical drilling jar in which the operative parts are continually protected from the drilling fluid and contained in a lubricating oil, thereby extending the useful life of the jar.

Still another object is to provide a mechanical drilling jar having the objects heretofore mentioned which may be economically manufactured and which may be economically serviced in that worn parts can be relatively easily replaced and the jar refurbished.

These and other objects are accomplieshed in accordance with the present invention by a drilling jar comprised of a tubular housing for connection to one section of the drill string, a tubular mandrel extensibly disposed in the tubular housing for connection to the other section of the drill string, first mechanical lug means connected within the housing, second mechanical lug means connected to the mandrel and operatively engaging the first mechanical means for transmitting torque between the housing and the mandrel and for selectively transmitting an impact force longitudinally between the housing and mandrel, first and second annular sealing means formed on the mandrel on opposite sides of the second mechanical lug means having equal cross-sectional areas, and third and fourth annular sealing means formed within the housing and cooperatively engaging the first and second annular sealing means to provide annular fluid seals at each end of the first and second mechanical lug means and thereby forming a fluid sealed annulus between the mandrel and the body around the first and second mechanical lug means from which the well fluids are excluded and which may be filled with a lubricating fluid.

In accordance with a more specific aspect of the invention, the mandrel has an annular knocker shoulder formed adjacent one end and a tubular body having a constant diameter sealing surface adjacent the shoulder and an equal or diminishing diameter extending from the sealing surface to the opposite end. The housing includes a sealing collar which is slipped over the tubular body and forms a continuous, peripheral sliding fluid seal with the sealing surface of the body. The second mechanical lug means is formed on a mandrel sleeve which is slipped over the tubular body and keyed against rotation thereon. One end of a tubular wash pipe is threaded onto the end of the tubular body and secures the mandrel sleeve against longitudinal movement on the body. The other end of the wash pipe has a sealing portion of the same diameter as the sealing portion adjacent the knocker shoulder. A housing body having the first lug means therein is then slipped over the mandrel and connected to the sealing collar. The housing also includes a wash pipe cylinder which is in peripheral, sliding sealing engagement with the wash pipe. Means is provided for filling the annular sealed cavity with a lubricating fluid.

The novel features believed characteristic of this invention are set forth in the appended claims. The invention itself however, as well as other objects and advantages thereof, may best be understood by reference to the following detailed description of illustrative embodiments, when read in conjunction with the accompanying drawings, wherein:

FIGURES 1*a*, 1*b* and 1*c*, collectively, are a longitudinal sectional view of a drilling jar constructed in accordance with this invention with the mandrel in the closed position;

FIGURE 2 is a sectional view taken substantially on lines 2—2 of FIGURE 1*b*;

FIGURE 3 is a sectional view taken substantially on lines 3—3 of FIGURE 1*b*;

FIGURE 4 is a simplified view, partially in section, of the drilling jar of FIGURES 1*a*–1*c* with the mandrel in the extended position;

FIGURE 5 is a sectional view taken on the same lines as FIGURE 2 but showing the jar in unlatched position; and

FIGURE 6 is a sectional view taken on the same lines as FIGURE 3 but showing the jar in the unlatched position.

Referring now to the drawings, a drilling jar constructed in accordance with this invention is shown in FIGURES 1*a*, 1*b* and 1*c*. The drilling jar is comprised of a tubular housing indicated generally by the reference numeral **10** and a tubular mandrel assembly, indicated generally by the reference numeral **12**, which is extensibly received within the housing **10**. The mandrel assembly **12** includes a tool joint portion **14**, which is in the form of a drill collar sub a few feet in length having a conventional box tool joint at the end. A knocker collar **16** is threaded onto a portion of the mandrel body **18** and abuts against an annular shoulder **20**. A pair of O-ring seals **22** and **24** is provided on opposite sides of the threads **26** to prevent sanding of the threaded connection. The collar **16** has a skirt portion **28** which extends downwardly over a tubular portion **30** to form an annular, downwardly-facing open cavity **32** to lessen the effects of sanding as will hereafter be described. The skirt portion **28** also lessens the stress on the mandrel adjacent the threads **26** by spacing the member **54** from the threads **26**.

A mandrel sleeve **34** is disposed around the mandrel body **30** and secured against rotation by an elongated key **36**, shown in dotted outline in FIGURE 1*b*, and which is received in grooves in the body **30** and sleeve **34** as shown in FIGURES 2 and 3. The groove in the mandrel sleeve **34** extends to the end so that the sleeve may be slipped over the body after the key has been inserted in the slot in the body to facilitate assembly. The mandrel sleeve **34** is secured against longitudinal movement on the mandrel body **30** by means of an annular shoulder **37** on the interior surface of the mandrel sleeve which abuts an annular shoulder **38** on the mandrel body **30**, and the end **40** of a tubular wash pipe **42** which is connected to the end of the mandrel body **30** by threads **44**. O-ring pairs **46** and **48** disposed on either side of the threads **44** provide a fluid tight connection between the wash pipe **42** and the mandrel body **30**. An annular shoulder **50** within the wash pipe **42** abuts against the end of the mandrel body **30**. Thus the sub **14**, knocker collar **16**, mandrel body **30**, mandrel sleeve **34** and wash pipe **42** are rigidly interconnected, and a fluid passageway **52** extends longitudinally through the mandrel assembly **12**.

The housing **10** is comprised of a sealing ring collar **54** having an annular knocker skirt **56** at one end which mates with and bumps the skirt **28** and forms an annular, open cavity **58**, and a lower end **59** which engages the mandrel sleeve hereafter described when the mandrel is fully extended. A number of bores **60** extend radially through the knocker collar **16** to vent sand from cavity **32**. The wiper lip **150***a* extends above the shoulder on the skirt **56** so that it extends above the sand that might fill the cavity **58**. The collar **54** is slidably disposed around the constant diameter portion of tubular mandrel body **30** and a pair of one piece O-ring seals **62** provides a peripheral fluid seal between the sealing collar **54** and the tubular body **30**. A pair of metallic nonextrusion rings **64** is provided on each side of each of the O-ring seals **62**. The tubular body **70** of the housing **10** is connected to the collar **54** by threads **72**. A pair of O-rings **74** provides a peripheral fluid seal between the collar **54** and tubular body **70**. A wash pipe cylinder liner **76** is inserted in the other end of the body **70**. The end of the liner **76** engages an inturned annular shoulder **78** within the body **70** which acts as a stop. A second sub **80** is connected to the liner **76** by threads **82** and the end of the sub **80** engages an annular shoulder **86** on the liner **76**. The sub **80** is connected to the housing body **70** by threads **84** and thus secures the liner **76** in place in the body **70**. A pair of O-ring seals **88** provides a peripheral fluid seal between the sub **80** and liner **76** to prevent fluid pressure in the passageway **52** from passing through the threaded connections **82** and **84**. A pair of O-rings **90** provides a peripheral seal between the body **70** and the wash pipe

liner **76** to prevent the escape of fluid from the annulus formed between the mandrel **12** and the housing **10** through the threaded connection **84**. The sub **80** may be several feet in length and provided with a standard tool joint such as the pin **92**.

A mechanical lug means indicated generally by the reference numeral **100** in FIGURE 4 is formed on the mandrel sleeve **34** and is comprised of a pair of upstanding, longitudinally extending lugs **102** and **104** (see FIGURES 2, 3 and 6). Circumferentially extending lugs **106**, **107**, **108** and **109** extend counterclockwise, when viewed from the large end of the mandrel, from the longitudinal lug **102**, and lugs **110**, **111**, **112** and **113** extend circumferentially and counterclockwise from the longitudinal lug **104**. The mechanical lug means **100** cooperatively engages a similar lug means formed in the interior surface of the housing body **70** by a pair of longitudinally extending grooves **120** and **122**. The longitudinally extending groove **120** is sufficiently wide to permit longitudinal movement of both the longitudinally extending lug **102** and the circumferentially extending lugs **106–109**. Similarly, the longitudinally extending groove **122** is so sized and spaced as to pass the longitudinally extending lug **104** and the circumferentially extending lugs **110–113** in the longitudinal direction. Circumferential grooves **124**, **125**, **126**, **127**, **128** and **129** intersect the longitudinally extending grooves **120** and **122** and are spaced to form inwardly directed lugs **130**, **131**, **132**, **133** and **134** and to also simultaneously receive the circumferentially extending lugs of the means **100**. For example, when the mandrel is in the retracted position illustrated in FIGURES 1*a*–1*c*, the lugs **106** and **110** are received by the groove **126**, lugs **107** and **111** by the groove **127**, lugs **108** and **112** by the groove **128**, and lugs **109** and **113** by groove **129**. When the mandrel is in the extended position illustrated in FIGURE 4, lugs **106** and **110** are received in groove **124**, lugs **107** and **111** in groove **125**, lugs **108** and **112** in groove **126** and lugs **109** and **113** in groove **127**. When the mandrel is rotated in the counter-clockwise direction, the circumferentially extending lugs **106–113** enter the appropriate circular grooves and the inwardly directed lugs **130–134** in the housing **10** prevent longitudinal movement of the mandrel relative to the housing. When the mandrel is rotated clockwise, the longitudinal lugs **102** and **104** on the mandrel engage the lugs **130–134** on the housing to transmit torque between the mandrel and housing while permitting true longitudinal movement between the mandrel and housing.

The diameter of the tubular body **30** of the mandrel **12** is of constant diameter down to the shoulder **38**, and the wash pipe **42** is of the same diameter as the body **30** from the annular shoulder **140** to its end. O-ring seals **142** are disposed around the wash pipe **42** adjacent the end thereof. Metal rings **144** are disposed on each side of the O-rings **142** to protect the O-rings against extrusion and from being abraded by entry into the scarf between the wash pipe **42** and the wash pipe liner **76**. Because the diameters of the tubular body **30** and wash pipe **42** of the mandrel are equal, the volume of the annular cavity formed between the mandrel and housing by the sliding O-ring seals **62** and **142** and the stationary O-ring seals **74**, **90**, **46** and **48** remains constant as the mandrel moves longitudinally within the housing **10**. The annular cavity thus formed may be completely filled by a suitable fluid, preferably a relatively light lubricating oil, through the filler plugs **146** and **148**.

A top resilient wiper ring **150** is disposed within the annular cavity **58** and retained in place by a snap ring **152**. The wiper ring **150** has a long annular lip **150***a* which extends substantially above the shoulder of the knocker skirt **56** so that any sand accumulating on the surface of the tubular portion **30** will be wiped off and tend to pass outwardly over the shoulder or through the vent bores. A standard grease fitting **154** is in fluid communication with an annular groove **155** formed in the interior surface of the collar **54** between the sealing rings **62** and the wiper ring **150**. Grease pumped through the fitting **154** will pass under the lip **150***a* to clean out the sand and other crud which may have collected under the lip and will also provide lubrication. A similar wiper ring **156** is positioned around the lower end of the wash pipe **42** and has an annular lip **156***a* which wipes the interior surface of the wash pipe liner **76** clean. The wiper ring **156** is secured in place by a spacer ring **158** and a snap ring **160**.

In order to assemble the drilling jar, the knocker ring **16** is first threaded onto the mandrel. Next the sealing collar **54**, with the wiper ring **150** and O-ring seals **62** in place, is passed over the end of the tubular body **30**. The key **36** can then be positioned in the slot in the surface of the tubular body **30** and the mandrel sleeve **34** slipped over the body **30** and over the key. The wash pipe **42** is then threaded on the end of the body **30** and tightened until the mandrel sleeve **34** is locked securely in place. The lower sub **80** may then be threaded over the wash pipe liner **76** at the threads **82** and this assembly inserted in the end of the housing body **70** and connected by threads **84**. This much of the housing may then be passed over the mandrel assembly **12**, including the wash pipe **42** and the mandrel sleeve **34**, and threaded onto the collar **54** by the threaded connection **72**. The annular cavity formed between the mandrel **12** and housing **10** by the annular O-ring seals **62**, **74**, **90**, **142**, **46** and **48** may then be filled with a lubricating oil through the plugs **146** and **148**. The upper wiper **150** may be lubricated by injecting a grease through the fitting **154**. The drilling jar is then ready for use.

In operation, the tool joint **14** at the end of the mandrel **12** is preferably a box and is connected to the section of the drill pipe extending to the surface. The pin **92** on the end of the sub **80** will customarily be threaded into the upper end of the drill collars which extend downwardly to the drill bit and are of the same diameter as the housing **10**. During normal drilling operations, the drill string is rotated in the clockwise direction when looking downhole and the longitudinally extending lug **102** engages the lugs **130–134** and transmits the necesary torque through the drilling jar to the drill bt. However, since the circumferentially extending lugs **106–113** are disposed in the longitudinally extending grooves **120** and **122** of the housing **10**, a force will be transmitted longitudinally through the drilling jar only at the upper or lower limits of the stroke of the mandrel within the housing. Thus if the mandrel is properly positioned, the weight of the drill pipe above the drilling jar will be totally suspended from the derrick and only the weight of the drill collars will be applied to the drill bit. As a result, the weight applied to the bit is uniformly controlled as the bit makes hole. This permits an increase in the bit loading for maximum penetration rate without increasing the danger of inadvertently overloading the bearings of the bit.

In the event the string of drill collars should become stuck in the borehole, the drilling jar is immediately available to assist in removing the drill collars from the hole. In order to strike an upwardly directed impact force on the drill collars, the drill string is lowered until the skirt **28** of the collar **16** engages the skirt **56** of the collar **54**. Then the drill string is rotated counterclockwise until the circumferentially extending lugs **106–113** have entered the lower grooves **126–129** as illustrated in FIGURES 1*a*–1*c*. The drill string is then lifted upwardly to stretch the string to a preselected tension. The string of drill pipe will stretch more than the total stroke of the mandrel **12** in the housing **10** when the proper amount of force is applied. Then the drill pipe is rotated in the clockwise direction until the circumferentially extending lugs **106–113** on the mandrel clear the lugs **130–134** in the housing. The mandrel **12** then moves upwardly with essentially unrestrained force until the upper end of the mandrel sleeve **34** impacts the lower end **59** of the collar **54** thereby

delivering an upwardly directed blow to the housing **10** and therefore to the string of drill collars.

On the other hand, if a downwardly directed impact blow is to be applied to the drill collars, the mandrel **12** is raised to the position illustrated in FIGURE 4, the drill string rotated in the counter-clockwise direction to engage the lugs **106–113** in the upper four circumferentially extending grooves **124–127**, the drill stem lowered to apply the desired weight to the mandrel **12**, and the drill string then rotated in the clockwise direction. When the lug **106** clears the lugs **130–133**, the mandrel travels downwardly at a very rapid rate until the skirt **28** of the knocker collar **16** contacts the skirt **56** of the collar **54** to deliver an impact force to the housing **10** and therefore to the string of drill collars.

Due to the fact that all working parts of the drilling jar are contained in a clean lubricating fluid, the drilling jar has a long life and is not susceptible to excessive wear due to movement in an abrasive, sand filled drilling mud as in the conventional mechanical jar. Further, the drilling jar may be safely used during normal drilling operations because the danger of leakage from the interior of the drilling jar to the annulus is substantially eliminated because the fluid would always have to pass through a minimum of two separate seals. For example, before the fluid could pass from the interior of the mandrel through the joint between the body **30** and wash pipe **42** to the annulus, it would have to pass through O-ring seals **48** and **46** and then through either O-ring seals **90**, **62** or **74**. Since O-ring seals **46** and **48** are static, the danger of leakage is virtually nonexistent. In order for drilling fluid to pass through the sliding seals **142** to the borehole annulus, the mud would have to displace the lubricating fluid and pass through the sliding sealing rings **62**, or through the static sealing rings **74** and **90**, in addition to the standard threaded couplings **72** or **84**, respectively, which are customarily fluid tight without O-rings. In addition to controlling the weight on the drill bit, the drilling jar is always available to free stuck drill collars by immediately delivering either an upwardly or downwardly directed impact force of preselected magnitude to the drill collars.

By completely filling the annulus with lubricating liquid at surface temperature and pressure, the increase in volume of the lubricating liquid due to the normal increase in temperature with depth in the borehole will tend to offset the increase in pressure with depth, thus resulting in a lower differential pressure across the seals. For example, at a drilling depth of 10,000 feet, the bottom hole pressure may be on the order of 8,000 p.s.i. and the temperature on the order of 200° F. As a result of the temperatutre, the internal pressure of the lubricating liquid may be on the order of 5,000 p.s.i., so that only a 3,000 p.s.i. differential is placed across the seals, as compared to an 8,000 p.s.i. differential, thus tending to increase the useful life of the seals and reducing the likelihood of a failure.

Although a preferred embodiment of the invention has been described in detail, it is to be understood that various changes, substitutions and alterations can be made therein without departing from the spirit and scope of the invention as defined by the appended claims.

What is claimed is:

1. In a device for connection in a drill string, the combination of:

a mandrel assembly comprised of a tubular mandrel body having tool joint means at one end for connection to one section of the drill string, an annular knocker shoulder adjacent the tool joint and facing the other end, and a tubular sealing portion of reduced, constant diameter extending from the knocker shoulder toward the other end of the mandrel, the mandrel body having no diameter greater than the diameter of the tubular sealing portion between the tubular sealing portion and the other end of the mandrel body, a mandrel sleeve having mechanical lug means formed thereon of greater diameter than the cylindrical sealing surface disposed around the mandrel body between thte cylindrical sealing portion and the other end and keyed against rotation on the mandrel body, means on the mandrel body cooperatively engaging means on the mandrel sleeve for preventing longitudinal movement of the mandrel sleeve on the mandrel body including a tubular wash pipe threaded onto the end of the mandrel body and engaging the mandrel sleeve, the end of the wash pipe having peripheral sealing means thereon of the same diameter as the cylindrical sealing portion on the mandrel body,

a housing assembly disposed around the mandrel assembly and comprising a sealing collar slidingly and sealingly disposed around the cylindrical sealing portion of the mandrel body, and with the upper end positioned to strike the knocker shoulder, a tubular housing body threadedly connected to the sealing collar having a mechanical lug means formed therein cooperatively engaging the lug means formed on the mandrel to transmit only torque between the mandrel assembly and housing assembly when one assembly is rotated in one direction while permitting free relative longitudinal movement between the assembles within a limited stroke and for selectively transmitting an impact force directed longitudinally between the assemblies, a wash pipe liner secured in the housing body and slidably and sealingly receiving the sealing means on the wash pipe to form an annular fluid chamber between the mandrel assembly and housing assembly and between the two sealing means, and

means for filling the annular fluid chamber with a lubricating fluid.

2. The combination defined in claim **1** further characterized by:

a peripheral wiper ring connected to the end of the sealing collar facing the annular shoulder on the mandrel assembly and having a peripheral lip extending toward the shoulder and slidingly engaging the cylindrical sealing section of the mandrel body to wipe the mandrel clean as it passes into the sealing collar.

3. The combination defined in claim **1** further characterized by:

a peripheral wiper ring connected to the end of the wash pipe having a peripheral lip extending away from the wash pipe and slidingly engaging the interior surface of the wash pipe liner to wipe the liner clean as the wash pipe passes through the liner.

4. The combination defined in claim **1** wherein:

the wash pipe liner is threaded into one end of a housing sub having a tool joint at the other end, and the housing sub is threaded into the end of the housing body.

5. The combination defined in claim **4** wherein:

the sealing collar includes an O-ring seal disposed in a peripheral groove within the sealing collar and slidingly and sealingly engaging the cylindrical sealing portion, and

the peripheral sealing means on the wash pipe includes an O-ring seal disposed in a peripheral groove in the outer surface of the wash pipe and slidingly and sealingly engaging the interior surface of the wash pipe liner.

6. The combination defined in claim **4** further characterized by O-ring seals disposed between each threaded connection in the mandrel assembly and housing assembly.

7. In a drilling jar, the combination of:

a housing assembly comprised of a sealing collar, a first resilient sealing ring means within the collar, a tubular housing body threadedly connected to one end of the sealing collar, a first elongated cylindrical sealing surface within the other end of the housing body, and first lug means secured within the housing body between the sealing collar and the first elongated cylindrical sealing surface, and

a mandrel assembly reciprocally disposed within the housing assembly comprising a mandrel body, a second elongated cylindrical sealing surface of the mandrel body sealingly engaging the first resilient sealing ring and having the same diameter as the first elongated cylindrical sealing surface, a second resilient sealing ring disposed around the other end of the mandrel body and sealingly engaging the first cylindrical sealing surface, the mandrel body having a maximum diameter between the second elongated cylindrical sealing surface and the other end of the mandrel body no greater than the diameters of the second cylindrical sealing surfaces, second lug means for cooperatively engaging the first lug means, and means for attaching the second lug means to the mandrel body after the sealing collar has been passed over the end of the mandrel body, over the second sealing ring, and into operative position around the second cylindrical sealing surface.

8. The combination defined in claim 7 wherein:

the second lug means comprises a lug sleeve disposed around the mandrel body, and the means for attaching the second lug means to the mandrel body includes oppositely facing shoulders on the mandrel body engaging the ends of the lug sleeve, and a threaded joint in the mandrel body between the shoulders.

9. The combination defined in claim 8 further characterized by key means for securing the lug sleeve against rotation on the mandrel body.

10. In a device for connection in a drill string, the combination of:

a mandrel assembly comprised of a tubular mandrel body having tool joint means at one end for connection to one section of the drill string, an annular knocker shoulder adjacent the tool joint and facing the other end, and a tubular sealing portion of reduced, constant diameter extending from the knocker shoulder toward the other end of the mandrel, the mandrel body having no diameter greater than the diameter of the tubular sealing portion between the tubular sealing portion and the other end of the mandrel body, a mandrel sleeve having mechanical lug means formed thereon of greater diameter than the cylindrical sealing surface disposed around the mandrel body between the cylindrical sealing portion and the other end and keyed against rotation on the mandrel body, means on the mandrel body cooperatively engaging means on the mandrel sleeve for preventing longitudinal movement of the mandrel sleeve on the mandrel body including a tubular wash pipe threaded onto the end of the mandrel body and engaging the mandrel sleeve, the end of the wash pipe having peripheral sealing means thereon of the same diameter as the cylindrical sealing portion on the mandrel body, and

a housing assembly disposed around the mandrel assembly and comprising a sealing collar slidingly and sealingly disposed around the cylindrical sealing portion of the mandrel body, and with the upper end positioned to strike the knocker shoulder, a tubular housing body threadedly connected to the sealing collar having mechanical lug means formed therein cooperatively engaging the lug means formed on the the mandrel, and an elongated cylindrical sealing surface formed in the housing body and slidably and sealingly receiving the sealing means on the wash pipe to form an annular fluid chamber between the mandrel assembly and housing assembly and between the two sealing means.

11. In a device for connection in a drill string, the combination of:

a mandrel assembly comprised of a tubular mandrel body having tool joint means at one end for connection to one section of the drill string, an annular knocker shoulder adjacent the tool joint and facing the other end, a first cylindrical sealing surface of reduced, constant diameter extending from the knocker shoulder toward the other end of the mandrel, peripheral sealing means on the other end of the mandrel assembly of the same diameter as the cylindrical sealing portion on the mandrel body, and first lug means formed on the mandrel body between the cylindrical sealing surface and the peripheral sealing means, and

a housing assembly comprising a housing body disposed around the mandrel assembly with the upper end positioned to strike the knocker shoulder, a sealing ring within the end of the housing body in sliding, sealing engagement with the first cylindrical sealing surface, second lug means formed within the housing body cooperatively engaging the first lug means, and a wash pipe liner secured within the housing body and slidably and sealingly receiving the peripheral sealing means on the mandrel assembly to form an annular fluid chamber between the mandrel assembly and housing assembly and between the two sealing means, the wash pipe liner being threaded into one end of a housing sub having a tool joint at the other end, and the housing sub being threaded into the end of the housing body.

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