REVERSIBLE HAMMER DRILL MECHANISMS

Spencer C. Rees, Pickens, S.C., assignor to The Singer Company, New York, N.Y., a corporation of New Jersey

Filed Oct. 17, 1967, Ser. No. 675,849
U.S. Cl. 173—48
Int. Cl. E02d 7/06; F16d 19/00, 23/00

10 Claims

ABSTRACT OF THE DISCLOSURE

This disclosure relates to a hammer drill mechanism for a power tool which permits the tool to be selectively operated either as a drill or as a hammer drill.

BACKGROUND OF THE INVENTION

In the prior art a power tool that included the option of operation either as a drill or a hammer drill was generally complex, not reversible, difficult to assemble, useable only in tools designed specifically for that purpose, and usually employed switching means inconveniently located or difficult to operate.

In addition, the prior art hammer drill tools imposed operational speed limitations and employed structure susceptible to excessive wear.

SUMMARY OF THE INVENTION

In accordance with the present invention the novel hammer drill mechanism is embodied in a power tool having an axially fixed rotary spindle shaft, which mechanism includes a hammer housing, a hammer spindle, a plurality of camming sleeves, a tool holder and locking means.

The hammer housing has a chamber into which the spindle shaft extends to be connected to the hammer spindle for continuous rotation therewith and limited axial movement therefrom. At least one of the sleeves is loosely disposed about the hammer spindle in fixed axial position by abutment with the housing, and at least one sleeve is connected for rotation with the hammer spindle. The tool holder is connected to the free end of the hammer spindle which is spring loaded to normally urge the camming surfaces of the plurality of sleeves to mate. The locking means is normally out of engagement with said one sleeve to permit free rotation thereof, and adapted to lock the one sleeve from rotating with the other sleeve whereby on rotation of the latter the camming surfaces will intermittently cause the outward axial shifting of the other sleeve or sleeves, the hammer spindle and the tool holder resulting in a hammering effect during operation of the power tool.

It is therefore an object of the present invention to provide an improved hammer drill mechanism which overcomes the prior art disadvantages; which is reversible; which is simple, economical and reliable; which does not cause excessive wear; which does not otherwise limit the operating speed of the power tool; which is driven by a spindle shaft, and adapted to be axially shiftable therefrom; which uses positive locking means for the hammer drill setting; which uses selector means which are shiftable to operate the tool either as a drill, or a hammer drill.

Other objects and advantages will be apparent from the following description of one embodiment of the invention and the novel features will be particularly pointed out hereinafter in the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

This invention is illustrated in the accompanying drawings in which:

FIGURE 1 is a side elevational view of a power tool embodying the present invention.

FIGURE 2 is a partial plan view of the tool taken along line 2—2 of FIGURE 1 and shows the two positions of the selector means of the present invention marked D and H, respectively, to correspond to the drill and hammer drill settings.

FIGURE 3 is a sectional elevational view of the disclosed embodiment of the hammer drill mechanism in the drilling position.

FIGURE 4 is a view taken along line 4—4 of FIGURE 3.

FIGURE 5 is a view taken along line 5—5 of FIGURE 3.

FIGURE 6 is an elevational view, partly in section, of the hammer drill mechanism in the hammer drill position and the spindles rotating in a counter-clockwise direction as viewed looking from the tool holder end toward the handle.

FIGURE 7 is a view taken along line 7—7 of FIGURE 6.

FIGURE 8 is a partial elevational view of the hammer drill mechanism in the hammer drill position and the spindles rotating in a clockwise direction as viewed looking from the tool holder end toward the handle.

FIGURE 9 is a view taken along line 9—9 of FIGURE 6.

FIGURE 10 is a view taken along line 10—10 of FIGURE 8.

FIGURE 11 is an exploded perspective view, partly in section, of the hammer drill mechanism of the present invention.

DESCRIPTION OF THE INVENTION

A conventional power tool 20 is shown in FIGURE 1 embodying the present invention. The power tool 20 has an electric motor 22 mounted in a lower section of the main housing 24 to drive a gear train 26. The last gear 28 of the train is affixed to rotate a spindle shaft 30 which results in the rotation of the tool holder or chuck 32 in which a suitable tool (not shown) will be connected to engage the work. A handle 34 is mounted at the end of the housing 24 opposite tool holder 32, and receives an electric cord 36 which is connected through a trigger switch 38 and a rotation reversing switch 39 to the motor 22 in the usual manner. Switch 39 may be a two position slide switch, set in one position for clockwise rotation of spindle shaft 30 and in the other position for counterclockwise rotation thereof.

In the event power tool 20 is designed solely as a drill the spindle shaft 30 could be lengthened or otherwise modified to connect to the tool holder 32 directly. However, in the present embodiment the shaft 30 extends into a hammer housing 40 which is connected to a partition and bearing boss 42 in the upper section of the housing 24 by threaded screws 44 shown in FIGURES 1 and 6.

The spindle shaft 30 is journaled in a pair of axially spaced ball bearings 46 to define a positively axially fixed position for said shaft within the main housing 24. The front section 48 of spindle shaft 30 is of reduced diameter, as illustrated in FIGURES 6 and 11, and in assembled position will extend into the central opening 50 of the hammer housing 40. Section 48 has a bore 52 that extends perpendicular to the spindle shaft axis at about its midpoint.

The hammer housing 40 is substantially cylindrically shaped and has an outwardly extending annular flange 54 at one end with holes 56 therein through which the screws 44 pass to connect the hammer housing 40 to the partition 42 of the main housing 24. The hammer housing 40 is counterbored as at 58 so as to permit the housing to be indexed onto the bearing boss 42. A chamber 60 is formed in a counterbore that extends from the other side
3 of the central opening 50 and has a shoulder 62 formed at the inner end of chamber 60, on one side of a wall 63. The end of the chamber 60 remote from the shoulder 62 has a counterbore 64 which defines a second shoulder 66. A radial bore 68 also counterbored extends outwardly from chamber 60, and is adapted to receive a large headed bolt 70 disposed in the head thereof and a spring 72 engaged therewith to normally urge the pin in the direction away from chamber 60, for purposes more fully explained hereinafter.

A hammer spindle 74, shown in FIGURES 6 and 11, is attached respectively to the spindle shaft 30 prior to assembly of the hammer housing 40 to the drill housing 24. The hammer spindle 74 has a cylindrically shaped periphery the inner end of which carries a flange 75 which in assembled position engages a spring 77. The outer end of spindle 74 is of reduced diameter and threaded. Ad-\n
9 adjacent the threaded section a pair of axial slabs or flats 76 are made. A bore 78 extends centrally into the hammer spindle 74 from the flanged end. Aligned slots 80 extend parallel to the axis of the spindle 74 and perpen-\n
dicularly through the bore 78. The hammer spindle 74 telescopes over the front section 48 of the spindle shaft 30 at the bore 78. A connecting pin 82 is passed through slots 80 and bore 52 to connect the members for joint rotation, while permitting axial movement of the hammer spindle 74 relative the spindle shaft 30 which is sized slightly longer than the maximum distance of axial shift so that the pin 82 never bottoms against the edge of the slot. Thereafter the hammer housing 40 is connected to the main housing 24. Spring 77 abuts the wall of recess 58 and flange 75 to bias the hammer spindle 74 inwardly to normally place pin 82 adjacent the right end of slot 80 as viewed in FIGURES 3 and 6.

15 A selector ring 84 and a selector lever 86 are joined by radial projections 88 of the lever extending into radial grooves 90 of the ring so that shifting the selector lever 86 of the lever acts to shift the ring 84. The lever 86 and the ring 84 are annular with the lever sized to slip onto the ring. The selector ring 84 and selector lever 86 are placed about a section 94 of the housing adjacent bore 68, which section has an outer diameter substantially equal to the inner diameter of the selector ring 84. The selector ring 84 has an arcuate recess 96 sized to permit the enlarged head of lock pin 70 and the ball 71 to ex-\n
20 tend therein to thus remove the shank of the pin from chamber 60 as illustrated in FIGURES 3 and 4.

The selector lever 86, the selector ring 84, the lock pin 70, the ball 71 and the spring 72 combine to define a locking means, designated generally as 100. In assembled position the handle 92 extends outwardly of a slot 102 of the main housing 24 as illustrated in FIGURE 2. The slot 102 may be formed as part of a removable plate to facilitate assembly thereof. The handle 92 is shiftable within the slot 102 from the full line view shown adjacent the end of slot 102 marked H corresponding to the hammer-drill operation of power tool 20 to the dotted line re-\nresentation thereof shown adjacent the other end of the slot 102 marked D which corresponds to the drilling op-\neration. To prevent accidental shifting of the handle 92 a detent aperture 92a is formed therein to be engaged by either one of a pair of spring loaded detent balls 103 disposed in the housing adjacent slot 102 either end of slot 102 adjacent the H and D markings as shown in FIGURES 2 and 6.

A radial roller bearing and thrust member 104 is disposed in counterbore 64 with one end abutting shoulder 66 and the other end held in assembled position by a snap ring 106 disposed in an annular lock groove 108. The inner diameter of the thrust member 104 is sufficiently large to permit the three camming sleeves 110 to be disposed into chamber 60 about the hammer spindle 74.

The innermost sleeve is a selector sleeve 112 which has a circular inner diameter that would permit independent, continuous rotation of the cylindrical portion of hammer spindle 74 relative thereto. The inner edge 115 of the selector sleeve 112 will abut the shoulder 62 of the chamber 60. Two axial recesses 114 formed on opposite sides of the sleeve 112 extending from edge 115 to-\nward the other edge 116 which has a plurality of circumferentially spaced teeth 118 defined in the surface 120. The outermost sleeve is a rotating sleeve 122 having an axially slotted inner periphery 124 correspond-\nging to the axially slotted portion 76 of the hammer spindle 74 to permit the sleeve 122 to slide axially onto said spindle portion but be so joined to the spindle by the slabs that the sleeve 122 and the hammer spindle 74 will al-\nways rotate together. The inner edge 126 has a plurality of circumferentially spaced teeth 128 defining a camming surface 130 which teeth are pitched 180° out of phase to the teeth 118 of the selector sleeve 112. A flange 132 is formed on the forward edge of the rotating sleeve 122 and adapted to engage the bearing 104 inwardly of the snap ring 106. The intermediate sleeve is an idler sleeve 133 which has a circular inner diameter which loosely fits about the cylindrical portion of the hammer spindle so as to provide the independent, continuous rotation thereof. Idler sleeve 133 is disposed between selector sleeve 112 and rotating sleeve 122.

The inner edge 116a of the idler sleeve 133 has a plu-\narity of circumferentially spaced teeth 118a to define a camming surface 120a which corresponds to the teeth 118 and surface 120 of selector sleeve 112.

The outer edge 126a of the idler sleeve 133 has a plurality of circumferentially spaced teeth 128a which are included in the opposite direction from that of the teeth 118a, 118, 118b and 118c and mates with the teeth 128 and surface 130 of the rotating sleeve 122. The teeth 118a and 128a have inclined sides which as viewed in FIGURES 3, 5, 9 and 10 slope downwardly and outwardly from each other. Adjoining sides of the teeth 118a and 128a are opposed and ac-\n
25 cessed by a stepped portion lying parallel to spindles axes to complete the assembly of the hammer housing 40 the tool holder 32 is threadedly connected to the forward section of the hammer spindle 74 and drawn up to abut the forward edge of the rotating sleeve 122, causing said sleeve to in turn abut the shoulders 134 formed at the inner end of the axial slab 76. The effect of mounting the tool holder 32 onto the hammer spindle 74 is to join the tool holder 32, the hammer spindle 74 and the rotating sleeve 122 as a single moveable unit capable of combined rotation or force exerted in FIGURES 3 and 4.

The power tool 20 will operate during the drilling op-\neration as illustrated in FIGURES 3, 4 and 5. The tool oper-ator will shift the handle 92 to the end of slot 102 marked D which indicates the drilling setting and is repre-\nented by the dotted line position of the handle 92 in FIGURE 2. Shifting of the handle 92 in this manner turns both selector lever 86 and the selector ring 84 to a posi-\tion, illustrated in FIGURES 3 and 4, which releases the camming action of the selector ring 84 upon lock pin 70 to permit the spring 72 to urge the lock pin 70 and the en-\ncased ball 71 radially outward into the annular recess 96. Thus, the bottom end of pin 70 is completely removed from the chamber 60 and is out of contact with the se-\n
30 lector sleeve 112. Actuation of the trigger 38 results in rotation of the spindle shaft 30 which in turn rotates the hammer spindle 74, the tool holder 32 and the three mated camming sleeves 110. The spring 77 urges the hammer spindle 74 inwardly to dampen end play and also cause the flange 132 of the rotating sleeve 122 to seat on the radial bearing 104. The camming sleeves 110 have been sized so that on the seating of the rotating sleeve 122 upon the bearing 104 with the camming sleeves 110 mated the inner edge 115 of the selector sleeve 112 will abut shoulder 62 of the hammer housing 40. Thus, with the power tool 20 set for drilling the camming sleeves 10 merely rotate along with the hammer spindle 74 with-
out modifying or influencing the rotary movement of said tool.

In order to operate the power tool 20 as a hammer drill the operator merely shifts the handle 92 of the selector lever 96 to the position adjacent the end of slot 102 marked H, represented by the full line illustration of handle 92 in FIGURE 2. Shifting the handle 92 also shifts the selector ring 84 so that the locked pin 70 is forced out of the arcuate recess 96 and the resulting camming action urges the lower end of the lock pin 70 into the chamber 71. The engagement within the recess 114. The ball 71 rolls along the inner periphery of selector ring 84 and prevents binding of the pinhead. In the event that the axial recess 114 of the selector sleeve 112 is out of alignment with the bore 68 the operator can actuate the trigger 38 and exert sideward pressure on the selector sleeve 112 whereby upon the axial recess 114 passing under the lock pin 70 the lower end of the pin 70 will be forced into the axial recess 114 to prevent the selector sleeve from further rotation as is shown in FIGURES 6, 7 and 8. With the selector sleeve 112 in the locked or non-rotatable position the power tool 20 will operate in its functioning as a hammer drill as illustrated in FIGURES 6-10.

The hammer effect will be produced regardless of whether the power tool 20 is rotated clockwise or counter-clockwise. This is made possible by the idler sleeve 133 which selectively rotates with either rotating sleeve 122 or the selector sleeve 112, respectively, while alternately engaging one or the other of said sleeves to produce the desired axial shifting.

Except for the camming sleeves 110 and the axial shifting which their co-action causes, the power tool 20 will operate as it did during the drilling operation.

Assuming the switch 39 to be in a position to cause a counter-clockwise rotation of the power tool 20 then the corresponding axial shifting is illustrated in FIGURES 6 and 9. The direction of rotation causes the teeth 128 and 128a of the rotating sleeve 112 and the idler sleeve 133, respectively, to come into sliding contact and the incline of said teeth forces an outwardly axial shifting of the rotating sleeve 122, the tool holder 32 and the hammer spindle 74. The camming action of the teeth 128 and 128a overcomes the slight force exerted in the opposite direction by the spring 77.

This creates a momentary clearance space between the radial bearing 104 and the flange 132. During the drilling operation when the flange 132 engaged the radial bearing 104, the pin 82 was at the right end of slot 80, now the relative position of the pin 82 will depend upon the degree that the teeth 128 and 128a have separated from each other and at the point of maximum separation as shown in FIGURE 9 the pin 82 will be adjacent the left most end of the slot 80. Regardless of the position of the pin 82 it never is required to take thrust forces. Instead the thrust forces are all passed to the radial bearing 104. The idler sleeve 133, during the counter-clockwise rotation of the spindles, is locked in a non-rotatable position against the non-rotating selector sleeve 112 by the stepped portion of the corresponding teeth 118 and 118a, respectively, engaging each other due to the direction of said inclined sides of said teeth. Accordingly as shown in FIGURES 6 and 9 the selector sleeve 112 and the idler sleeve 133 act as a non-rotatable unit.

During the hammer-drilling operation, continued rotation of the spindles in the counter-clockwise direction results in alignment of the stepped portions of the teeth 128 and 128a, respectively, and the remating thereof to repeat the cycle. The co-action of the selector-idler sleeve unit with the rotating sleeve 122 produces the outward axial shifting, while the spring 77 and the pressure of the operator pushing against the work produces the inward axial shifting.

Changing the position of the switch 39 to cause a clockwise rotation of the power tool 20 will result in the tool operating, as illustrated in FIGURES 8 and 10, to produce a hammer effect. The major difference that the change of direction of rotation dictates is a shift by the idler sleeve 133 which now locks against the rotating sleeve 122 as to act therewith to define a rotating unit. Now, the sliding contact is between teeth 118 and 118a of the selector sleeve 112 and the idler sleeve 133, respectively.

Accordingly there will be a momentary mating of the teeth 118 and 118a, prior to the inclined sides thereof causing the outward axial shifting of the rotating unit, the tool holder 32 and the hammer spindle 74. This camming action overcomes the spring 77 force and also any operator-work pressure.

Thus the idler sleeve 133 may be selectively shifted to form a unit with either the selector sleeve 112 or the rotating sleeve 122, while co-acting with the other of said sleeves to produce the outward axial shifting resulting in the hammering effect.

It will be understood that various changes in the details, materials, arrangements of parts and operating conditions which have been herein described and illustrated in order to explain the nature of the invention may be made by those skilled in the art within the principles and scope of the invention as expressed in the claims.

Having thus set forth the nature of the invention, what is claimed herein:

1. A hammer drill mechanism for a reversible power tool having an axially fixed rotary spindle shaft, said mechanism comprising:
   (a) a hammer housing for the tool,
   (b) the housing having a chamber into which the spindle shaft extends,
   (c) a hammer spindle disposed into the chamber to be connected to the spindle shaft for continuous rotation therewith and limited axial movement relative thereto,
   (d) a plurality of sleeves having a plurality of camming surfaces disposed in the chamber to define a selector unit and a rotating unit the selector unit loosely disposed about the hammer spindle with one end thereof in abutment with the housing to fix the axial position of said end,
   (e) the rotating unit connected to the hammer spindle for rotation therewith,
   (f) the selector unit and the rotating unit each having a camming surface formed on the adjacent edges thereof,
   (g) a tool holder means connected to the free end of the hammer spindle to normally urge the camming surfaces of said unit to mate on the tool holder shifting inwardly an amount equal to the limited axial movement of the hammer spindle at its connection to the shaft spindle, and
   (h) means normally out of engagement with the selector unit to permit free rotation thereof, and adapted to lock the selector unit from rotating with the rotating unit whereby on rotation of the latter the camming surfaces to intertially cause outwardly axial shifting of the rotating unit and tool holder means resulting in a hammering effect during operation of the power tool.

2. The combination claimed in claim 1 wherein:
   (a) the selector unit includes a selector sleeve,
   (b) the rotating unit includes a rotating sleeve,
   (c) one of the plurality of sleeves defines an idler sleeve,
   (d) the idler sleeve selectively shiftable responsive to the direction of rotation to lock against one of said selector or rotating sleeves and co-act with the other of said sleeves to produce said axial shifting.

3. The combination claimed in claim 2 wherein:
   (a) a flange is formed on the rotating sleeve to extend radially outwardly therefrom,
   (b) a bearing is mounted in the housing inwardly of the flange and having radially disposed rollers continuously engaged by said flange when the plurality
of sleeves rotate therewith and intermittently engaged by said flange when the selector unit is non-rotatably locked during the hammer drilling of the power tool.

4. The combination claimed in claim 1 wherein:
   (a) the end of the hammer spindle adjacent the spindle shaft has a bore into which the spindle shaft is disposed,
   (b) axial slot means are formed on the hammer spindle in communication with the bore, and
   (c) pinning means are fixedly connected in the spindle shaft to extend into the slot means to permit limited axial movement of the hammer spindle relative to the spindle shaft, and join said spindle for rotation with each other.

5. The combination claimed in claim 2 wherein the locking means comprises:
   (a) a lock pin disposed in the housing in communication with the chamber and normally urged radially outwardly away from the selector sleeve,
   (b) at least one axial recess formed in the selector sleeve to pass under the lock pin on rotation of said sleeve, and
   (c) a selector ring connected to the housing in superposition to the lock pin and adapted to be shifted to effect a camming action that forces the lock pin radially inwardly into engagement in the axial recess of the selector sleeve to lock the selector sleeve from rotating whereby the hammer effect will be produced on operation of the power tool.

6. The combination claimed in claim 5 wherein:
   (a) the selector ring has an arcuate recess in which the lock pin may extend out of contact with the selector sleeve,
   (b) a selector lever is connected to the selector ring and extends outwardly from the housing, and
   (c) the selector lever is adapted to shift the selector ring to remove the lock pin from said recess therein and force it downwardly into the recess of the selector sleeve to lock the same from rotation.

7. The combination claimed in claim 2 wherein:
   (a) the hammer spindle has a forward portion formed cylindrically with at least one axial slab thereon, and
   (b) the rotating sleeve has an internal cylindrical periphery with at least one axial slab thereon to mate with the surface of the forward portion of the hammer spindle to permit axial sliding and combined rotation therebetween.

8. In a power tool for selectively drilling or hammer drilling, the combination of:
   (a) a housing,
   (b) a reversible motor mounted in the housing,
   (c) at least one spindle axially shiftably mounted in the housing,
   (d) a drive means connected between the motor and the spindle to rotate the spindle in a clockwise or counter-clockwise direction,
   (e) a plurality of camming sleeves having interacting camming surfaces disposed about the spindle, and including a selector sleeve, an idler sleeve and a rotating sleeve,
   (f) the selector sleeve at one end of the spindle having a substantially fixed axial position,
   (g) means normally out of engagement with the selector sleeve, and adapted to engage and prevent the rotation of the selector sleeve with the spindle,
   (h) the rotating sleeve at the other end of the spindle, and
   (i) the idler sleeve disposed between the selector sleeve and the rotating sleeve and responsive to the direction of rotation adapted to lock against one or said sleeves and to co-act with the other of said sleeves to cause outward axial shifting of said spindle when the selector sleeve is non-rotatably fixed.

9. The combination claimed in claim 8 wherein:
   (a) the camming surfaces of the interacting camming sleeves formed with oppositely directed inclined teeth so that rotation in one direction causes the teeth to lock together while rotation in the other direction causes the teeth to slide and axially separate from each other.

10. The combination claimed in claim 9 wherein:
   (a) the idler sleeve has inclined teeth formed on the opposite edges thereof extending downwardly and away from each other, and
   (b) the camming sleeves adjacent either side of the idler sleeve have correspondingly inclined teeth as the idler sleeve to permit mating thereof or axial sliding contact therebetween.

References Cited
UNITED STATES PATENTS
1,217,815 2/1917 Payne 173—48 X
1,356,556 10/1920 Payne 173—48 X
3,000,225 9/1961 Taylor 173—48 X
3,123,156 3/1964 Gapstur 173—48 X

NILE C. BYERS, Jr., Primary Examiner.