(54) Titre : PRESSES A FORER COMPORTANT DES COMPOSANTS DE REDUCTION DU BruIT
(54) Title: DRILL PRESSES HAVING NOISE REDUCING COMPONENTS

(57) Abrégé/Abstract:
A drill press includes a spindle pulley having a first central opening extending along an axis, a sleeve disposed within the pulley central opening, the sleeve having a central opening aligned with the pulley central opening and the axis, and a locking nut connecting an upper end of the sleeve with the spindle pulley for supporting simultaneous rotation of the sleeve and the spindle pulley about the axis. The drill press includes a spindle disposed within the sleeve central opening and extending along the axis, the spindle being slidable along the axis relative to the sleeve and being rotatable with the sleeve. The drill press includes a spacer disposed between the spindle and the locking nut or between the spindle and the sleeve for aligning the spindle with the axis and preventing the spindle from contacting the upper end of the sleeve during rotation, which reduces noise during operation.
ABSTRACT

A drill press includes a spindle pulley having a first central opening extending along an axis, a sleeve disposed within the pulley central opening, the sleeve having a central opening aligned with the pulley central opening and the axis, and a locking nut connecting an upper end of the sleeve with the spindle pulley for supporting simultaneous rotation of the sleeve and the spindle pulley about the axis. The drill press includes a spindle disposed within the sleeve central opening and extending along the axis, the spindle being slidable along the axis relative to the sleeve and being rotatable with the sleeve. The drill press includes a spacer disposed between the spindle and the locking nut or between the spindle and the sleeve for aligning the spindle with the axis and preventing the spindle from contacting the upper end of the sleeve during rotation, which reduces noise during operation.
DRILL PRESSES HAVING NOISE REDUCING COMPONENTS

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention is generally related to power equipment, and more specifically is related to drill presses having noise reducing components.

Description of the Related Art

[0002] Drill presses typically include a base, a vertical support column extending upwardly from the base, a table attached to a mid-section of the vertical support column for holding work pieces, and a head stock secured to an upper end of the vertical support column. The head stock includes a rotatable handle that is turned for moving a spindle up and down along a vertical axis that is parallel with the longitudinal axis of the vertical support column. The height of the table may be adjusted using a second rotatable handle coupled with a rack and pinion system. The table may be rotated about the longitudinal axis of the support column to offset the table from the vertical axis of the spindle. In some designs, a drill chuck for holding a drill bit is connected to a lower end of the spindle. The drill chuck may have three jaws that hold an upper end of the drill bit in the chuck. Some drill presses include a spindle having a lower end with a tapered opening for receiving a drill bit having a tapered shaft that fits into the tapered opening. When the drill press is activated, a motor rotates pulleys via one or more drive belts, which, in turn, rotate the spindle and the drill bit secured to the lower end of the spindle.

[0003] Drill presses provide many advantages over hand-held drills. First, the spindle is moved up and down along a vertical axis by a rotatable handle coupled with a rack and pinion system, which provides an operator with considerable mechanical advantage. Thus, less effort is required to advance the drill bit through a work piece. Second, a drill press has a table for supporting a work piece, which enables a vice grip or clamp to be used to hold the work piece in an immovable position on the table. In addition, the spindle moves along a fixed vertical axis relative to the top surface of the table, which allows operators to accurately drill holes in work pieces.

[0004] Many drill presses have a mechanism for changing the speed of rotation of the drill. Often, the speed is changed by manually moving one or more drive belts across a stepped pulley arrangement. In one conventional design, in order to change the speed,
an operator must first move the motor to provide sufficient slack in at least one of the drive belts. After the drive belts are repositioned, the motor is moved back to its initial position for tensioning the drive belts. Moving the motor requires that the motor be mounted in such a way that it may be translated to allow for belt tensioning. This mounting arrangement may cause unwanted noise and vibration if the machining of the drill press is not precise. Recently, some drill presses have added a third stepped pulley to increase the range of speeds. Some drill presses are equipped with a variable speed motor or a continuously variable transmission, which enable operators to change speeds while the machine is running.

FIGS. 1A and 1B show a conventional drill press including a drive system for driving a spindle. The drive system includes a stepped spindle pulley 10 that is driven by a drive belt 12. The stepped spindle pulley 10 is rotatably mounted to a head stock 14 of a drill press and includes an upper end 16, a lower end 18 and a series of steps 20 of progressively larger diameter extending between the upper end and the lower end. Referring to FIG. 1B, the stepped spindle pulley 10 includes a central opening 22 extending between the upper end 16 and the lower end 18 thereof. The central opening 22 is adapted to receive a sleeve 24 that rotates simultaneously with the stepped spindle pulley 10. A locking nut 25 couples the stepped spindle pulley 10 with the sleeve 24. The sleeve 24 has an upper end 26 having a larger diameter opening and a lower end 28 having a smaller diameter opening that is smaller than the larger diameter opening at the upper end 26. The drive system includes a spindle 30 that is adapted for reciprocating movement along a vertical axis A1. Thus, the spindle 30 may be extended and retracted relative to the sleeve 24 along the vertical axis A1. Referring to FIG. 1A, the spindle 30 has an outer surface including a plurality of splines 32 that extend along the axial length thereof. The splines 32 mesh with the second smaller diameter opening at the lower end 28 of the sleeve 24. As a result, the splined spindle 30 is able to move along the vertical axis A1 relative to the sleeve 24; however, the meshing of the smaller diameter opening of the sleeve 24 with the splines 32 on the spindle 30 transmits rotational movement from the sleeve 24 to the spindle 30.

In conventional drill presses, there is excessive clearance between the larger diameter opening at the sleeve upper end 26 and the spindle outer surface. As a result, when the drill press is operated with the spindle 30 in the retracted position shown in FIG. 1B, the rotating spindle 30 knocks against the sleeve at a high frequency, which creates a rattling noise. The rattling noise tends to disappear when the spindle 30 is lowered along
the vertical axis $A_1$ toward a work piece supporting table, which only makes the noise that much more obvious to operators when the spindle is once again retracted.

[0007] In view of the above deficiencies, there is a need for drill presses that have noise reducing components, and which are quieter when being operated.

5 SUMMARY OF THE INVENTION

[0008] In one embodiment, a drill press having noise reducing components desirably includes a spindle pulley having a central opening extending along an axis, the spindle pulley being rotatable about the axis, and a sleeve disposed within the pulley central opening, the sleeve having a central opening aligned with the pulley central opening and the axis. The drill press preferably includes a locking nut connecting an upper end of the sleeve with the spindle pulley for supporting simultaneous rotation of the sleeve and the spindle pulley. A spindle is desirably disposed within the sleeve central opening of the sleeve and extends along the axis, whereby the spindle is slidable along the axis relative to the sleeve and is rotatable with the sleeve about the axis. The drill press desirably includes a spacer disposed between the spindle and the locking nut for aligning the spindle with the axis and for preventing the spindle from contacting the sleeve upper end during rotation of the spindle and the sleeve about the axis.

[0009] In one embodiment, the sleeve has the upper end, a lower end, and the sleeve central opening extends between the upper and lower ends of the sleeve. The sleeve central opening preferably has a larger diameter section adjacent the sleeve upper end and a smaller diameter section adjacent the sleeve lower end.

[0010] In one embodiment, the spindle preferably has an elongated spindle shaft with a length aligned with and extending along the axis. The spindle desirably includes splines that extend along the length of the elongated spindle shaft. The splines are desirably adapted to mesh with the smaller diameter section at the sleeve lower end for transmitting rotation forces from the sleeve to the spindle shaft. In one embodiment, the sleeve smaller diameter section has a plurality of protrusions adapted to mesh with the spindle shaft splines for transmitting rotational forces from the sleeve to the spindle shaft. The splines desirably define an outer diameter of the spindle shaft that is smaller than the sleeve larger diameter section.

[0011] In one embodiment, the sleeve upper end desirably has external threads adapted to mesh with internal threads on the locking nut. The locking nut preferably has a
central aperture aligned with the axis, and the spindle is slidable along the axis relative to the locking nut. In one embodiment, the spacer is ring-shaped (e.g. shaped like a grommet) and is secureable within the locking nut central aperture. The spacer desirably has a central aperture aligned with the axis, whereby the spindle is adapted to slide along the axis relative to the spacer.

[0012] In one embodiment, the locking nut has an annular projection that extends into the locking nut central aperture and the ring-shaped spacer has an outer surface including an annular groove that is adapted to receive the locking nut annular projection. In one embodiment, the spacer is desirably made of a non-metallic material such as rubber, polymers, and elastic materials, and the locking nut may be made of metal such as steel.

[0013] In one embodiment, a drill press having at least one noise reducing component includes a spindle pulley having an axis and a central opening extending along the axis, a sleeve disposed within the pulley central opening, the sleeve having a central opening aligned with the axis, and an elongated spindle disposed within the sleeve central opening and being aligned with the axis, the elongated spindle being adapted to slide along the axis relative to the sleeve and the spindle pulley, and the elongated spindle being adapted to rotate simultaneously with the sleeve and the spindle pulley. The drill press preferably includes a locking nut for connecting an upper end of the sleeve with the spindle pulley. The locking nut preferably has a central aperture aligned with the pulley central opening and the sleeve central opening, whereby the spindle extends through the locking nut central aperture. The drill press desirably includes a spacer disposed between an outer surface of the spindle and the locking nut central aperture for preventing the spindle from contacting the upper end of the sleeve during rotation of the sleeve and the spindle about the axis.

[0014] In one embodiment, the sleeve preferably has an upper end, a lower end, and the sleeve central opening between the upper and lower ends. The sleeve central opening desirably has a larger diameter section adjacent the sleeve upper end adapted for enabling the spindle to slide along the axis relative to the sleeve, and a smaller diameter section adjacent the sleeve lower end adapted to mesh with the spindle for transmitting rotation forces between the sleeve and the spindle while enabling the spindle to slide along the axis relative to the sleeve. The spindle preferably includes splines extending along a length of the spindle. The splines are preferably adapted to mesh with the smaller diameter section of the sleeve central opening for transmitting rotation forces.
from the sleeve to the spindle. The smaller diameter section of the sleeve preferably includes protuberances for transmitting rotational forces from the sleeve to the spindle. The splines are able to slide through the protuberances for enabling axial movement of the spindle relative to the sleeve.

[0015] These and other preferred embodiments of the present invention will be described in more detail below.

BRIEF DESCRIPTION OF THE DRAWING

[0016] FIG. 1A shows a perspective view of a conventional drive system for a drill press including a stepped spindle pulley and a spindle, in accordance with one embodiment of the present invention.

[0017] FIG. 1B shows a cross-sectional view of the prior art stepped spindle pulley and spindle shown in FIG. 1A.

[0018] FIG. 2 shows a perspective view of a drill press including a head stock, a vertical support column, a stand, and a work piece supporting table, in accordance with one embodiment of the present invention.

[0019] FIG. 3A shows a top perspective view of a drive system for the drill press shown in FIG. 2 including drive belts, a motor pulley, a center pulley, a spindle pulley coupled with a spindle, and a noise reducing component coupled with the spindle, in accordance with one embodiment of the present invention.

[0020] FIG. 3B shows a front perspective view of the drive system shown in FIG. 3A, in accordance with one embodiment of the present invention.

[0021] FIG. 4A shows a cross-sectional view of the spindle pulley, the spindle shaft and the noise reducing component shown in FIGS. 3A and 3B, in accordance with one embodiment of the present invention.

[0022] FIG. 4B shows a cross-section of FIG. 4A taken along line 4B-4B thereof.

[0023] FIG. 4C shows a cross-section of FIG. 4A taken along line 4C-4C thereof.

[0024] FIGS. 5A-5C show a locking nut for a drill press, in accordance with one embodiment of the present invention.
FIG. 6 shows a perspective view of a spacer and the spacer coupled with the locking nut of FIGS. 5A-5C, in accordance with one embodiment of the present invention.

FIG. 7A shows the drive system of FIGS. 3A-3B and 4A with the spindle in a retracted position, in accordance with one embodiment of the present invention.

FIG. 7B shows the drive system of FIGS. 3A-3B and 4A with the spindle in an extended position, in accordance with one embodiment of the present invention.

FIG. 8 shows a cross-sectional view of a noise reducing component engaging a spindle of a drill press, in accordance with one embodiment of the present invention.

DETAILED DESCRIPTION

Referring to FIG. 2, in one embodiment, a drill press 40 preferably includes a head stock 42 supported atop a vertically-extending support column 44 and a stand 46 supporting a lower end of the support column 44. The drill press desirably includes a rotatable spindle 48 projecting from a lower end of the head stock 42 and a chuck 50 mounted to a lower end of the spindle. The chuck is preferably adapted to receive a drill bit 52 used for drilling holes in work pieces. The drill press desirably includes a rotatable handle 54 that may be engaged for lowering the rotatable spindle 48, the chuck 50 and the drill bit 52 along a vertical axis \( A_2 \) that is parallel with the longitudinal axis of the support column 44. The drill press 40 also preferably includes a table 56 having a top surface 58 adapted to support a work piece below the spindle 48, the chuck 50, and the drill bit 52. The drill press preferably includes a table adjustment handle 60 that may be operated for raising and lowering the table 56 along the support column 44 using a rack and pinion arrangement.

The head stock 42 preferably includes a head stock pulley cover 62 that covers a drive system for supplying power to the spindle 48. In one embodiment, the drive system preferably includes a motor 64 that is coupled with the spindle 48 via one or more pulleys and drive belts, as will be described in more detail below. The head stock cover 62 is desirably moveable between the closed position shown in FIG. 2 and an open position for accessing the drive belts and rotatable pulleys located between the motor 64 and the spindle 48. In one embodiment, the position of the drive belts on the pulleys may be changed for modifying the speed of the drill press.
[0031] Referring to FIGS. 3A and 3B, in one embodiment, the head stock cover 62 may be opened for exposing a portion of the drive system of the drill press. In one embodiment, the drive system preferably includes a stepped motor pulley 66 that is rotated by a motor shaft 68 coupled with the motor 64 (FIG. 2). In one embodiment, a stepped center pulley 70 is rotatably mounted on a center pulley shaft 71. A lower end of the center pulley shaft is preferably mounted to the head stock via a pivoting arm 72 that desirably enables the position of the center pulley 70 to be selectively shifted for changing the positions of the drive belts 74, 82. In one embodiment, the center pulley 70 is a stepped pulley having five steps of varying radii.

[0032] The drive system preferably includes a first drive belt 74 that extends about the motor pulley 66 and the center pulley 70. In one embodiment, the first drive belt 74 is preferably adapted to transmit power from the motor pulley 66 to the center pulley 70. In one embodiment, the first drive belt 74 is preferably a poly-v drive belt with v-shaped grooves formed on an inner face thereof, and the stepped pulleys have v-shaped grooves or projections adapted to mesh with the v-shaped grooves on the drive belts. In another embodiment, the drive belts may be conventional drive belts having a smooth inner face and the pulleys may have smooth stepped surfaces that mesh with the smooth inner faces of the drive belts. In other embodiments, any type of drive belt well-known to those skilled in the art may be used.

[0033] In one embodiment, the drive system preferably includes a stepped spindle pulley 76 that is coupled with the spindle 48 having an elongated shaft 78 and splines 80 extending along the axial length of the elongated shaft 78. The drive system preferably includes a second drive belt 82 that interconnects the rotatable center pulley 70 with the spindle pulley 76.

[0034] In one embodiment, the drive system preferably includes a spring-loaded drive belt tensioner 84 that is adapted to apply tension to an outer surface or face of one of the drive belts, such as disclosed in commonly assigned U.S. Patent Appln. Ser. No. 12/813,554, filed June 11, 2010, the disclosure of which is hereby incorporated by reference herein. In one embodiment, the spring loaded tensioner 84 desirably applies tension to the outer face of the first drive belt 74. In one embodiment, the spring-loaded tensioner 84 uses spring force for automatically and continuously applying tension to the slack side and/or outer surface of the first drive belt 74 to maintain optimum tension on the first drive belt. As such, the motor associated with the motor pulley 66 may be rigidly mounted to the drill press, thereby eliminating several parts previously required in prior art
systems for shifting the position of the motor for changing speeds, as well as the previously required extra machining on the head stock casting. Other benefits desirably include insuring that proper belt tension will always be maintained on the drive belts 74, 82, thereby eliminating user error when attempting to set the tension on the drive belts.

In one embodiment, the tensioner preferably applies tension to the slack side of the first drive belt 74. In one embodiment, the spring-loaded tensioner may be rotated in a counterclockwise direction designated R1 for lessening the amount of tension applied by the tensioner 84 to the first drive belt 74 so that the position of at least one of the first and second drive belts 74, 82 may be changed for modifying the speed of the drill press. In one embodiment, zero tension is applied to the first drive belt 74 when the tensioner 84 is retracted. After the position of at least one of the first and second drive belts has been modified for changing the speed of the drive system, the spring-loaded tensioner may be rotated a clockwise direction designated R2 so that the belt tensioner 84 re-engages the first drive belt 74 for applying tension to the drive system. The tensioner preferably includes a spring that normally urges the tensioner 84 to rotate in the direction R2.

In one embodiment, the tension force applied by the spring-loaded tensioner 84 to the poly-V belt is according to the belt manufacturer's requirements. In one preferred embodiment, the spring-loaded tensioner 84 preferably engages the slack side of the first drive belt.

In one embodiment, the motor shaft 68 rotates the motor pulley 66 for driving the first drive belt 74. In turn, the first drive belt 74 rotates the center pulley 70 about the center pulley shaft 71. As the center pulley 70 rotates, the center pulley drives the second drive belt 82, which, in turn, rotates the spindle pulley 76. Rotation of the spindle pulley simultaneously rotates the spindle shaft 78, the chuck 50 and the drill bit 52 (FIG. 2) secured to the chuck. In one embodiment, the position of the first drive belt and the second drive belt on the stepped pulleys may be adjusted for changing the speed of rotation of the spindle.

Referring to FIGS. 3B and 4A, in one embodiment, the splined spindle shaft 78 is adapted to move upward and downward along the vertical axis A₂. The splined spindle shaft 78 preferably moves upward when being retracted and downward when being extended. The splines 80 extending along the outer surface of the spindle shaft 78 preferably mesh with a smaller diameter section at a lower end of a sleeve, as will be described in more detail herein.
[0039] Referring to FIG. 4A, in one embodiment, the drive system preferably includes the stepped spindle pulley 76 having an upper end 90, a lower end 92 and a series of steps 94 of progressively larger diameter extending between the upper end 90 and the lower end 92. The stepped spindle pulley 76 preferably includes a central opening 96 that extends between the upper and lower ends 90, 92 thereof. The pulley central opening 96 is desirably aligned with the vertical axis A2. The pulley central opening 96 is adapted to receive a tubular shaped or elongated sleeve 98 that is preferably coupled with the stepped spindle pulley 76 for rotating simultaneously with the stepped spindle pulley. The sleeve 98 desirably includes an upper end 100 and a lower end 102. The sleeve upper end 100 preferably defines a larger diameter section 104 having a first radius R1. The sleeve lower end 102 preferably defines a smaller diameter section 106 including projections 107 having a second radius R2 that is smaller than the first radius R1. The splines 80 extend along the longitudinal axis A2 of the spindle shaft 78 so that the spindle shaft may move along axis A2 relative to the sleeve 98 for being extended and retracted. The projections defining the smaller diameter section 106 at the sleeve lower end 102 preferably mesh with the splines 80 extending along the outer surface of the spindle shaft 78 so that rotation of the sleeve 98 results in rotation of the spindle shaft 78.

[0040] FIG. 4B shows a cross-section of the upper end 100 of the sleeve 98 including the larger diameter section 104 having a first radius R1, which is spaced from the splines 80 on the outer surface of the spindle shaft 78. FIG. 4C shows a cross-section of the lower end 102 of the sleeve 98 including the projections 107 defining the smaller diameter section 106 that mesh with the splines 80 extending along the outer surface of the spindle shaft so that the rotating sleeve 98 transmits rotational force to the spindle shaft 78.

[0041] As noted herein, the elongated sleeve 98 is preferably affixed within the first central opening 96 of the stepped spindle pulley 76. As a result, when the stepped spindle pulley 76 is rotated by a drive belt 82 (FIG. 3B), the sleeve 98 rotates simultaneously with the stepped spindle pulley 76.

[0042] In one embodiment, the drive system preferably includes a spacer 110 having an axial opening 112 or central aperture. The spacer 110 is preferably adapted to slide over the outer surface of the spindle shaft 78 for assembling the spacer and a locking nut 120 together. The drive system preferably includes the locking nut 120 that is secured over the sleeve upper end 100. The locking nut 120 preferably couples the spindle pulley and the sleeve 98 together for simultaneous rotation. In one embodiment, the spacer 110 includes an outer surface having an annular groove 114 and the locking nut 120 includes...
an annular projection 124 that sits within the spacer annular groove 114. The spacer may be ring-shaped and may be made of non-metallic materials such as rubber, polymers and elastic materials. In one embodiment, the spacer may be a grommet.

[0043] In one embodiment, the central aperture of the spacer 110 defines a rounded, annular or ring-shaped inner surface. In one embodiment, the central aperture of the spacer 110 has a plurality of elongated grooves formed therein that are adapted to receive splines on an outer surface of the spindle. The elongated grooves formed within the central aperture of the spacer 110 preferably closely conform with and/or interface with the splines on the outer surface of the spindle as the spindle moves along a vertical axis relative to the spacer. In one embodiment, the spindle and the spacer are adapted to rotate simultaneously with one another about the vertical axis.

[0044] In one embodiment, the spacer 110 preferably includes an outer surface having an annular projection and the locking nut 120 has an inner surface including an annular groove that is adapted to receive the annular projection for coupling the spacer and the locking nut together. In one embodiment, the spacer 110 includes an outer surface having an annular groove with an 0-ring disposed in the annular groove and the locking nut 120 has an inner surface including an annular groove that is adapted to receive the 0-ring attached to the spacer for coupling the spacer and the locking nut together.

[0045] In one embodiment, the spacer 110 is positioned between the outer surface of the spindle and the locking nut for preventing the rotating spindle from rattling against the sleeve. In one embodiment, the spacer may be positioned between the upper end of the sleeve and the spindle for preventing the rotating spindle from rattling against the sleeve, such as by incorporating the spacer into the upper end of the sleeve.

[0046] Although the present invention is not limited by any particular theory of operation, it is believed that using a spacer that fits around a spindle shaft 78 for aligning it with the sleeve 98 prevents contact between the rotating spindle shaft 78 and the sleeve 98 for reducing noise found in prior art systems. In one embodiment, the spacer 110 is preferably made of a material that is soft enough to firmly hold onto the spindle shaft 78, while enabling the rotating spindle shaft 78 to freely move along the vertical axis A2. In one embodiment, using a spacer 110 between the locking nut 120 and the spindle shaft 78 preferably produces a drill press that is extremely quiet and that absorbs any manufacturing tolerances between the parts, particularly between the sleeve 98 and the
spindle shaft 78. In one embodiment, the use of the spacer 110 and the locking nut 120 preferably reduces the noise level of an operating drill press to at least 2-5 decibels lower than may be obtained when using conventional drill presses, thereby providing a much quieter drill press.

[0047] Referring to FIGS. 5A-5C, in one embodiment, the locking nut 120 preferably includes an upper end 122 having an annular projection 124 that bounds a central aperture 126 extending between the upper end 122 and a lower end 128 of the locking nut. Referring to FIG. 5A, the locking nut 120 includes internal threads 130 that bound the central aperture 126 adjacent the locking nut lower end 128. The internal threads 130 are preferably adapted to mesh with external threads at an upper end of the sleeve for coupling the locking nut 120 with the sleeve 98 (FIG. 4A). Referring to FIGS. 5A and 5C, the locking nut 120 desirably includes a pocket 132 positioned between the annular projection 124 and the lower end 128 of the locking nut 120. The annular projection 124 is adapted to sit within an annular groove 114 formed in the outer surface of the spacer 110 for holding the spacer within the pocket 132.

[0048] Referring to FIG. 5C, the locking nut central aperture 126 preferably includes a smaller diameter section 134 adjacent the upper end 122 of the locking nut 120 and a larger diameter section 136 adjacent the lower end 128 of the locking nut 120. The smaller diameter section 134 preferably conforms to the outer diameter of the annular groove of the spacer. The larger diameter section 136 preferably conforms to the outer diameter of the upper end of the sleeve.

[0049] In one embodiment, the outer portion of the locking nut 120 has wrench flats or other features which allow the locking nut to be properly assembled and/or torqued, with an inner diameter suitable for forming a mating fit with a grommet or other elastomeric material, and a height sufficient to accommodate the grommet and provide satisfactory clamping force on the pulley. Referring to FIG. 5B, in one embodiment, the locking nut 120 preferably has a width OD across the flats of about 1.25 inches. Referring to FIG. 5C, in one embodiment, the pocket 132 of the locking nut 120 has an inner diameter ID of about 0.75 inches. In one embodiment, the locking nut has a height H of about 1.0 inches.

[0050] FIG. 6 shows a perspective view of the ring-shaped spacer 110. The ring-shaped spacer 110 desirably includes a central aperture 112 that is sized to enable axial movement of the spindle shaft 78 (FIG. 4A) relative to the spacer. An outer surface of the
ring-shaped spacer 110 includes an annular groove 114 that is adapted to mesh with the
annular projection 124 adjacent the upper end 122 of the locking nut 120 (FIG. 5A). The
left side of FIG. 6 shows the locking nut 120 after the ring-shaped spacer 110 has been
assembled with the locking nut. An upper end of the spacer 110 lies above the upper end
122 of the locking nut 120. The locking nut internal threads 130 extend around the locking
nut central aperture 126 adjacent the locking nut lower end 128.

[0051] FIG. 7A shows the ring-shaped spacer 110 and the locking nut 120 secured to
the upper end 90 of the stepped spindle pulley 76. In FIG. 7A, the splined spindle shaft 78
is in a retracted position whereby the drill bit 52 (FIG. 2) is retracted away from the top
surface 58 of the table 56. FIG. 7B shows the splined spindle shaft 78 in an extended
position so that only an upper end of the splined spindle shaft 78 is visible through the
spacer 110 and the locking nut 120. The locking nut 120 preferably couples the spindle
pulley 76 with the sleeve upper end 100 (FIG. 4A).

[0052] FIG. 8 shows a cross-sectional view of the spacer 110 and the locking nut 120
that clearly depicts how the locking nut couples the components together. In FIG. 8, the
spindle pulley has been removed so that the sleeve upper end 100 may be clearly shown.
The sleeve upper end 100 includes external threads 105 that mesh with the internal
threads 130 at the locking nut lower end 128. The locking nut 120 includes an upper end
122 having an annular projection 124 that is seated in the annular groove 114 formed in
the outer surface of the spacer 110. The spacer 110 includes a central aperture 112 that
receives the splined spindle shaft 78. The splined spindle shaft 78 is free to move along
the axis A2 relative to the spacer 110, the locking nut 120, and the sleeve 98. The spacer
110 and the locking nut 120 desirably cooperate to space the outer surface of the spindle
shaft 78 away from the inner surface of the sleeve 100 so as to prevent the rotating
spindle shaft 78 from knocking and/or rattling against the sleeve upper end 100 during
operation of the drill press, thereby minimizing noise present in prior art systems when
the rotating spindle shaft knocks and/or rattles against the sleeve.

[0053] The headings used herein are for organizational purposes only and are not
meant to limit the scope of the description or the claims. As used throughout this
application, the word "may" is used in a permissive sense (i.e., meaning having the
potential to), rather than the mandatory sense (i.e., meaning must). Similarly, the words
"include", "including", and "includes" mean including but not limited to. To facilitate
understanding, like reference numerals have been used, where possible, to designate like
elements common to the figures.
While the foregoing is directed to embodiments of the present invention, other and further embodiments of the invention may be devised without departing from the basic scope thereof, which is only limited by the scope of the claims that follow. For example, the present invention contemplates that any of the features shown in any of the embodiments described herein, or incorporated by reference herein, may be incorporated with any of the features shown in any of the other embodiments described herein, or incorporated by reference herein, and still fall within the scope of the present invention.
CLAIMS:

1. A drill press comprising:
   a spindle pulley having a central opening extending along an axis, said spindle
   pulley being rotatable about said axis;
   a sleeve disposed within said pulley central opening, said sleeve having a central
   opening aligned with said pulley central opening and said axis;
   a locking nut connecting an upper end of said sleeve with said spindle pulley for
   supporting simultaneous rotation of said sleeve and said spindle pulley;
   a spindle disposed within said sleeve central opening and extending along said
   axis, said spindle being slidable along said axis relative to said sleeve and being rotatable
   with said sleeve about said axis;
   a spacer disposed between said spindle and said locking nut for aligning said
   spindle with said axis and for preventing said spindle from contacting said sleeve upper
   end during rotation of said spindle and said sleeve about said axis.

2. The drill press as claimed in claim 1, wherein said sleeve has said upper end, a
   lower end, and said sleeve central opening extends between said upper and lower ends
   of said sleeve.

3. The drill press as claimed in claim 2, wherein said sleeve central opening has a
   larger diameter section adjacent said sleeve upper end and a smaller diameter section
   adjacent said sleeve lower end.

4. The drill press as claimed in claim 3, wherein said spindle has an elongated
   spindle shaft with a length aligned with and extending along said axis.

5. The drill press as claimed in claim 4, wherein said spindle comprises splines
   extending along the length of said elongated spindle shaft.

6. The drill press as claimed in claim 5, wherein said splines are adapted to mesh
   with said sleeve smaller diameter section at said sleeve lower end for transmitting rotation
   forces from said sleeve to said spindle shaft.

7. The drill press as claimed in claim 6, wherein said sleeve smaller diameter section
   comprises a plurality of protrusions adapted to mesh with said spindle shaft splines for
   transmitting rotation forces from said sleeve to said spindle shaft.
8. The drill press as claimed in claim 7, wherein said splines define an outer diameter of said spindle shaft that is smaller than said larger diameter section.

9. The drill press as claimed in claim 1, wherein said sleeve upper end has external threads adapted to mesh with internal threads on said locking nut.

10. The drill press as claimed in claim 9, wherein said locking nut has a central aperture aligned with said axis, and wherein said spindle is slidable along said axis relative to said locking nut.

11. The drill press as claimed in claim 10, wherein said spacer is ring-shaped and is secureable within said locking nut central aperture.

12. The drill press as claimed in claim 11, wherein said spacer has a central aperture aligned with said axis, and wherein said spindle is adapted to slide along said axis relative to said spacer.

13. The drill press as claimed in claim 12, wherein said locking nut has an annular projection that extends into said locking nut central aperture and said ring-shaped spacer has an outer surface including an annular groove that is adapted to receive said locking nut annular projection.

14. The drill press as claimed in claim 1, wherein said spacer comprises a non-metallic material selected from the group consisting of rubber, polymers and elastic materials.

15. The drill press as claimed in claim 1, wherein said spacer has a central aperture adapted to receive said spindle.

16. The drill press as claimed in claim 1 wherein said central aperture of said spacer defines an annular surface or a surface having a plurality of elongated grooves adapted to mesh with splines on said spindle.

17. A drill press comprising:
a spindle pulley having an axis and a central opening extending along said axis;
a sleeve disposed within said pulley central opening, said sleeve having a central opening aligned with said axis;
an elongated spindle disposed within said sleeve central opening and being aligned with said axis, said elongated spindle being adapted to slide along said axis
relative to said sleeve and said spindle pulley, and said elongated spindle being adapted to rotate simultaneously with said sleeve and said spindle pulley;

a locking nut for connecting an upper end of said sleeve with said spindle pulley, said locking nut having a central aperture aligned with said pulley central opening and said sleeve central opening, wherein said spindle extends through said locking nut central aperture;

a spacer disposed between an outer surface of said spindle and said locking nut central aperture for preventing said spindle from contacting said sleeve upper end during rotation of said sleeve and said spindle about said axis.

18. The drill press as claimed in claim 17, wherein said locking nut comprises metal and said spacer comprises a non-metal.

19. The drill press as claimed in claim 17, wherein said sleeve has an upper end, a lower end, and said sleeve central opening extends between said upper and lower ends, wherein said sleeve central opening has a larger diameter section adjacent said sleeve upper end adapted for enabling said spindle to slide along said axis relative to said sleeve, and a smaller diameter section adjacent said sleeve lower end adapted to mesh with said spindle for transmitting rotation forces between said sleeve and said spindle while enabling said spindle to slide along said axis relative to said sleeve.

20. The drill press as claimed in claim 19, wherein said spindle comprises splines extending along a length of said spline, and wherein said splines are adapted to mesh with said smaller diameter section of said sleeve central opening for transmitting rotation forces from said sleeve to said spindle.

21. The drill press as claimed in claim 17, wherein said spacer is ring-shaped and is secureable within said locking nut central aperture.
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Figures: IA, IB, 2) 3A, 3B, 4A
6) 7A, 7B, 8

Pages:__________________________

Unscannable items
received with this application
(Request original documents in File Prep. Section on the 10th floor)

Documents reçu avec cette demande ne pouvant être balayés
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