IN THE UNITED STATES DISTRICT COURT

FOR THE DISTRICT OF SOUTH CAROLINA

COLUMBIA DIVISION

Power Tool Holders Incorporated and Jacobs Chuck Manufacturing Company, Plaintiffs,	)	Civil Action No. 3 03 3614 17
vs.	)	Jury Trial Requested
Makita Corporation of America Defendant.	)	

COMPLAINT

Parties

1. Plaintiff, Power Tool Holders Incorporated, is a corporation of the State of Delaware and maintains a principal place of business at 16 W. Main Street, Christiana, Delaware 19702. Plaintiff, Jacobs Chuck Manufacturing Company, is a corporation of the State of Delaware and maintains a principal place of business at One Jacobs Road, Clemson, South Carolina 29633.

2. Defendant, Makita Corporation of America ("Makita"), is, upon information and belief, a corporation of the State of Georgia and maintains a principal place of business at 2650 Buford Hwy, Buford, Georgia 30518.

Jurisdiction and Venue

3. The action herein alleged arises under the Patent Laws of the United States, 35 U.S.C. §§ 1 *et seq.* and, more particularly, 35 U.S.C. §§271 and 281-287.

4. Subject matter jurisdiction is conferred upon this Court by 28 U.S.C. §§1331 and 1338(a).

5. Personal jurisdiction as to Defendant Makita is invoked under the provisions of South Carolina Code §36-2-803 and 36-2-805.

6. Venue is properly laid under the provisions of 28 U.S.C. §§1391(b) and (c) and 1400(b).

7. This is a suit for infringement by Defendant Makita of United States Patent Nos. 5,330,204, 5,573,254 and 5,816,582 (Exhibit A hereto) and involves drill chucks that are used, imported, offered for sale and/or sold by Defendant Makita.

8. Upon information and belief, Defendant Makita manufactures drills with drill chucks at issue herein in the United States or abroad for importation into the United States, and such chucks are offered for sale and sold by Makita in South Carolina either directly or through intermediaries. Makita places infringing chucks into the stream of commerce with knowledge that the actual or potential ultimate purchasers and users of such chucks are located in South Carolina, as well as elsewhere in the United States. An example of an infringing chuck purchased in Columbia, South Carolina is contained on Makita drill Model 6217DWDE.

Patents-in-Suit

9. United States Patent No. 5,330,204 entitled "Non-Impact Keyless Chuck," was duly and legally issued on July 19, 1994, to Robert O. Huff, Paul T. Jordan, and William F. Forquer as the inventors.

10. Robert O. Huff, Paul T. Jordan, and William F. Forquer have assigned all right, title, and interest in and to U.S. Patent No. 5,330,204 to Jacobs Chuck Technology

Corporation, by change of name Power Tool Holders Incorporated, which is one of the Plaintiffs in this action.

11. Power Tool Holders Incorporated has granted a license to make, use, and sell products under U.S. Patent No. 5,330,204 to Jacobs Chuck Manufacturing Company, which is one of the Plaintiffs in this action.

12. United States Patent No. 5,573,254 entitled "Non-Impact Keyless Chuck," was duly and legally issued on November 12, 1996, to Robert O. Huff, Paul T. Jordan, and William F. Forquer as the inventors.

13. Robert O. Huff, Paul T. Jordan, and William F. Forquer have assigned all right, title, and interest in and to U.S. Patent No. 5,573,254 to Power Tool Holders Incorporated, which is one of the Plaintiffs in this action.

14. Power Tool Holders Incorporated has granted a license to make, use, and sell products under U.S. Patent No. 5,573,254 to Jacobs Chuck Manufacturing Company, which is one of the Plaintiffs in this action.

15. United States Patent No. 5,816,582 entitled "Chuck", was duly and legally issued on October 6, 1998 to Stephen W. Steadings and Christopher B. Barton as the inventors.

16. Stephen W. Steadings and Christopher B. Barton have assigned all right, title, and interest in and to U.S. Patent No. 5,816,582 to Power Tool Holders Incorporated, which is one of the Plaintiffs in this action.

17. Power Tool Holders Incorporated has granted a license to make, use, and sell products under U.S. Patent No. 5,816,582 to Jacobs Chuck Manufacturing Company, which is one of the Plaintiffs in this action.

Count - Patent Infringement

18. The allegations of paragraphs 1-17 are incorporated by reference as if fully set forth herein.

19. Upon information and belief, Defendant Makita has for a time past and continues to infringe and induce the infringement of United States Patent Nos. 5,330,204, 5,573,254 and 5,816,582 by selling or causing to be sold drill chucks embodying the patented inventions to customers in the United States, including customers in Columbia, South Carolina, either directly or through intermediaries.

20. Upon information and belief, the aforementioned acts of infringement of U.S. Patent Nos. 5,330,204, 5,573,254 and 5,816,582 have been and are being willfully and deliberately committed by Defendant Makita with full knowledge of Plaintiffs' patent rights.

PRAYER FOR RELIEF

WHEREFORE, Plaintiffs pray for entry of judgment:

(a) Holding that Defendant Makita has infringed and induced the infringement of U.S. Patent No. 5,330,204, 5,573,254 and 5,816,582;

(b) Preliminarily and permanently enjoining Defendant Makita, its officers, agents, employees, representatives, and all others acting in concert therewith, from further infringing or inducing infringement of U.S. Patent No. 5,330,204, 5,573,254 and 5,816,582;

(c) Awarding Plaintiffs damages adequate to compensate for such infringement and increasing such damages three (3) times by reason of the willful and deliberate nature of such infringement, together with interest and costs;

(d) Awarding Plaintiffs their reasonable attorneys' fees; and

(e) Affording such further and other relief as this Court may deem just and proper.

NELSON MULLINS RILEY & SCARBOROUGH, L.L.P.

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Columbia, South Carolina 11/13,2003

PLAINTIFFS DEMAND A JURY TRIAL

EXHIBIT A

US005330204A

United States Patent [19]

Huff et al.

[11] Patent Number: 5,330,204

[45] Date of Patent: * Jul. 19, 1994

[54] NON-IMPACT KEYLESS CHUCK

[75] Inventors: Robert O. Huff, Piedmont; Paul T. Jordan, Seneca; William F. Forquer, West Union, all of S.C.

[73] Assignee: Jacobs Chuck Technology Corporation, Wilmington, Del.

[*] Notice: The portion of the term of this patent subsequent to Jun. 30, 2009 has been disclaimed.

[21] Appl. No.: 99,160

[22] Filed: Jul. 29, 1993

Related U.S. Application Data

[60] Continuation of Ser. No. 884,205, May 18, 1992, Pat. No. 5,253,879, which is a division of Ser. No. 449,722, Dec. 11, 1989, Pat. No. 5,125,673.

[51] Int. Cl.[5] B23B 31/10

[52] U.S. Cl. 279/62; 279/902

[58] Field of Search 279/60-65, 279/902

[56] References Cited

U.S. PATENT DOCUMENTS

897,335	9/1908	Almond .	
911,012	1/1909	Jacobs .	
1,123,541	1/1915	Jacobs .	
1,526,328	2/1925	Englund .	
2,292,470	8/1942	Ostberg	279/60
2,684,856	7/1954	Stoner	279/61
3,589,486	6/1971	Kelch	192/46
3,813,827	6/1974	Bloch	51/219 R
3,927,892	12/1975	Pradota	279/62
4,252,333	2/1981	Vogel	279/72
4,275,893	6/1981	Bilanceri	279/64
4,305,597	12/1981	McCarty	279/22
4,423,881	1/1984	Whitehead	279/62
4,460,296	7/1984	Sivertson	408/124
4,575,108	3/1986	Whitehead	279/59
4,648,608	3/1987	Smith	279/1 K
4,660,841	4/1987	Chouinard	279/61
4,664,394	5/1987	Theissig et al.	279/1 ME
4,682,918	7/1987	Palm	408/241 R
4,695,065	9/1987	Komatsu et al.	279/60
4,702,122	10/1987	Richard	74/412 TA
4,817,971	4/1989	Flynn	279/1 K
4,840,387	6/1989	McCarthy	279/1 K
4,842,288	6/1989	Ando	279/62
4,951,955	8/1990	Sakamaki	279/62
5,125,673	6/1992	Huff et al.	279/60

FOREIGN PATENT DOCUMENTS

3439668	4/1986	Fed. Rep. of Germany .
63-216604	9/1988	Japan .
661643	11/1951	United Kingdom .
89/03267	4/1989	World Int. Prop. O. .

OTHER PUBLICATIONS

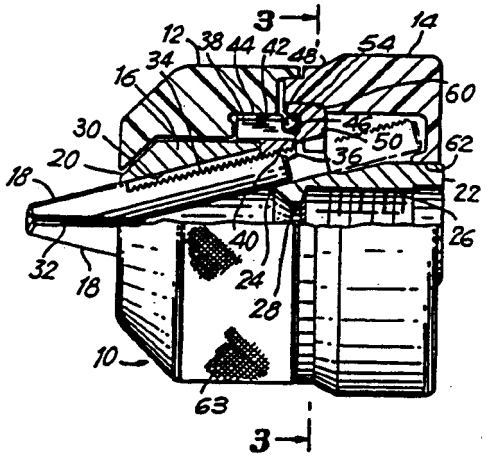
Bosch Catalog No. 890,021, Sep. 1990, pp. 15 and 17.
Yukiwa "Products" brochure.

Primary Examiner—Steven C. Bishop
Attorney, Agent, or Firm—Robert R. Jackson; G. Victor Treyz

[57] ABSTRACT

A non-impact keyless chuck suitable for use with manual or powered drivers is disclosed. The chuck comprises a body which carries a rotatable split nut having a relatively fine thread and a plurality of slidable jaws, which may be identical, driven by the rotatable nut. An anti-friction bearing is disposed between the rotatable nut and a bearing thrust ring mounted on the body. A clutch or torque limiting mechanism is provided to limit the tightening torque to a predetermined value while the loosening torque may be limited or unlimited. The front sleeve, and rear sleeve, if used, may be formed from a structural plastic to reduce manufacturing costs. A relatively soft elastomeric grip boot may be placed on the front sleeve to improve the grip and temporarily restrain and center the tool during chuck tightening or loosening operations. A relatively soft elastomeric grip boot may also be placed on the rear sleeve, if used.

30 Claims, 5 Drawing Sheets



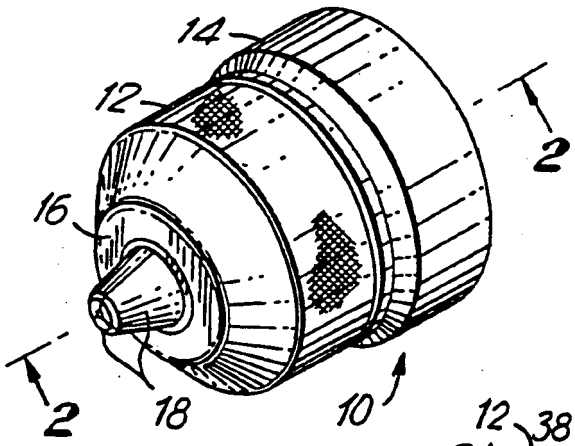


FIG. 1

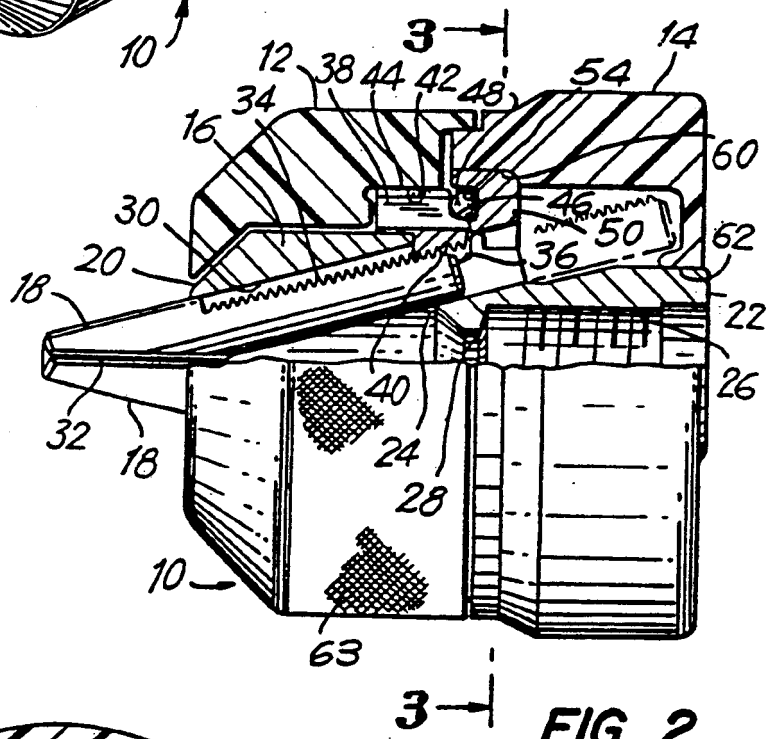
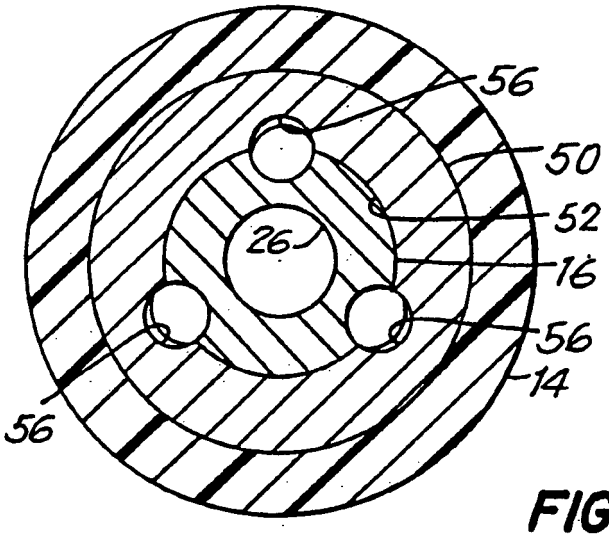


FIG. 2



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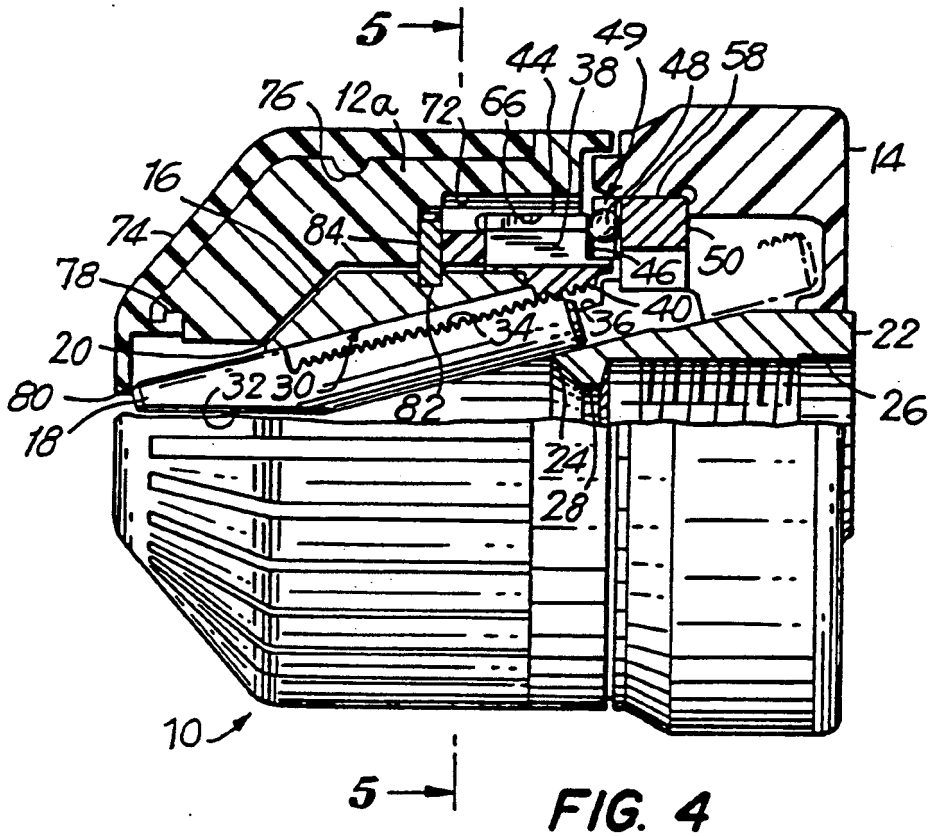
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FIG. 4

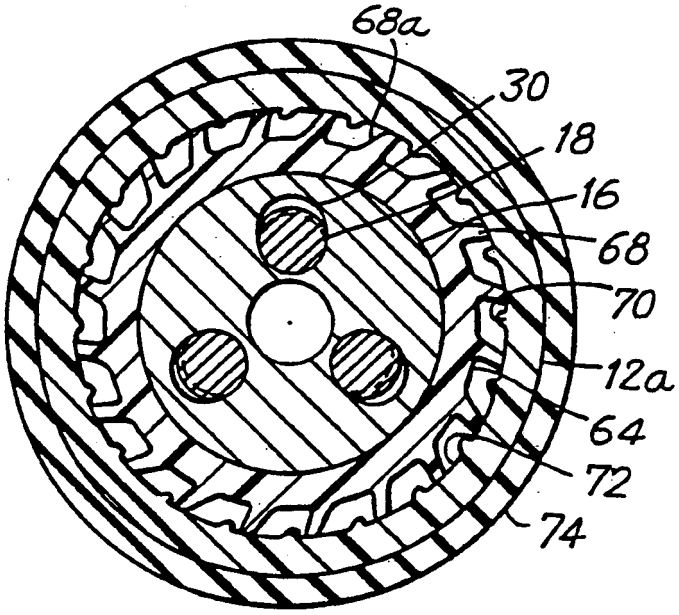
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FIG. 5

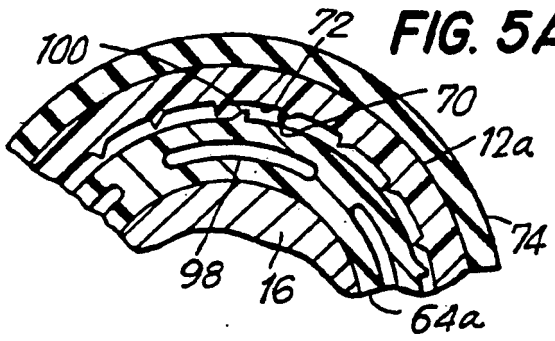


FIG. 5A

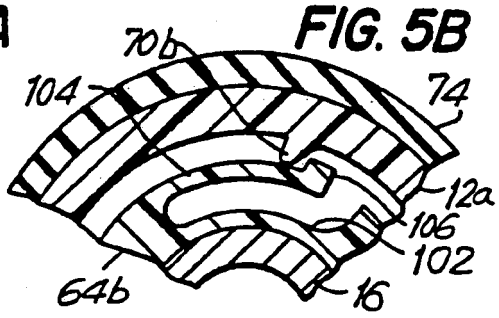


FIG. 5B

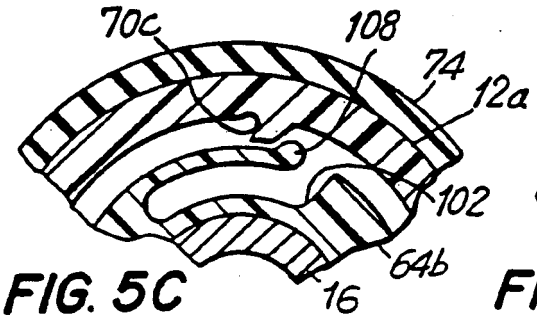


FIG. 5C

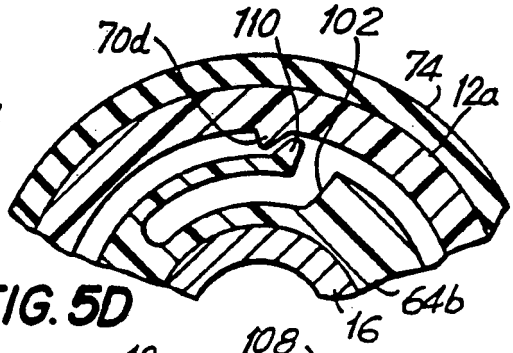


FIG. 5D

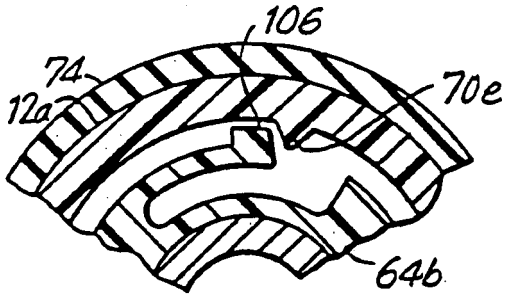


FIG. 5E

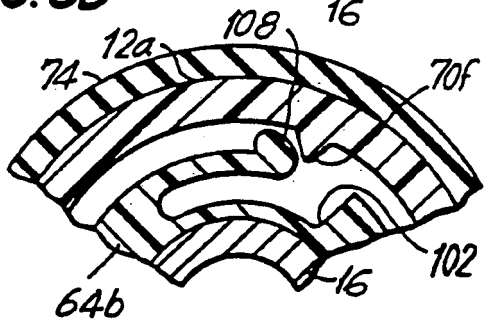


FIG. 5F

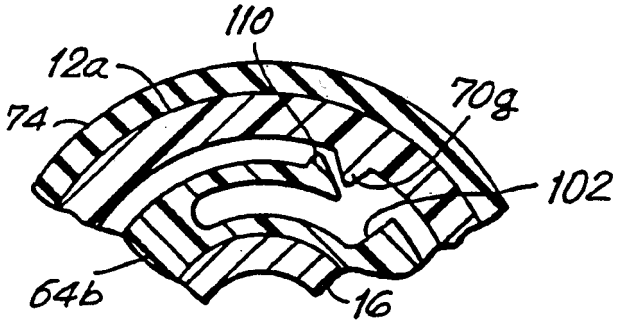


FIG. 5G

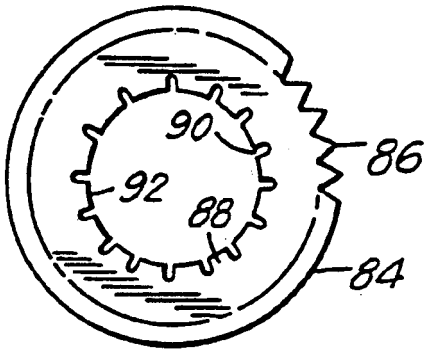


FIG. 6A

FIG. 6B

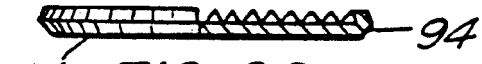


FIG. 6C

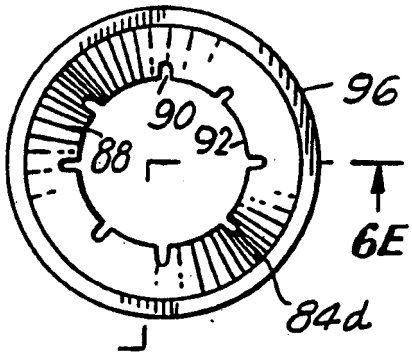


FIG. 6D

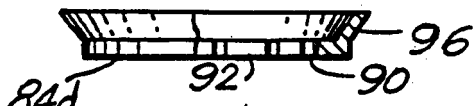
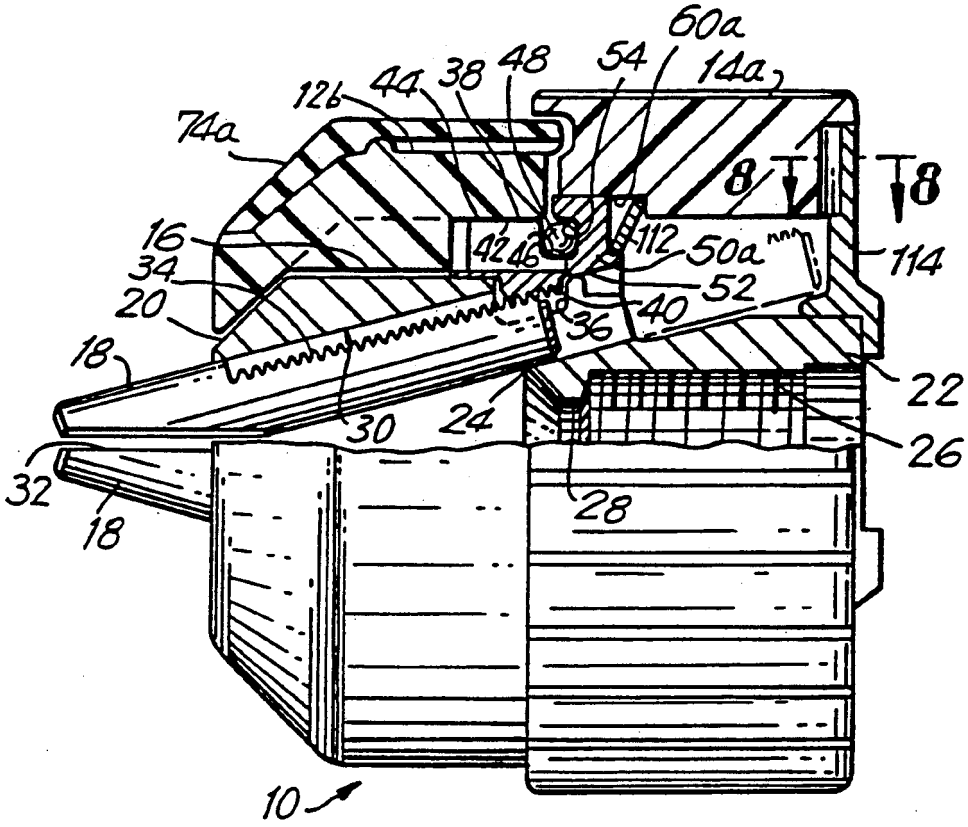


FIG. 6E

FIG. 7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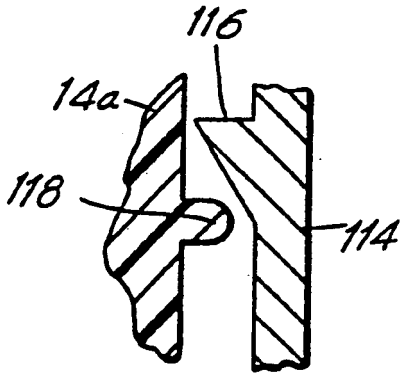
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FIG. 8

NON-IMPACT KEYLESS CHUCK

This is a division of application Ser. No. 07/884,205, filed May 18, 1992, now U.S. Pat. No. 5,253,879, entitled NON-IMPACT KEYLESS CHUCK, which was a division of application Ser. No. 07/449,722, filed Dec. 11, 1989, now U.S. Pat. No. 5,125,673.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to drill chucks for use with hand drills or with electric or pneumatic power drivers. More particularly, it relates to a chuck of the keyless type which may be tightened or loosened by hand or by actuation of the driver motor.

2. Prior Art

Both hand and electric or pneumatic tool drivers are well known. Although twist drills are the most common tools used with such drivers, the tools may also comprise screw drivers, nut drivers, burrs, mounted grinding stones and other cutting or abrading tools. Since the tools may have shanks of varying diameter or the cross-section of the tool shank may be polygonal, the device is usually provided with a chuck which is adjustable over a relatively wide range. The chuck may be attached to the driver by a threaded or tapered bore.

A wide variety of chucks has been developed by the art. In the simplest form of chuck, three jaws spaced circumferentially 120° apart from each other are constrained by a conical body threaded onto the drive shaft so that rotation of the body in one direction relative to the drive shaft forces the jaws into gripping relationship with respect to the cylindrical shank of a tool while rotation in the opposite direction releases the gripping relationship. Such a chuck may be keyless if the body is rotated by hand. However, because the tightening or loosening torque which may be applied directly in a hand operation is limited, the art developed the so-called three-jaw geared chuck. This design overcomes the principal problems in the earlier design by providing guideways in the chuck body to control more accurately the motion of the jaws and teeth on the jaws which mesh with a gear driven nut mounted on the chuck body. The gear is actuated by a pinion formed on a separate key which may be rotated in a bearing hole formed in the chuck body.

The three-jaw geared chuck is, or can be, a high quality precision tool which can exert a relatively large gripping force on the tool. However, the separate key may easily be misplaced or accidentally left in the chuck when the driver is actuated, thus possibly leading to some personal injury. In addition, the chucking or unchucking operation is a two-handed procedure which is time consuming.

To overcome these perceived disadvantages of the key operated gear chuck, various keyless chucks have now been developed. Such keyless chucks fall broadly into two classes: impact and non-impact chucks. Impact chucks employ means to apply a series of impacts to the nut so as to tighten or loosen the jaws. In the non-impact design, manual or mechanical means are used to restrain one member of the chuck while a torque is applied to another member of the chuck either manually or by the power driver to move the nut relative to the jaws. A keyless chuck of the impact type is disclosed in McCarthy U.S. Pat. No. 4,840,387 while the prior art

cited therein illustrates keyless chucks both of the impact and the non-impact variety.

SUMMARY OF THE INVENTION

In accordance with the present invention, a keyless chuck of the non-impact type is provided. The invention employs an anti-friction bearing interposed between the nut and the body to decrease the friction losses in the mechanism so as to increase the effective tightening torque. The bearing thrust ring is formed separately from the body member and pressed thereon so as to increase the effective diameter of the body while minimizing the machining requirements. The principal load-bearing parts of the chuck, i.e., the jaws, body, nut, bearing and bearing race are formed from metal while the front and back sleeves and related parts may be formed from plastic materials so as to reduce the cost and permit customizing of the chuck. Additional features of the invention include an elastomeric grip boot for the front sleeve which also functions as a bit holder and centering device, a one-way torque limiting clutch for limiting the tightening torque while permitting positive loosening torque, and a torque-limiting clutch which provides greater loosening torque than tightening torque. In accordance with a process feature of the invention, the three jaws are identical with respect to their nut engaging threads and the eccentricity of their engagement is overcome by a grinding procedure following assembly of the chuck.

DESCRIPTION OF THE DRAWINGS

Further objects and advantages of the invention will become apparent from the following detailed description and the accompanying drawings in which:

FIG. 1 is a perspective view of a keyless chuck in accordance with the present invention,

FIG. 2 is an enlarged longitudinal view, partly in section taken along line 2—2 of FIG. 1,

FIG. 3 is a transverse cross-sectional view taken along line 3—3 of FIG. 2,

FIG. 4 is an enlarged longitudinal view, partly in section, of an alternative form of the invention including a torque limiting mechanism and a bit retaining and centering device,

FIG. 5 is a transverse cross-sectional view taken along 5—5 of FIG. 4 and showing the torque limiting mechanism.

FIG. 5A–5G are fragmentary cross-sectional views showing alternative forms of the torque limiting mechanism,

FIG. 6A is a plan view of a toothed retainer disc shown in FIG. 4,

FIG. 6B is an edge view, of the retainer disc shown in FIG. 6A,

FIG. 6C is an edge view, partly in section, of an alternative form of the retainer disc having a beveled rim,

FIG. 6D is a plan view of a toothless retainer disc having a beveled rim,

FIG. 6E is an edge view, partly in section, of the retainer disc shown in FIG. 6D,

FIG. 7 is an enlarged longitudinal view, partly in section, of a further alternative form of the invention which is particularly adapted for manual operation,

FIG. 8 is a fragmentary view taken along line 8—8 of FIG. 7 and showing the clutch mechanism.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to FIG. 1, there is illustrated a chuck 10 in accordance with the present invention. The chuck 10 includes a front sleeve member 12, an optional rear sleeve member 14, a body member 16 and jaws 18.

As shown more clearly in FIG. 2, the body member 16 is generally cylindrical in shape and comprises a nose or forward section 20 and a tail or rearward section 22. The nose section 20 is, preferably, chamfered at its outer end. An axial bore 24 is formed in the nose section 20 of the body member 16. Axial bore 24 is somewhat larger than the largest tool shank which the chuck is designed to accommodate. A threaded bore 26 is formed in the tail section 22 of the body 16 and is of a standard size to mate with the threaded drive shaft of a powered or hand driver (not shown). The bores 24, 26 may communicate at the central region 28 of the body member 16. If desired, the threaded bore 26 may be replaced by a tapered, unthreaded bore of a standard size to mate with a tapered drive shaft.

Passageways 30 are formed in the body member 16 to accommodate each jaw 18. Preferably, three jaws 18 are employed and each jaw 18 is separated from the adjacent jaw by an arc of 120°. The axes of the passageways 30 and the jaws 18 are angled with respect to the chuck axis but intersect the chuck axis at a common point ahead of the chuck body 16. Each jaw 18 has a tool engaging face 32 which is generally parallel to the axis of the chuck body 16 and threads 34 on its opposite or outer surface. In accordance with a feature of the present invention, the threads 34 have a relatively fine pitch, i.e., a pitch greater than 20 threads per inch, e.g., 32 threads per inch, and the threads, preferably, are of the buttress type though other thread forms may be employed. By employing the buttress thread form the tightening force applied to the jaw threads 34 is substantially axial to the jaw 18 so as to maximize the conversion of the tightening torque applied to the chuck into a gripping force applied to the tool shank. The use of a relatively fine pitch thread results in two advantages for the chuck in accordance with the present invention. First, the relatively fine pitch results in a greater mechanical advantage so that a given tightening torque is converted into a larger gripping force. Second, it becomes possible to use interchangeable jaws 18 of identical design rather than slightly different jaws that must be selected and assembled as a set. The small eccentricity which results from the use of identical jaw pieces in accordance with the present invention can be counteracted by a grinding step as more fully described below.

A circumferential groove 36 is formed in the body member 16 and extends into the passageways 30. A split nut 38 having female threads 40 is located in the circumferential groove 36 and secured therein by the front sleeve member 12. The split nut 38 is preferably formed with circumferential serrations or teeth 44 and the outer edges are provided with a small chamfer to facilitate press fitting of the split nut 38 into the bore 42 of the front sleeve 12. Preferably, the front sleeve is formed from a structural plastic such as a polycarbonate, a filled polypropylene, e.g., glass-filled polypropylene, or a blend of structural plastic materials. The serrations or teeth on the split nut 38 assure that the front sleeve 12 will hold the split nut 38 securely without being subjected to an excessive hoop stress.

A circumferential race 46, which may be grooved or a flat surface, is formed on the rear face of split nut 38 to accommodate an anti-friction bearing, for example, ball bearing assembly 48. If desired, the bearing assembly 48 may include a bearing retainer 49 (see FIG. 4) which locates the plurality of balls while permitting them to roll. A bearing thrust ring 50 is provided with a central hole 52 sized to be press fitted on the body member 16. One face of the bearing thrust ring 50 has formed thereon a bearing race 54, which may be grooved or flat, against which the bearing assembly 48 rides. A plurality of jaw guideways 56 are formed around the circumference of the central hole 52 in the thrust ring 50 to permit the retraction of the jaws 18 therethrough. The guideways are shaped to conform with the toothed area of the jaws 18 so as to reduce or prevent toggling of the jaws 18. To perform this function, the axial length of the guideways 56 must be greater than the pitch of the threads 34 on the jaws 18. The outer circumference of the bearing thrust ring 50 may have formed thereon serrations or teeth 58 and the outer edges may be chamfered so as to facilitate pressing of the bearing thrust ring 50 into a bore 60 formed in the rear sleeve member 14. The rear sleeve member 14 also contains a bore 62 adapted to mate with the tail section 22 of the body member 16. If desired, the rear sleeve member 14 may be omitted and the front sleeve member 12 extended to the tail end of the body 16. This alternative is feasible when a spindle lock is provided on the driver or when the driver is used to tighten or loosen the jaws.

The circumferential surface of the front sleeve member 12 may be knurled as suggested at 63 or may be provided with longitudinal ribs or other protrusions to enable the operator to grip it securely. In like manner, the circumferential surface of the rear sleeve member 14, if employed, may be knurled or ribbed, if desired.

It will be appreciated that the rear sleeve member 14 is fixed to the body member 16 while the front sleeve member 12 is fixed to the split nut 38. Thus, relative movement of the front and rear sleeve members 12, 14 will cause the jaws 18 to be advanced or retracted, depending upon the direction of the relative motion. As the bearing 48 is interposed between the relatively moving parts, the frictional losses are minimized and a maximum portion of the applied tightening torque is converted to a tightening force on the tool shank. While the chuck of FIGS. 2 and 3 may be operated manually, it may also be operated by the power driver.

As noted above, the jaws 18 are preferably formed so as to be identical to each other. In three-jaw geared chucks, it is common practice to offset the threads proportional to the thread pitch so that when the jaws contact each other they will meet on the axis of the chuck. By making the jaws identical a degree of eccentricity will result but this is minimized by the fine pitch of the threads. In accordance with the present invention, a grinding procedure may be performed after the chuck is assembled to remove the eccentricity resulting from the small axial displacement of the jaws relative to each other. When the eccentricity is removed, the centering accuracy of the chuck will be the same as if custom sets of jaws had been provided.

Reference is now made to FIGS. 4 and 5 which illustrate an alternative form of the present invention containing a torque limiting mechanism and a bit holding and centering device. Parts which are substantially the same as in the embodiment shown in FIGS. 2 and 3 are

identified by the same designators while modified parts are designated with the additional letter "a."

In the embodiment shown in FIGS. 4 and 5 a torque limiting mechanism is provided which produces an audible "click" when the chuck has attained its maximum tightness. This may be accomplished by providing a toothed annulus 64 having a bore 66 which engages the outside diameter of, or the teeth or serrations 44 on, the split nut 38 so as to lock the split nut 38 in place. A series of flexible teeth 68 are formed on the circumference of the annulus 64 which engage ribs 70 formed on the lateral surface of a bore 72 in the front sleeve member 12*a*. As most clearly shown in FIG. 5 the flexible teeth 68 have a sloping forward edge 68*a* which engages the ribs 70 during tightening of the chuck. When a predetermined tightening torque is reached, the ribs 70 pass over the flexible teeth 68 producing an audible "click." However, when the front sleeve 12*a* is turned so as to loosen the chuck jaws 18, the ribs 70 lock with the teeth 68 to transfer all the applied torque to the split nut 38.

It will be noted that the front sleeve 12*a* extends beyond the nose 20 of the body member 16 to the region where the jaws 18 meet in their fully closed position. A grip boot 74 may be fastened to the front sleeve 12*a* by ribs 76, 78 and prevented from turning relative to the front sleeve 12*a* by longitudinal ribs (not shown). The grip boot 74 is preferably made from an elastomeric material such as natural or synthetic rubber and has a relatively small flexible orifice 80 aligned with the axis of the chuck body member 16. Preferably, the grip boot 74 is made from a relatively soft material having a Shore A hardness of from 40 to 70. The orifice 80 is sized so that it will stretch to grip the shank of a drill or other tool inserted in the chuck and temporarily center and restrain the tool during chucking or unchucking operations.

In the embodiment of the invention shown in FIGS. 2 and 3, the front sleeve 12 is held in place because it is press fitted to the split nut 38. In the embodiment shown in FIGS. 4 and 5 other means are required to locate the front sleeve 12*a*. A circumferential groove 82 is formed in the nose section 20 of the body member 16 to receive a retainer disc 84 which is pressed into the bore 72 of the front sleeve 12*a*. FIG. 6A shows a plan view of the retainer disc 84 having circumferential teeth 86 and flexible engaging tabs 88 formed by a series of slots 90 stamped in the disc 84 around its center hole 92. As shown in FIG. 6B, the retainer disc 84 is flat and relatively thin so as to enable it to be pressed on to the body member 16 and turn freely in the groove 82. The retainer disc 84 is sized so that the teeth 86 firmly grip the bore 72 of the front sleeve member 12*a*. FIG. 6C illustrates an alternative form of a toothed retainer disc 84*c* having a beveled rim 94. FIG. 6D shows a toothless retainer disc 84*d* in plan view. Like the toothed retainer disc 84, the center hole 92 has slots 90 formed around its edge to define flexible engaging tabs 88. FIG. 6E shows the beveled rim 96 which forms a deformable gripping member.

As noted above with reference to FIG. 5, the toothed annulus 64 performs two functions: first, it holds the split nut 38 in place, and, second, it forms one part of the torque limiting mechanism. FIGS. 5A–5G illustrate a number of alternative designs for the toothed annulus 64. In FIG. 5A the annulus 64*a* is formed with a series of axial slots 98 located intermediate its inner and outer surfaces. A tooth 100 is located midway between the ends of each slot 98 which engages with the ribs or teeth 70 formed on the bore 72 of the front sleeve member 12*a*. The slots 98 provide the flexibility required for the tooth action while still maintaining the strength of annulus. In FIGS. 5B–5G further variations are shown in the design of the annulus. In FIG. 5B the annulus 64*b* is provided with a series of open slots 102 which result in a series of pawls 104 having a tooth 106 at the end thereof which engages the teeth 70*b* on the bore 72 of the front sleeve 12*a*. In FIG. 5B the tooth 106 has a square profile so that limited torque is transmitted when the sleeve 12*a* is rotated in a clockwise direction relative to the body 16 as viewed in FIG. 5B but unlimited torque is transmitted with counterclockwise rotation. This difference is due to the asymmetrical shape of the tooth 70*b*. FIG. 5C is similar to FIG. 5B except that the tooth 108 has a round rather than a square shape and the rear face of the tooth 70*c* has correlative shape. FIG. 5D is likewise similar to FIG. 5B except that the tooth 110 has a triangular rather than a square shape and the tooth 70*d* has a correlative asymmetric shape.

FIGS. 5E–5G show modifications of the structures respectively shown in FIGS. 5B–5D. In these modifications the tooth 70*e*, 70*f*, or 70*g* is designed to be substantially symmetrical about a radius of the front sleeve 12*a* so that the tightening torque and the loosening torque are substantially equal. It will be understood that the torque transmitted through the mechanism is principally a function of the angle of the surface of the teeth 70 and 68, 100, 106, 108 or 110, the coefficient of friction between the teeth, the force required to depress or deform the teeth 68, 100, 106, 108 or 110, and the number of teeth in contact. The torque increases as the tooth surface approaches a radius of the front sleeve, as the coefficient of friction increases, as the stiffness of the teeth on the annulus 64 increases, and as the number of teeth in contact increases. By appropriately controlling these variables, the desired tightening and loosening torque may be predetermined.

Reference is now made to FIGS. 7 and 8 which show an embodiment of the present invention which is particularly adapted for manual operation. Again, parts which are substantially the same as in the earlier embodiments bear the same designations while modified parts are designated by "a" or "b." The embodiment of FIG. 7 is characterized by the location of the torque limiting mechanism in the rear sleeve member 14*a*. The basic structure of the body member 16, the jaws 18, and the split nut member 38 upon which the front sleeve member 12*b* is pressed is similar to that shown in FIG. 2 except that a grip boot 74*a* is applied to the surface of the front sleeve member 12*b* to enhance the grippability of the sleeve member. Grip boot 74*a* does not provide the tool holding feature shown in FIG. 4 but it is apparent that this feature could be added, if desired. The arrangement of bearing 48 and bearing thrust ring 50*a* is also similar to that shown in FIGS. 2 and 4 except that no serrations or teeth are formed on the outer periphery of the bearing thrust ring 50*a*. In the embodiment of FIG. 7, the bore 60*a* is sized for a sliding fit with the bearing thrust ring 50*a* and accommodates a Belleville or other form of compression spring 112 which biases the rear sleeve member 14*a* toward a back plate 114 which is press fitted onto the tail section 22 of the body member 16. As shown in FIG. 8, the back plate 114 may be provided with a plurality of teeth 116 and the rear sleeve member 14*a* provided with a plurality of radial ribs 118. It will be appreciated that during a chucking

operation the rear sleeve 14*a* will be held while the front sleeve 12*b* is turned in a clockwise direction as viewed from the jaw end of the chuck. At a predetermined torque, the ribs 118 will ride over the teeth 116 while the rear sleeve 14*a* is displaced in a forward direction against the bias of the spring 112. The teeth 116 on the back plate 114 are designed to produce a limited tightening torque and an unlimited loosening torque. By varying the angle of the teeth faces and the spring rate of the compression spring 112 the tightening and loosening torque may be varied as desired and as explained above. Of course, the teeth 116 and the ribs 118 may be interchanged, if desired, and various shapes of teeth may be employed as suggested in FIGS. 5–5G

The chuck in accordance with the present invention has a number of advantages with respect to the ease and cost of manufacture. The body member 16 may be machined from a relatively small diameter bar since the bearing thrust ring 50 is made separately and then pressed onto the body member. This reduces the machining costs for the body member. Certain parts, such as the split nut and bearing thrust ring may be formed from powdered metal or stamped or otherwise cold formed with limited machining steps. With this design of the load-bearing parts, the more massive front and rear sleeves may be formed from structural plastic materials thereby reducing weight and manufacturing costs while providing the ability to customize the chuck through the use of colors, rib shapes, knurling, or identification logos.

The terms and expressions which have been employed are used as terms of description and not of limitation and there is no intention in the use of such terms and expressions of excluding any equivalents of the features shown and described or portions thereof, but it is recognized that various modifications are possible within the scope of the invention claimed.

What is claimed is:

1. A chuck for use with a manual or powered driver having a rotatable drive shaft comprising a generally cylindrically body having a nose section and a tail section, said tail section having a first axial bore formed therein to mate with said drive shaft of said driver and said nose section having a second axial bore formed therein and a plurality of angularly disposed passageways formed therethrough and intersecting said second axial bore and an exterior surface of said body, a plurality of jaws slidably positioned in each of said angularly disposed passageways, each of said jaws having a jaw face formed on one side thereof and threads formed on the opposite side thereof, a nut rotatably mounted on said body substantially concentric with said body, said nut being in threaded engagement with said threads on said jaws, and a generally cylindrical front sleeve member overlying said nose section of said body and being permanently rotatably and axially fixed on said nut, wherein said nut has substantially axially directed serrations formed around its circumferential surface, said serrations projecting radially out from the remainder of said nut so that when said front sleeve member is pressed on to said nut, said serrations dig into said front sleeve member in order to cause the material of said front sleeve member to interdigitate with said serrations and thereby rotatably fix said front sleeve member on said nut without subjecting said front sleeve member to excessive hoop stress.

2. The chuck defined in claim 1 wherein said front sleeve member is made of a structural plastic material.

3. The chuck defined in claim 2 wherein said structural plastic material comprises polycarbonate.

4. The chuck defined in claim 2 wherein said structural plastic material comprises a filled polypropylene.

5. The chuck defined in claim 2 wherein said structural plastic material comprises glass-filled polypropylene.

6. The chuck defined in claim 1 further comprising a generally cylindrical rear sleeve member overlying said tail section of said body and being permanently rotatably and axially fixed on said body, wherein said tail section of said body has substantially axially directed tail section serrations formed around its circumferential surface, said tail section serrations projecting radially out from the circumferentially adjacent remainder of said tail section so that when said rear sleeve member is pressed on to said tail section, said tail section serrations dig into said rear sleeve member in order to cause the material of said rear sleeve member to interdigitate with said tail section serrations and thereby rotatably fix said rear sleeve member on said tail section without subjecting said rear sleeve member to excessive hoop stress.

7. The chuck defined in claim 6 wherein said rear sleeve member is made of a structural plastic material.

8. The chuck defined in claim 7 wherein said structural plastic material comprises polycarbonate.

9. The chuck defined in claim 7 wherein said structural plastic material comprises a filled polypropylene.

10. The chuck defined in claim 7 wherein said structural plastic material comprises glass-filled polypropylene.

11. A chuck for use with a manual or powered driver having a rotatable drive shaft comprising a generally cylindrically body having a nose section and a tail section, said tail section having a first axial bore formed therein to mate with said drive shaft of said driver and said nose section having a second axial bore formed therein and a plurality of angularly disposed passageways formed therethrough and intersection said second axial bore and an exterior surface of said body, a plurality of jaws slidably positioned in each of said angularly disposed passageways, each of said jaws having a jaw face formed on one side thereof and threads formed on the opposite side thereof, a nut rotatably mounted on said body substantially concentric with said body, said nut being in threaded engagement with said threads on said jaws, and a generally cylindrical front sleeve member overlying said nose section of said body and being permanently rotatably and axially fixed on said nut, wherein said nut has substantially axially directed teeth formed around its circumferential surface, said teeth projecting radially out from the remainder of said nut so that when said front sleeve member is pressed on to said nut, said teeth dig into said front sleeve member in order to cause the material of said front sleeve member to interdigitate with said teeth and thereby rotatably fix said front sleeve member on said nut without subjecting said front sleeve member to excessive hoop stress.

12. The chuck defined in claim 11 wherein said front sleeve member is made of a structural plastic material.

13. The chuck defined in claim 12 wherein said structural plastic material comprises polycarbonate.

14. The chuck defined in claim 12 wherein said structural plastic material comprises a filled polypropylene.

15. The chuck defined in claim 12 wherein said structural plastic material comprises glass-filed polypropylene.

16. The chuck defined in claim 11 further comprising a generally cylindrical rear sleeve member overlying said tail section of said body and being permanently rotatably and axially fixed on said body, wherein said tail section of said body has substantially axially directed tail section teeth formed around its circumferential surface, said tail section teeth projecting radially out from the circumferentially adjacent remainder of said tail section so that when said rear sleeve member is pressed on to said tail section, said tail section teeth dig into said rear sleeve member in order to cause the material of said rear sleeve member to interdigitate with said tail section teeth and thereby rotatably fix said rear sleeve member on said tail section without subjecting said rear sleeve member to excessive hoop stress.

17. The chuck defined in claim 16 wherein said rear sleeve member is made of a structural plastic material.

18. The chuck defined in claim 17 wherein said structural plastic material comprises polycarbonate.

19. The chuck defined in claim 17 wherein said structural plastic material comprises a filled polypropylene.

20. The chuck defined in claim 17 wherein said structural plastic material comprises glass-filled polypropylene.

21. A chuck for use with a manual or powered driver having a rotatable drive shaft comprising a generally cylindrical body having a nose section and a tail section, said tail section having a first axial bore formed therein to mate with said drive shaft of said driver and said nose section having a second axial bore formed therein and a plurality of angularly disposed passageways formed therethrough and intersecting said second axial bore and an exterior surface of said body, a plurality of jaws slidably positioned in each of said angularly disposed passageways, each of said jaws having a jaw face formed on one side thereof and threads formed on the opposite side thereof, a nut rotatably mounted on said body substantially concentric with said body, said nut being in threaded engagement with said threads on said jaws, and a generally clindrical rear sleeve member overlying said tail section of said body and being permanently rotatably and axially fixed on said body, wherein said tail section of said body has substantially axially directed serrations formed around its circumferential surface, said serrations projecting radially out from the circumferentially adjacent remainder of said tail section so that when said rear sleeve member is pressed on to said tail section, said serrations dig into said rear sleeve member in order to cause the material of said rear sleeve member to interdigitate with said serrations and thereby rotatably fix said rear sleeve member on said tail section without subjecting said rear sleeve member to excessive hoop stress.

22. The chuck defined in claim 21 wherein said rear sleeve member is made of a structural plastic material.

23. The chuck defined in claim 22 wherein said structural plastic material comprises polycarbonate.

24. The chuck defined in claim 22 wherein said structural plastic material comprises a filled polypropylene.

25. The chuck defined in claim 22 wherein said structural plastic material comprises glass-filled polypropylene.

26. A chuck for use with a manual or powered driver having a rotatable drive shaft comprising a generally clindrical body having a nose section and a tail section, said tail section having a first axial bore formed therein to mate with said drive shaft of said driver and said nose section having a second axial bore formed therein and a plurality of angularly disposed passageways formed therethrough and intersecting said second axial bore and an exterior surface of said body, a plurality of jaws slidably positioned in each of said angularly disposed passageways, each of said jaws having a jaw face formed on one side thereof and threads formed on the opposite side thereof, a nut rotatably mounted on said body substantially concentric with said body, said nut being in threaded engagement with said threads on said jaws, and a generally cylindrical rear sleeve member overlyings aid tail section of said body and being permanently rotatably and axially fixed on said body, wherein said tail section of said body has substantially axially directed teeth formed around its circumferential surface, said teeth projecting radially out from the circumferentially adjacent remainder of said tail section so that when said rear sleeve member is pressed on to said tail section, said teeth dig into said rear sleeve member in order to cause the material of said rear sleeve member to interdigitate with said teeth and thereby rotatably fix said rear sleeve member on said tail section without subjecting said rear sleeve member to excessive hoop stress.

27. The chuck defined in claim 26 wherein said rear sleeve member is made of a structural plastic material.

28. The chuck defined in claim 27 wherein said structural plastic material comprises polycarbonate.

29. The chuck defined in claim 27 wherein said structural plastic material comprises a filled polypropylene.

30. The chuck defined in claim 27 wherein said structural plastic material comprises glass-filled polypropylene.

* * * * *

US005573254A

United States Patent [19]

Huff et al.

[11] Patent Number: 5,573,254

[45] Date of Patent: Nov. 12, 1996

[54] **NON-IMPACT KEYLESS CHUCK**

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[73] Assignee: **Power Tool Holders Incorporated**, Wilmington, Del.

[21] Appl. No.: **476,896**

[22] Filed: **Jun. 7, 1995**

Related U.S. Application Data

[63] Continuation of Ser. No. 322,356, Oct. 13, 1994, Pat. No. 5,452,906, which is a continuation of Ser. No. 234,227, Apr. 28, 1994, abandoned, which is a continuation of Ser. No. 99,160, Jul. 29, 1993, Pat. No. 5,330,204, which is a continuation of Ser. No. 884,205, May 18, 1992, Pat. No. 5,253,879, which is a division of Ser. No. 449,722, Dec. 11, 1989, Pat. No. 5,125,673.

[51] **Int. Cl.**[6] **B23B 31/10**

[52] **U.S. Cl.** **279/62**; 279/902

[58] **Field of Search** 279/60, 61, 62, 279/902

[56] **References Cited**

U.S. PATENT DOCUMENTS

661,382	11/1900	Noll	279/62
897,335	9/1908	Almond .	
911,012	1/1909	Jacobs .	
1,123,541	1/1915	Jacobs .	
1,526,328	2/1925	Englund .	
2,292,470	8/1942	Ostberg .	
2,684,856	7/1954	Stoner .	
3,589,486	6/1971	Kelch .	
3,813,827	6/1974	Bloch .	
3,927,892	12/1975	Pradota .	
4,170,366	10/1979	Alessio	279/62
4,252,333	2/1981	Vogel .	
4,275,893	6/1981	Bilanceri .	
4,305,597	12/1981	McCarty .	
4,423,881	1/1984	Whitehead .	
4,460,296	7/1984	Sivertson .	
4,575,108	3/1986	Whitehead .	
4,648,608	3/1987	Smith .	
4,660,841	5/1987	Chouinard .	
4,664,394	5/1987	Theissig et al. .	
4,682,918	7/1987	Palm .	
4,695,065	9/1987	Komatsu et al. .	
4,702,122	10/1987	Richard .	
4,817,971	4/1989	Flynn .	
4,840,387	6/1989	McCarthy .	
4,842,288	6/1989	Ando .	
4,951,955	8/1990	Sakamaki .	
5,125,673	6/1992	Huff et al. .	
5,234,223	8/1993	Sakamaki .	
5,253,879	10/1993	Huff et al. .	
5,330,204	7/1994	Huff et al. .	
5,431,420	7/1995	Huff et al.	279/62
5,452,906	9/1995	Huff et al.	279/62

FOREIGN PATENT DOCUMENTS

3439668	4/1986	Germany .	
63-216604	9/1988	Japan .	
27804	1/1989	Japan	279/902
92009	4/1989	Japan	279/62
661643	11/1951	United Kingdom .	
1330065	9/1973	United Kingdom .	
1565048	4/1980	United Kingdom .	
WO8903267	10/1988	WIPO .	

OTHER PUBLICATIONS

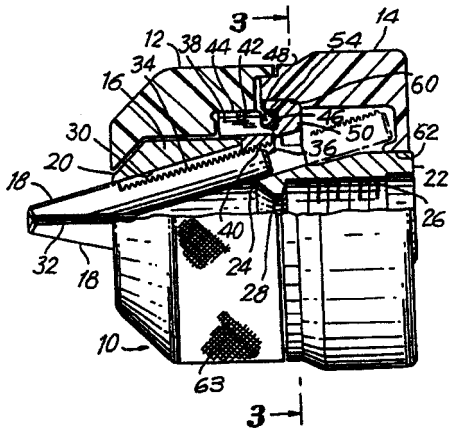
Bosch Catalog No. 890,021; Sep., 1990; pp. 15 and 17.
Yukiwa "Products" brochure.

Primary Examiner—Daniel W. Howell
Attorney, Agent, or Firm—Dority & Manning

[57] **ABSTRACT**

A non-impact keyless chuck suitable for use with manual or powered drivers is disclosed. The chuck comprises a body which carries a rotatable split nut having a relatively fine thread and a plurality of slidable jaws, which may be identical, driven by the rotatable nut. An anti-friction bearing is disposed between the rotatable nut and a bearing thrust ring mounted on the body. A clutch or torque limiting mechanism is provided to limit the tightening torque to a predetermined value while the loosening torque may be limited or unlimited. The front sleeve, and rear sleeve, if used, may be formed from a structural plastic to reduce manufacturing costs. A relatively soft elastomeric grip boot may be placed on the front sleeve to improve the grip and temporarily restrain and center the tool during chuck tightening or loosening operations. A relatively soft elastomeric grip boot may also be placed on the rear sleeve, if used.

32 Claims, 5 Drawing Sheets



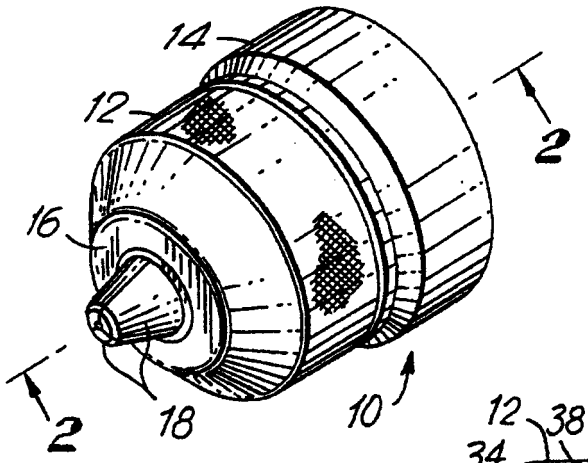


FIG. 1

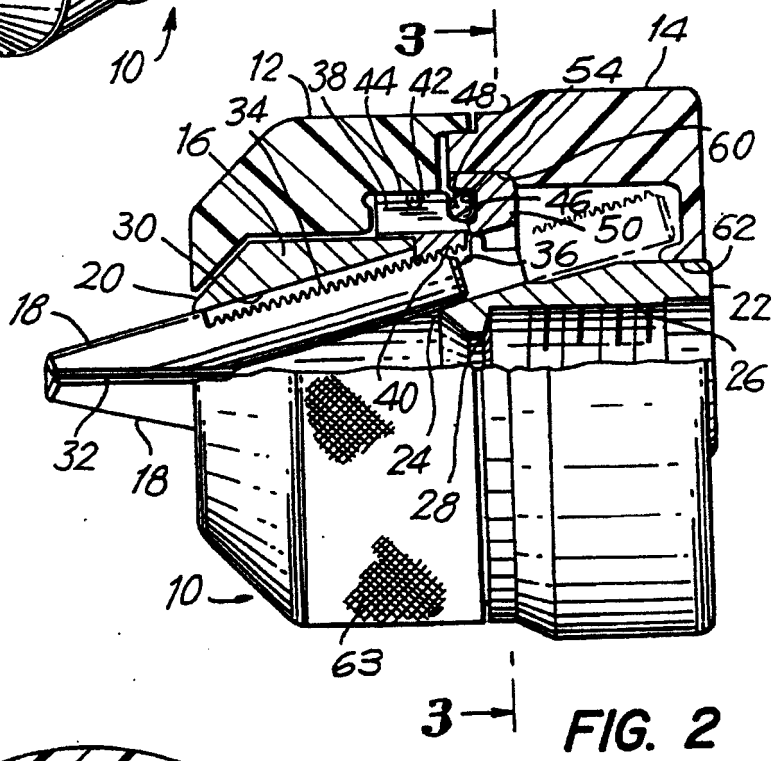


FIG. 2

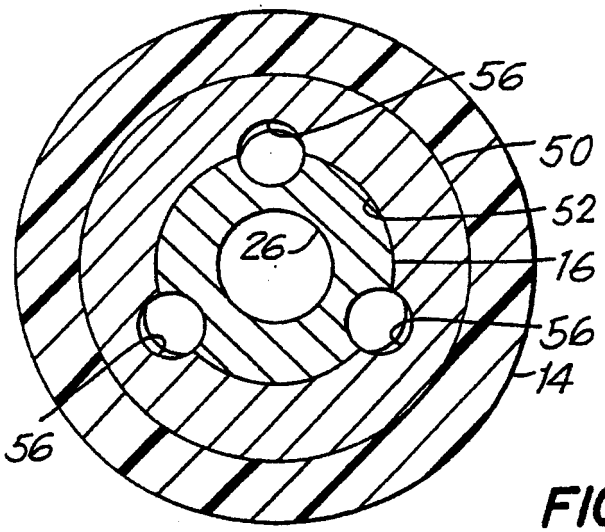


FIG. 3

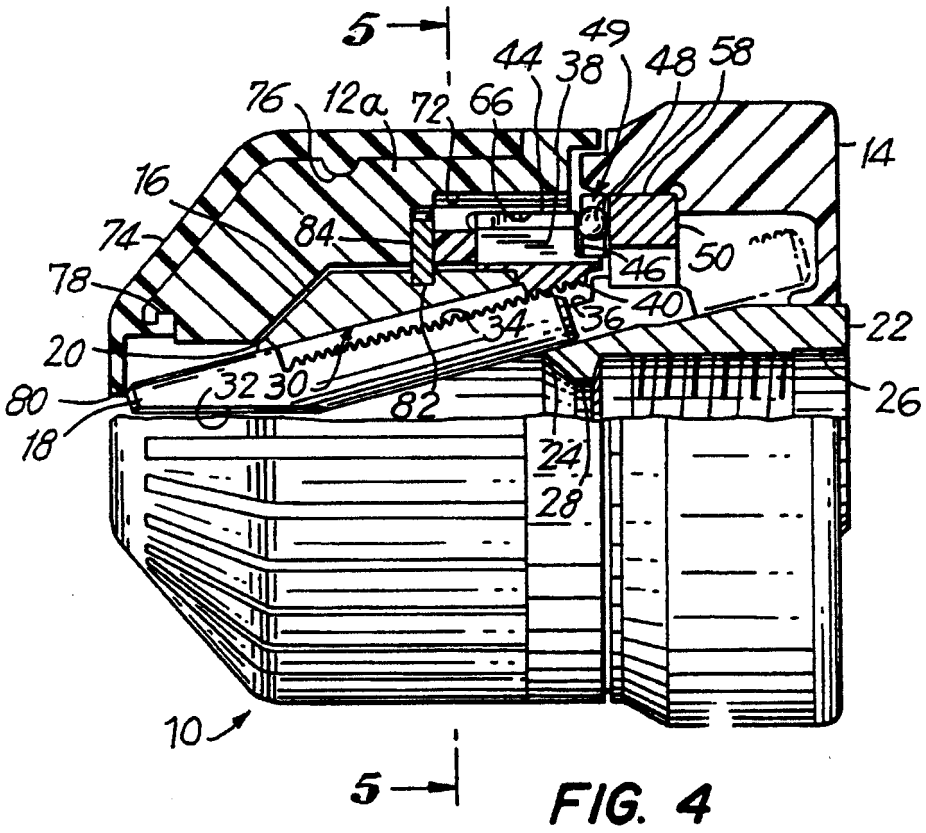

5
49
44
38
48
58
76
12a
72
66
14
16
74
84
46
50
78
34
36
40
22
20
32
30
82
26
80
18
24
28
10
5

FIG. 4

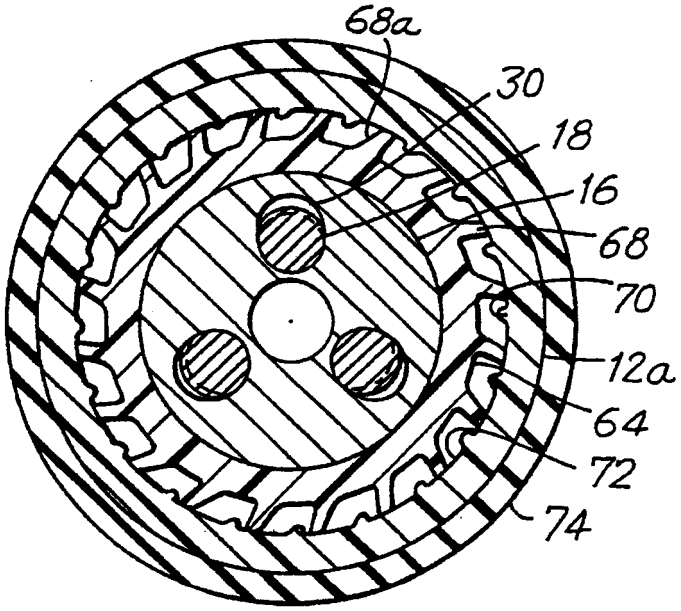

68a
30
18
16
68
70
12a
64
72
74

FIG. 5

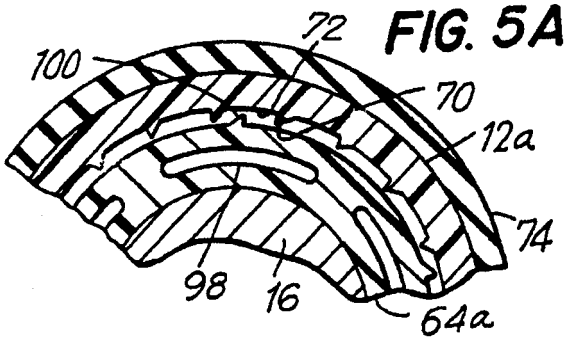


FIG. 5A

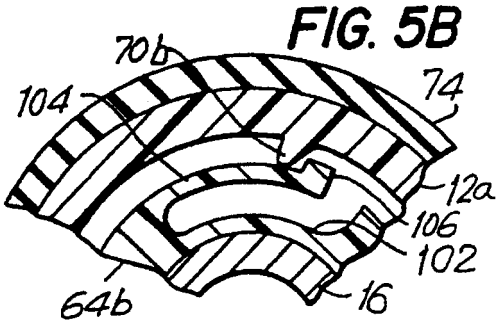


FIG. 5B

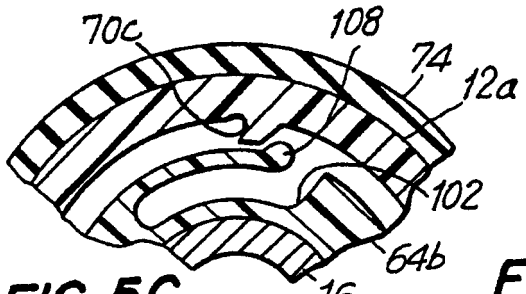


FIG. 5C

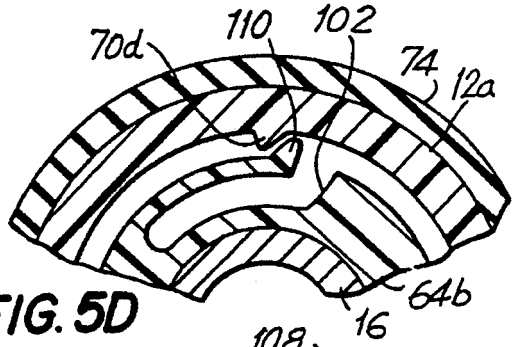


FIG. 5D

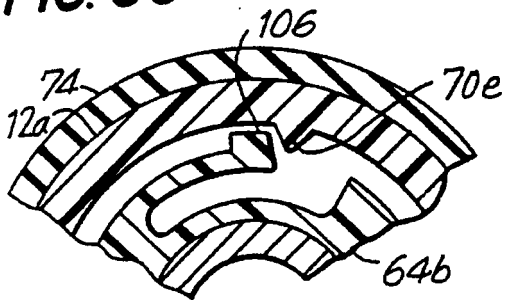


FIG. 5E

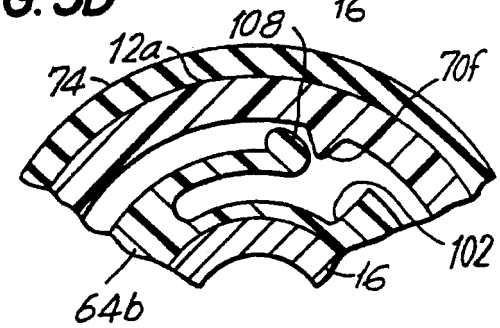


FIG. 5F

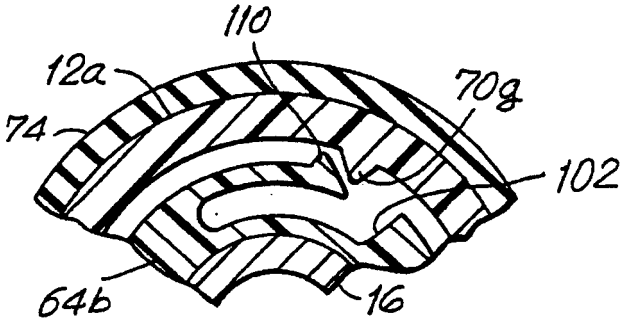


FIG. 5G

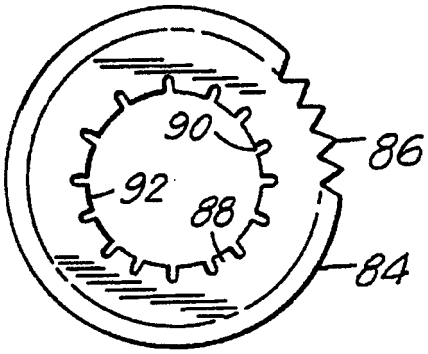


FIG. 6A

FIG. 6B

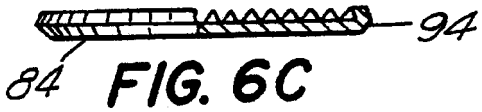


FIG. 6C

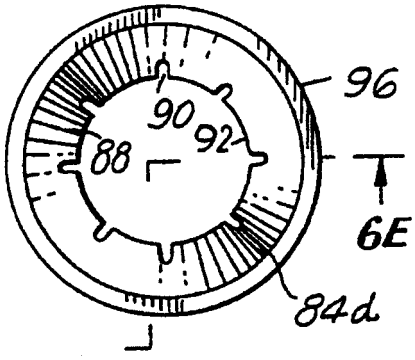


FIG. 6D

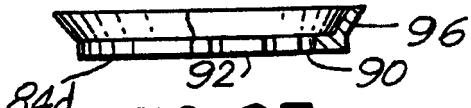
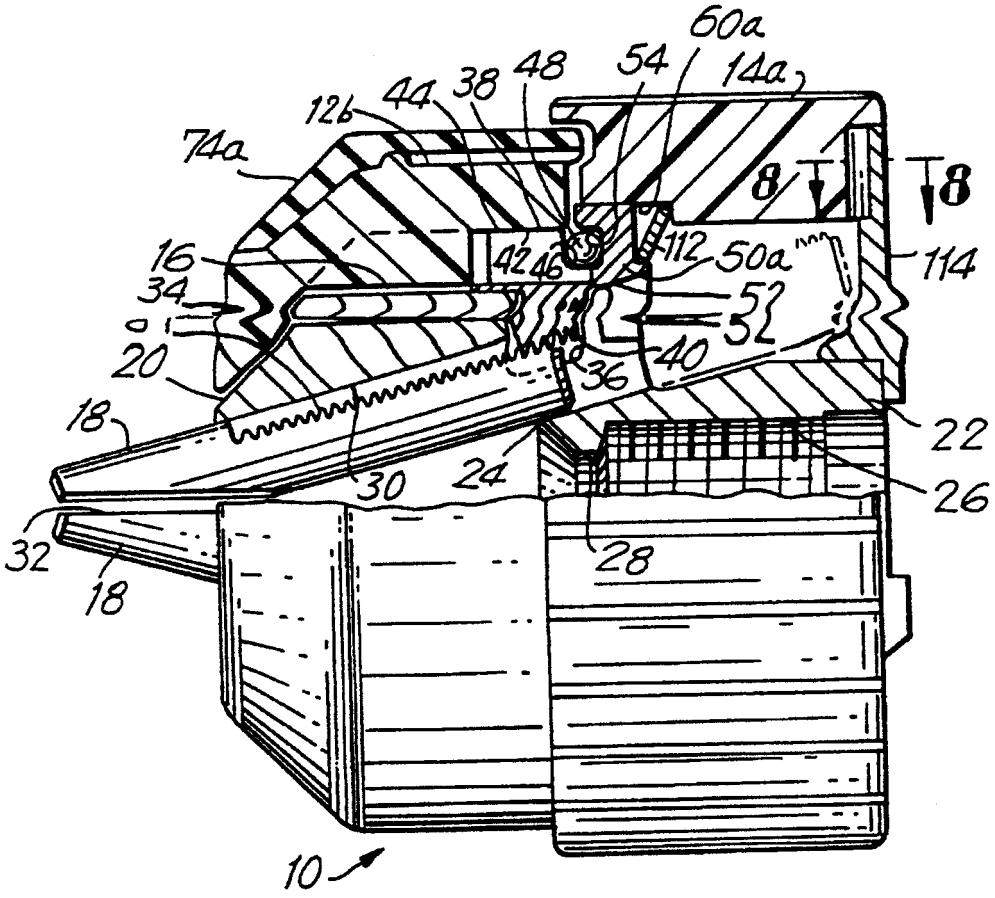


FIG. 6E

FIG. 7


60a
54
14a
48
38
44
126
74a
8
8
16
42
46
112
50a
114
34
52
20
40
36
22
18
30
24
26
32
18
28
10

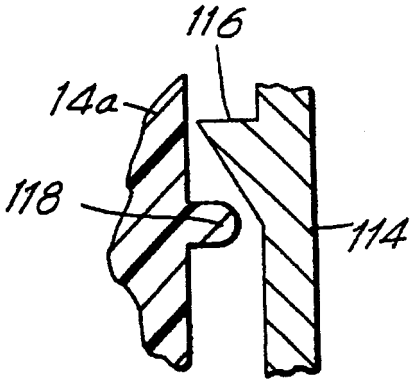

116
14a
118
114

FIG. 8

NON-IMPACT KEYLESS CHUCK

This is a continuation, of application Ser. No. 08/322,356 filed Oct. 13, 1994, now U.S. Pat. No. 5,452,906 which is a continuation of application Ser. No. 08/234,227 filed Apr. 28, 1994, now abandoned which is a continuation of application Ser. No. 08/099,160 filed Jul. 29, 1993, now U.S. Pat. No. 5,330,204, which is a continuation of application Ser. No. 07/884,205 filed May 18, 1992, now U.S. Pat. No. 5,253,879, which is a divisional of application Ser. No. 07/449,722 filed Dec. 11, 1989, now U.S. Pat. No. 5,125,673.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to drill chucks for use with hand drills or with electric or pneumatic power drivers. More particularly, it relates to a chuck of the keyless type which may be tightened or loosened by hand or by actuation of the driver motor.

2. Prior Art

Both hand and electric or pneumatic tool drivers are well known. Although twist drills are the most common tools used with such drivers, the tools may also comprise screw drivers, nut drivers, burrs, mounted grinding stones and other cutting or abrading tools. Since the tools may have shanks of varying diameter or the cross-section of the tool shank may be polygonal, the device is usually provided with a chuck which is adjustable over a relatively wide range. The chuck may be attached to the driver by a threaded or tapered bore.

A wide variety of chucks has been developed by the art. In the simplest form of chuck, three jaws spaced circumferentially 120° apart from each other are constrained by a conical body threaded onto the drive shaft so that rotation of the body in one direction relative to the drive shaft forces the jaws into gripping relationship with respect to the cylindrical shank of a tool while rotation in the opposite direction releases the gripping relationship. Such a chuck may be keyless if the body is rotated by hand. However, because the tightening or loosening torque which may be applied directly in a hand operation is limited, the art developed the so-called three-jaw geared chuck. This design overcomes the principal problems in the earlier design by providing guideways in the chuck body to control more accurately the motion of the jaws and teeth on the jaws which mesh with a gear driven nut mounted on the chuck body. The gear is actuated by a pinion formed on a separate key which may be rotated in a bearing hole formed in the chuck body.

The three-jaw geared chuck is, or can be, a high quality precision tool which can exert a relatively large gripping force on the tool. However, the separate key may easily be misplaced or accidentally left in the chuck when the driver is actuated, thus possibly leading to some personal injury. In addition, the chucking or unchucking operation is a two-handed procedure which is time consuming.

To overcome these perceived disadvantages of the key operated gear chuck, various keyless chucks have now been developed. Such keyless chucks fall broadly into two classes: impact and non-impact chucks. Impact chucks employ means to apply a series of impacts to the nut so as to tighten or loosen the jaws. In the non-impact design, manual or mechanical means are used to restrain one member of the chuck while a torque is applied to another member of the chuck either manually or by the power driver to move the nut relative to the jaws. A keyless chuck of the impact type is disclosed in McCarthy U.S. Pat. No. 4,840,387 while the prior art cited therein illustrates keyless chucks both of the impact and the non-impact variety.

SUMMARY OF THE INVENTION

In accordance with the present invention, a keyless chuck of the non-impact type is provided. The invention employs an anti-friction bearing interposed between the nut and the body to decrease the friction losses in the mechanism so as to increase the effective tightening torque. The bearing thrust ring is formed separately from the body member and pressed thereon so as to increase the effective diameter of the body while minimizing the machining requirements. The principal load-bearing parts of the chuck, i.e., the jaws, body, nut, bearing and bearing race are formed from metal while the front and back sleeves and related parts may be formed from plastic materials so as to reduce the cost and permit customizing of the chuck. Additional features of the invention include an elastomeric grip boot for the front sleeve which also functions as a bit holder and centering device, a one-way torque limiting clutch for limiting the tightening torque while permitting positive loosening torque, and a torque-limiting clutch which provides greater loosening torque than tightening torque. In accordance with a process feature of the invention, the three jaws are identical with respect to their nut engaging threads and the eccentricity of their engagement is overcome by a grinding procedure following assembly of the chuck.

DESCRIPTION OF THE DRAWINGS

Further objects and advantages of the invention will become apparent from the following detailed description and the accompanying drawings in which:

FIG. **1** is a perspective view of a keyless chuck in accordance with the present invention,

FIG. **2** is an enlarged longitudinal view, partly in section taken along line **2—2** of FIG. **1**,

FIG. **3** is a transverse cross-sectional view taken along line **3—3** of FIG. **2**,

FIG. **4** is an enlarged longitudinal view, partly in section, of an alternative form of the invention including a torque limiting mechanism and a bit retaining and centering device,

FIG. **5** is a transverse cross-sectional view taken along **5—5** of FIG. **4** and showing the torque limiting mechanism,

FIGS. **5A–5G** are fragmentary cross-sectional views showing alternative forms of the torque limiting mechanism,

FIG. **6A** is a plan view of a toothed retainer disc shown in FIG. **4**,

FIG. **6B** is an edge view, of the retainer disc shown in FIG. **6A**,

FIG. **6C** is an edge view, partly in section, of an alternative form of the retainer disc having a beveled rim,

FIG. **6D** is a plan view of a toothless retainer disc having a beveled rim,

FIG. **6E** is an edge view, partly in section, of the retainer disc shown in FIG. **6D**,

FIG. **7** is an enlarged longitudinal view, partly in section, of a further alternative form of the invention which is particularly adapted for manual operation,

FIG. **8** is a fragmentary view taken along line **8—8** of FIG. **7** and showing the clutch mechanism.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to FIG. **1**, there is illustrated a chuck **10** in accordance with the present invention. The chuck **10** includes a front sleeve member **12**, an optional rear sleeve member **14**, a body member **16** and jaws **18**.

As shown more clearly in FIG. **2**, the body member **16** is generally cylindrical in shape and comprises a nose or forward section **20** and a tail or rearward section **22**. The nose section **20** is, preferably, chamfered at its outer end. An axial bore **24** is formed in the nose section **20** of the body member **16**. Axial bore **24** is somewhat larger than the largest tool shank which the chuck is designed to accommodate. A threaded bore **26** is formed in the tail section **22** of the body **16** and is of a standard size to mate with the threaded drive shaft of a powered or hand driver (not shown). The bores **24**, **26** may communicate at the central region **28** of the body member **16**. If desired, the threaded bore **26** may be replaced by a tapered, unthreaded bore of a standard size to mate with a tapered drive shaft.

Passageways **30** are formed in the body member **16** to accommodate each jaw **18**. Preferably, three jaws **18** are employed and each jaw **18** is separated from the adjacent jaw by an arc of 120° . The axes of the passageways **30** and the jaws **18** are angled with respect to the chuck axis but intersect the chuck axis at a common point ahead of the chuck body **16**. Each jaw **18** has a tool engaging face **32** which is generally parallel to the axis of the chuck body **16** and threads **34** on its opposite or outer surface. In accordance with a feature of the present invention, the threads **34** have a relatively fine pitch, i.e., a pitch greater than **20** threads per inch, e.g., **32** threads per inch, and the threads, preferably, are of the buttress type though other thread forms may be employed. By employing the buttress thread form the tightening force applied to the jaw threads **34** is substantially axial to the jaw **18** so as to maximize the conversion of the tightening torque applied to the chuck into a gripping force applied to the tool shank. The use of a relatively fine pitch thread results in two advantages for the chuck in accordance with the present invention. First, the relatively fine pitch results in a greater mechanical advantage so that a given tightening torque is converted into a larger gripping force. Second, it becomes possible to use interchangeable jaws **18** of identical design rather than slightly different jaws that must be selected and assembled as a set. The small eccentricity which results from the use of identical jaw pieces in accordance with the present invention can be counteracted by a grinding step as more fully described below.

A circumferential groove **36** is formed in the body member **16** and extends into the passageways **30**. A split nut **38** having female threads **40** is located in the circumferential groove **36** and secured therein by the front sleeve member **12**. The split nut **38** is preferably formed with circumferential serrations or teeth **44** and the outer edges are provided with a small chamfer to facilitate press fitting of the split nut **38** into the bore **42** of the front sleeve **12**. Preferably, the front sleeve is formed from a structural plastic such as a polycarbonate, a filled polypropylene, e.g., glass-filled polypropylene, or a blend of structural plastic materials. The serrations or teeth on the split nut **38** assure that the front sleeve **12** will hold the split nut **38** securely without being subjected to an excessive hoop stress.

A circumferential race **46**, which may be grooved or a flat surface, is formed on the rear face of split nut **38** to accommodate an anti-friction bearing, for example, ball

bearing assembly **48**. If desired, the bearing assembly **48** may include a bearing retainer **49** (see FIG. **4**) which locates the plurality of balls while permitting them to roll. A bearing thrust ring **50** is provided with a central hole **52** sized to be press fitted on the body member **16**. One face of the bearing thrust ring **50** has formed thereon a bearing race **54**, which may be grooved or flat, against which the bearing assembly **48** rides. A plurality of jaw guideways **56** are formed around the circumference of the central hole **52** in the thrust ring **50** to permit the retraction of the jaws **18** therethrough. The guideways are shaped to conform with the toothed area of the jaws **18** so as to reduce or prevent toggling of the jaws **18**. To perform this function, the axial length of the guideways **56** must be greater than the pitch of the threads **34** on the jaws **18**. The outer circumference of the bearing thrust ring **50** may have formed thereon serrations or teeth **58** and the outer edges may be chamfered so as to facilitate pressing of the bearing thrust ring **50** into a bore **60** formed in the rear sleeve member **14**. The rear sleeve member **14** also contains a bore **62** adapted to mate with the tail section **22** of the body member **16**. If desired, the rear sleeve member **14** may be omitted and the front sleeve member **12** extended to the tail end of the body **16**. This alternative is feasible when a spindle lock is provided on the driver or when the driver is used to tighten or loosen the laws.

The circumferential surface of the front sleeve member **12** may be knurled as suggested at **63** or may be provided with longitudinal ribs or other protrusions to enable the operator to grip it securely. In like manner, the circumferential surface of the rear sleeve member **14**, if employed, may be knurled or ribbed, if desired.

It will be appreciated that the rear sleeve member **14** is fixed to the body member **16** while the front sleeve member **12** is fixed to the split nut **38**. Thus, relative movement of the front and rear sleeve members **12**, **14** will cause the jaws **18** to be advanced or retracted, depending upon the direction of the relative motion. As the bearing **48** is interposed between the relatively moving parts, the frictional losses are minimized and a maximum portion of the applied tightening torque is converted to a tightening force on the tool shank. While the chuck of FIGS. **2** and **3** may be operated manually, it may also be operated by the power driver.

As noted above, the jaws **18** are preferably formed so as to be identical to each other. In threejaw geared chucks, it is common practice to offset the threads proportional to the thread pitch so that when the jaws contact each other they will meet on the axis of the chuck. By making the jaws identical a degree of eccentricity will result but this is minimized by the fine pitch of the threads. In accordance with the present invention, a grinding procedure may be performed after the chuck is assembled to remove the eccentricity resulting from the small axial displacement of the jaws relative to each other. When the eccentricity is removed, the centering accuracy of the chuck will be the same as if custom sets of jaws had been provided.

Reference is now made to FIGS. **4** and **5** which illustrate an alternative form of the present invention containing a torque limiting mechanism and a bit holding and centering device. Parts which are substantially the same as in the embodiment shown in FIGS. **2** and **3** are identified by the same designators while modified parts are designated with the additional letter "a."

In the embodiment shown in FIGS. **4** and **5** a torque limiting mechanism is provided which produces an audible "click" when the chuck has attained its maximum tightness. This may be accomplished by providing a toothed annulus

64 having a bore 66 which engages the outside diameter of, or the teeth or serrations 44 on, the split nut 38 so as to lock the split nut 38 in place. A series of flexible teeth 68 are formed on the circumference of the annulus 64 which engage ribs 70 formed on the lateral surface of a bore 72 in the front sleeve member 12*a*. As most clearly shown in FIG. 5 the flexible teeth 68 have a sloping forward edge 68*a* which engages the ribs 70 during tightening of the chuck. When a predetermined tightening torque is reached, the ribs 70 pass over the flexible teeth 68 producing an audible "click." However, when the front sleeve 12*a* is turned so as to loosen the chuck jaws 18, the ribs 70 lock with the teeth 68 to transfer all the applied torque to the split nut 38.

It will be noted that the front sleeve 12*a* extends beyond the nose 20 of the body member 16 to the region where the jaws 18 meet in their fully closed position. A grip boot 74 may be fastened to the front sleeve 12*a* by ribs 76, 78 and prevented from turning relative to the front sleeve 12*a* by longitudinal ribs (not shown). The grip boot 74 is preferably made from an elastomeric material such as natural or synthetic rubber and has a relatively small flexible orifice 80 aligned with the axis of the chuck body member 16. Preferably, the grip boot 74 is made from a relatively soft material having a Shore A hardness of from 40 to 70. The orifice 80 is sized so that it will stretch to grip the shank of a drill or other tool inserted in the chuck and temporarily center and restrain the tool during chucking or unchucking operations.

In the embodiment of the invention shown in FIGS. 2 and 3, the front sleeve 12 is held in place because it is press fitted to the split nut 38. In the embodiment shown in FIGS. 4 and 5 other means are required to locate the front sleeve 12*a*. A circumferential groove 82 is formed in the nose section 20 of the body member 16 to receive a retainer disc 84 which is pressed into the bore 72 of the front sleeve 12*a*. FIG. 6A shows a plan view of the retainer disc 84 having circumferential teeth 86 and flexible engaging tabs 88 formed by a series of slots 90 stamped in the disc 84 around its center hole 92. As shown in FIG. 6B, the retainer disc 84 is flat and relatively thin so as to enable it to be pressed on to the body member 16 and turn freely in the groove 82. The retainer disc 84 is sized so that the teeth 86 firmly grip the bore 72 of the front sleeve member 12*a*. FIG. 6C illustrates an alternative form of a toothed retainer disc 84*c* having a beveled rim 94. FIG. 6D shows a toothless retainer disc 84*d* in plan view. Like the toothed retainer disc 84, the center hole 92 has slots 90 formed around its edge to define flexible engaging tabs 88. FIG. 6E shows the beveled rim 96 which forms a deformable gripping member.

AS noted above with reference to FIG. 5, the toothed annulus 64 performs two functions: first, it holds the split nut 38 in place, and, second, it forms one part of the torque limiting mechanism. FIGS. 5A–5G illustrate a number of alternative designs for the toothed annulus 64. In FIG. 5A the annulus 64*a* is formed with a series of axial slots 98 located intermediate its inner and outer surfaces. A tooth 100 is located midway between the ends of each slot 98 which engages with the ribs or teeth 70 formed on the bore 72 of the front sleeve member 12*a*. The slots 98 provide the flexibility required for the tooth action while still maintaining the strength of annulus. In FIGS. 5B–5G further variations are shown in the design of the annulus. In FIG. 5B the annulus 64*b* is provided with a series of open slots 102 which result in a series of pawls 104 having a tooth 106 at the end thereof which engages the teeth 70*b* on the bore 72 of the front sleeve 12*a*. In FIG. 5B the tooth 106 has a square profile so that limited torque is transmitted when the sleeve 12*a* is rotated in a clockwise direction relative to the body 16 as viewed in FIG. 5B but unlimited torque is transmitted with counterclockwise rotation. This difference is due to the asymmetrical shape of the tooth 70*b*. FIG. 5C is similar to FIG. 5B except that the tooth 108 has a round rather than a square shape and the rear face of the tooth 70*c* has correlative shape. FIG. 5D is likewise similar to FIG. 5B except that the tooth 110 has a triangular rather than a square shape and the tooth 70*d* has a correlative asymmetric shape.

FIGS. 5E–5G show modifications of the structures respectively shown in FIGS. 5B–5D. In these modifications the tooth 70*e*, 70*f*, or 70*g* is designed to be substantially symmetrical about a radius of the front sleeve 12*a* so that the tightening torque and the loosening torque are substantially equal. It will be understood that the torque transmitted through the mechanism is principally a function of the angle of the surface of the teeth 70 and 68, 100, 106, 108 or 110, the coefficient of friction between the teeth, the force required to depress or deform the teeth 68, 100, 106, 108 or 110, and the number of teeth in contact. The torque increases as the tooth surface approaches a radius of the front sleeve, as the coefficient of friction increases, as the stiffness of the teeth on the annulus 64 increases, and as the number of teeth in contact increases. By appropriately controlling these variables, the desired tightening and loosening torque may be predetermined.

Reference is now made to FIGS. 7 and 8 which show an embodiment of the present invention which is particularly adapted for manual operation. Again, parts which are substantially the same as in the earlier embodiments bear the same designations while modified parts are designated by "a" or "b." The embodiment of FIG. 7 is characterized by the location of the torque limiting mechanism in the rear sleeve member 14*a*. The basic structure of the body member 16, the jaws 18, and the split nut member 38 upon which the front sleeve member 12*b* is pressed is similar to that shown in FIG. 2 except that a grip boot 74*a* is applied to the surface of the front sleeve member 12*b* to enhance the grippability of the sleeve member. Grip boot 74*a* does not provide the tool holding feature shown in FIG. 4 but it is apparent that this feature could be added, if desired. The arrangement of bearing 48 and bearing thrust ring 50*a* is also similar to that shown in FIGS. 2 and 4 except that no serrations or teeth are formed on the outer periphery of the bearing thrust ring 50*a*. In the embodiment of FIG. 7, the bore 60*a* is sized for a sliding fit with the bearing thrust ring 50*a* and accommodates a Belleville or other form of compression spring 112 which biases the rear sleeve member 14*a* toward a back plate 114 which is press fitted onto the tail section 22 of the body member 16. As shown in FIG. 8, the back plate 114 may be provided with a plurality of teeth 116 and the rear sleeve member 14*a* provided with a plurality of radial ribs 118. It will be appreciated that during a chucking operation the rear sleeve 14*a* will be held while the front sleeve 12*b* is turned in a clockwise direction as viewed from the jaw end of the chuck. At a predetermined torque, the ribs 118 will ride over the teeth 116 while the rear sleeve 14*a* is displaced in a forward direction against the bias of the spring 112. The teeth 116 on the back plate 114 are designed to produce a limited tightening torque and an unlimited loosening torque. By varying the angle of the teeth faces and the spring rate of the compression spring 112 the tightening and loosening torque may be varied as desired and as explained above. Of course, the teeth 116 and the ribs 118 may be interchanged, if desired, and various shapes of teeth may be employed as suggested in FIGS. 5–5G.

The chuck in accordance with the present invention has a number of advantages with respect to the ease and cost of

manufacture. The body member **16** may be machined from a relatively small diameter bar since the bearing thrust ring **50** is made separately and then pressed onto the body member. This reduces the machining costs for the body member. Certain parts, such as the split nut and bearing thrust ring may be formed from powdered metal or stamped or otherwise cold formed with limited machining steps. With this design of the load-bearing parts, the more massive front and rear sleeves may be formed from structural plastic materials thereby reducing weight and manufacturing costs while providing the ability to customize the chuck through the use of colors, rib shapes, knurling, or identification logos.

The terms and expressions which have been employed are used as terms of description and not of limitation and there is no intention in the use of such terms and expressions of excluding any equivalents of the features shown and described or portions thereof, but it is recognized that various modifications are possible within the scope of the invention claimed.

What is claimed is:

1. A single sleeve hand actuatable chuck for use with a manual or powered driver having a lockable rotatable drive shaft, said chuck comprising:

a generally cylindrical body member, said body member having a forward section and a rearward section, said rearward section having an axial bore formed therein to mate with said lockable drive shaft of said driver and said forward section having an axial bore formed therein and a plurality of angularly disposed passageways formed therethrough and intersecting said axial bore;

a plurality of jaws slidably positioned in each of said angularly disposed passageways, each of said jaws having a jaw face formed on one side thereof and threads formed on the opposite side thereof;

a jaw engaging mechanism rotatably mounted relative said body so as to engage said jaw threads;

a hand actuatable sleeve member received over the forward section of said body and extending toward the rearward section, said sleeve member being in driving engagement with said jaw engaging mechanism, said sleeve member having a forward portion tapered toward the forward section axial bore and substantially cylindrical portion extending rearwardly from said forward section;

and further including a retaining member located on the forward section of said body and retaining said sleeve member to said body.

2. A single sleeve hand actuatable chuck for use with a manual or powered driver having a lockable rotatable drive shaft, said chuck comprising:

a generally cylindrical body member, said body member having a forward section and a rearward section, said rearward section having an axial bore formed therein to mate with said lockable drive shaft of said driver and said forward section having an axial bore formed therein and a plurality of angularly disposed passageways formed therethrough and intersecting said axial bore;

a plurality of laws slidably positioned in each of said angularly disposed passageways, each of said jaws having a jaw face formed on one side thereof and threads formed on the opposite side thereof;

a jaw engaging mechanism rotatably mounted relative said body so as to enqage said jaw threads;

a hand actuatable sleeve member received over the forward section of said body and extending toward the rearward section, said sleeve member being in driving engagement with said jaw engaging mechanism, said sleeve member having a forward portion tapered toward the forward section axial bore and substantially cylindrical portion extending rearwardly from said forward section;

wherein said jaw engaging mechanism includes an annular collar having a threaded inner diameter and an annulus non-rotationally engaged with said annular collar.

3. A single sleeve hand actuatable chuck for use with a manual or powered driver having a lockable rotatable drive shaft, said chuck comprising:

a generally cylindrical body member, said body member having a forward section and a rearward section, said rearward section having an axial bore formed therein to mate with said lockable drive shaft of said driver and said forward section having an axial bore formed therein and a plurality of angularly disposed passageways formed therethrough and intersecting said axial bore;

a plurality of laws slidably positioned in each of said angularly disposed passageways, each of said jaws having a jaw face formed on one side thereof and threads formed on the opposite side thereof;

a jaw engaging mechanism rotatably mounted relative said body so as to engage said jaw threads;

a hand actuatable sleeve member received over the forward section of said body and extending toward the rearward section, said sleeve member being in driving engagement with said jaw engaging mechanism, said sleeve member having a forward portion tapered toward the forward section axial bore and substantially cylindrical portion extending rearwardly from said forward section;

wherein said jaw engaging mechanism includes a split nut.

4. A single sleeve hand actuatable chuck for use with a manual or powered driver having a lockable rotatable drive shaft, said chuck comprising:

a generally cylindrical body member, said body member having a forward section and a rearward section, said rearward section having an axial bore formed therein to mate with said lockable drive shaft of said driver and said forward section having an axial bore formed therein and a plurality of angularly disposed passageways formed therethrough and intersecting said axial bore;

a plurality of jaws slidably positioned in each of said angularly disposed passageways, each of said jaws having a jaw face formed on one side thereof and threads formed on the opposite side thereof;

a jaw engaging mechanism rotatably mounted relative said body so as to engage said jaw threads;

a thrust ring located on said body, said thrust ring being formed separately from said body and extending radially outward therefrom; and

a hand actuatable sleeve member received over at least a portion of said body, said sleeve member being in driving engagement with said jaw engaging mechanism so that when said sleeve member is rotated, said jaws will be actuated;

and further including a retaining member located on the forward section of said body and retaining said sleeve member to said body.

5. A single sleeve hand actuatable chuck for use with a manual or powered driver having a lockable rotatable drive shaft, said chuck comprising:

a generally cylindrical body member, said body member having a forward section and a rearward section, said rearward section having an axial bore formed therein to mate with said lockable drive shaft of said driver and said forward section having an axial bore formed therein and a plurality of angularly disposed passageways formed therethrough and intersecting said axial bore;

a plurality of jaws slidably positioned in each of said angularly disposed passageways, each of said jaws having a jaw face formed on one side thereof and threads formed on the opposite side thereof;

a jaw engaging mechanism rotatably mounted relative said body so as to engage said law threads;

a thrust ring located on said body, said thrust ring being formed separately from said body and extending radially outward therefrom; and

a hand actuatable sleeve member received over at least a portion of said body, said sleeve member being in driving engagement with said jaw engaging mechanism so that when said sleeve member is rotated, said jaws will be actuated;

wherein said jaw engaging mechanism includes an annular collar having a threaded inner diameter and an annulus non-rotationally engaged with said annular collar.

6. A hand actuatable chuck for use with a manual or powered driver having a rotatable drive shaft, said chuck comprising:

a generally cylindrical body member, said body member having a forward section and a rearward section, said rearward section having an axial bore formed therein to mate with said drive shaft of said driver and said forward section having an axial bore formed therein and a plurality of angularly disposed passageways formed therethrough and intersecting said axial bore;

a plurality of jaws slidably positioned in each of said angularly disposed passageways, each of said jaws having a jaw face formed on one side thereof and threads formed on the opposite side thereof;

a jaw engaging mechanism rotatably mounted relative said body so as to engage said law threads;

a hand actuatable sleeve member received over at least a portion of said body, said sleeve member being in driving engagement with said jaw engaging mechanism;

a tightening torque indicator, said tightening torque indicator providing an audible indication when a predetermined tightness of the jaws about the shank of a tool received therein has been reached;

wherein said sleeve member is press fitted on said jaw engaging mechanism.

7. A hand actuatable chuck for use with a manual or powered driver having a rotatable drive shaft, said chuck comprising:

a generally cylindrical body member, said body member having a forward section and a rearward section, said rearward section having an axial bore formed therein to mate with said drive shaft of said driver and said forward section having an axial bore formed therein and a plurality of angularly disposed passageways formed therethrough and intersecting said axial bore;

a plurality of jaws slidably positioned in each of said angularly disposed passageways, each of said jaws having a jaw face formed on one side thereof and threads formed on the opposite side thereof;

a jaw engaging mechanism rotatably mounted relative said body so as to engage said jaw threads;

a hand actuatable sleeve member received over at least a portion of said body, said sleeve member being in driving engagement with said jaw engaging mechanism;

a tightening torque indicator, said tightening torque indicator providing an audible indication when a predetermined tightness of the jaws about the shank of a tool received therein has been reached;

and further including a retaining member located on the forward section of said body and retaining said sleeve member to said body.

8. A hand actuatable chuck for use with a manual or powered driver having a rotatable drive shaft, said chuck comprising:

a generally cylindrical body member, said body member having a forward section and a rearward section, said rearward section having an axial bore formed therein to mate with said drive shaft of said driver and said forward section having an axial bore formed therein and a plurality of angularly disposed passageways formed therethrough and intersecting said axial bore;

a plurality of jaws slidably positioned in each of said angularly disposed passageways, each of said jaws having a jaw face formed on one side thereof and threads formed on the opposite side thereof;

a jaw engaging mechanism rotatably mounted relative said body so as to engage said saw threads;

a hand actuatable sleeve member received over at least a portion of said body, said sleeve member being in driving engagement with said jaw engaging mechanism;

a tightening torque indicator, said tightening torque indicator providing an audible indication when a predetermined tightness of the Saws about the shank of a tool received therein has been reached;

wherein said jaw engaging mechanism includes an annular collar having a threaded inner diameter and an annulus engaged with said annular collar.

9. A hand actuatable chuck for use with a manual or powered driver having a rotatable drive shaft, said chuck comprising:

a generally cylindrical body member, said body member having a forward section and a rearward section, said rearward section having an axial bore formed therein to mate with said drive shaft of said driver and said forward section having an axial bore formed therein and a plurality of angularly disposed passageways formed therethrough and intersecting said axial bore;

a plurality of jaws slidably positioned in each of said angularly disposed passageways, each of said jaws having a jaw face formed on one side thereof and threads formed on the opposite side thereof;

a jaw engaging mechanism rotatably mounted relative said body so as to engage said jaw threads;

a hand actuatable sleeve member received over at least a portion of said body, said sleeve member being in driving engagement with said jaw engaging mechanism;

a tightening torque indicator, said tightening torque indicator providing an audible indication when a predeter-

mined tightness of the jaws about the shank of a tool received therein has been reached;

wherein said jaw engaging mechanism includes a split nut.

10. A hand actuatable chuck for use with a manual or powered driver having a rotatable drive shaft, said chuck comprising:

a generally cylindrical body member, said body member having a forward section and a rearward section, said rearward section having an axial bore formed therein to mate with said drive shaft of said driver and said forward section having an axial bore formed therein and a plurality of angularly disposed passageways formed therethrough and intersecting said axial bore;

a plurality of jaws slidably positioned in each of said angularly disposed passageways, each of said jaws having a jaw face formed on one side thereof and threads formed on the opposite side thereof;

a jaw engaging mechanism rotatably mounted relative said body so as to engage said jaw threads;

a hand actuatable sleeve member received over at least a portion of said body, said sleeve member being in driving engagement with said jaw engaging mechanism;

a tightening torque indicator, said tightening torque indicator providing an audible indication when a predetermined tightness of the jaws about the shank of a tool received therein has been reached;

wherein said tightening torque indicator includes at least one flexible tooth which engages a portion of said sleeve to provide said audible indication.

11. A hand actuatable chuck as in claim **10**, wherein said at least one flexible tooth is operatively associated with said jaw engaging mechanism.

12. A single sleeve hand actuatable chuck as in claim **5**, and further including a thrust ring located on said body member and operatively associated with said jaw engaging mechanism.

13. A single sleeve hand actuatable chuck as in claim **1**, and further including at least one anti-friction bearing disposed between said jaw engaging mechanism and said thrust ring.

14. A single sleeve hand actuatable chuck as in claim **1**, wherein said sleeve member includes gripping ribs on at least a portion of its exterior surface.

15. A single sleeve hand actuatable chuck as in claim **2**, and further including a thrust ring located on said body member and operatively associated with said jaw engaging mechanism.

16. A single sleeve hand actuatable chuck as in claim **2**, and further including at least one anti-friction bearing disposed between said jaw engaging mechanism and said thrust ring.

17. A single sleeve hand actuatable chuck as in claim **2**, wherein said sleeve member includes gripping ribs on at least a portion of its exterior surface.

18. A single sleeve hand actuatable chuck as in claim **3**, and further including a thrust ring located on said body member and operatively associated with said jaw engaging mechanism.

19. A single sleeve hand actuatable chuck as in claim **3**, and further including at least one anti-friction bearing disposed between said jaw engaging mechanism and said thrust ring.

20. A single sleeve hand actuatable chuck as in claim **3**, wherein said sleeve member includes gripping ribs on at least a portion of its exterior surface.

21. A single sleeve hand actuatable chuck as in claim **4**, and further including at least one anti-friction bearing disposed between said jaw engaging mechanism and said thrust ring.

22. A single sleeve hand actuatable chuck as in claim **5**, and further including at least one anti-friction bearing disposed between said jaw engaging mechanism and said thrust ring.

23. A hand actuatable chuck as in claim **6**, and further including a thrust ring located on said body member.

24. A hand actuatable chuck as in claim **6**, and further including at least one anti-friction bearing being disposed between said jaw engaging mechanism and said thrust ring.

25. A hand actuatable chuck as in claim **7**, and further including a thrust ring located on said body member.

26. A hand actuatable chuck as in claim **7**, and further including at least one anti-friction bearing being disposed between said jaw engaging mechanism and said thrust ring.

27. A hand actuatable chuck as in claim **8**, and further including a thrust ring located on said body member.

28. A hand actuatable chuck as in claim **8**, and further including at least one anti-friction bearing being disposed between said jaw engaging mechanism and said thrust ring.

29. A hand actuatable chuck as in claim **9**, and further including a thrust ring located on said body member.

30. A hand actuatable chuck as in claim **9**, and further including at least one anti-friction bearing being disposed between said jaw engaging mechanism and said thrust ring.

31. A hand actuatable chuck as in claim **10**, and further including a thrust ring located on said body member.

32. A hand actuatable chuck as in claim **10**, and further including at least one anti-friction bearing being disposed between said jaw engaging mechanism and said thrust ring.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 5,573,254
DATED : November 12, 1996
INVENTOR(S) : Huff et al.

It is certified that error appears in the above-indentified patent and that said Letters Patent is hereby corrected as shown below:

In column 4, line 25, delete "laws" and replace with --jaws--;

in column 7, line 61, delete "laws" and replace with --jaws--;

in column 9, lines 17 and 46, delete "law" and replace with --jaw--;

in column 10, line 33, delete "saw" and replace with --jaw--; and

in line 40, delete "Saws" and replace with --jaws--.

Signed and Sealed this
Fourth Day of March, 1997

Attest:

BRUCE LEHMAN

Attesting Officer

Commissioner of Patents and Trademarks

US005816582A

United States Patent [19]

Steadings et al.

[11] Patent Number: 5,816,582

[45] Date of Patent: Oct. 6, 1998

[54] **CHUCK**

[75] Inventors: **Stephen W. Steadings; Christopher B. Barton**, both of Seneca, S.C.

[73] Assignee: **Power Tool Holders Incor.**, Wilmington, Del.

[21] Appl. No.: **755,848**

[22] Filed: **Dec. 6, 1996**

Related U.S. Application Data

[63] Continuation of Ser. No. 514,515, Aug. 11, 1995, abandoned.

[51] **Int. Cl.**[6] **B23B 31/12**

[52] **U.S. Cl.** **279/62**; 279/140; 279/902

[58] **Field of Search** 279/60–65, 140, 279/902

[56] **References Cited**

U.S. PATENT DOCUMENTS

573,189	12/1896	Vogel	279/62
5,125,673	6/1992	Huff et al. .	
5,172,923	12/1992	Nakamura	279/140
5,234,223	8/1993	Sakamaki	279/902
5,322,303	6/1994	Nakamura	279/62
5,348,317	9/1994	Steadings et al.	279/62
5,431,419	7/1995	Mack	279/140
5,458,345	10/1995	Amyot	279/62
5,499,829	3/1996	Rohm	278/140
5,499,830	3/1996	Schnizler .	
5,615,899	4/1997	Sakamaki	279/62

FOREIGN PATENT DOCUMENTS

0618029A1	10/1994	European Pat. Off. .
0710518A2	4/1995	European Pat. Off. .
0710519A2	4/1995	European Pat. Off. .
0710520A2	4/1995	European Pat. Off. .
0677348A1	10/1995	European Pat. Off. .
4238503C1	11/1993	Germany .
19506708	3/1996	Germany .
29600727 U1	4/1996	Germany .
4438991A1	5/1996	Germany .
4365504	12/1992	Japan .

OTHER PUBLICATIONS

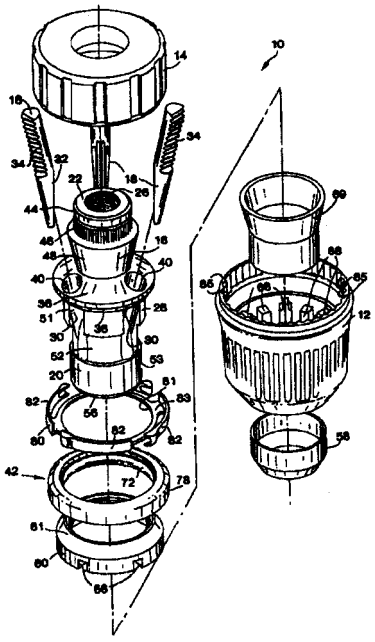
PCT International Search Report, 6 pages, Oct. 23, 1996.
Translation of DE 44 38 991 A1.
Translation of DE 195 06 708 C1.
Translation of EP 0 710 520 A2.
Translation of EP 0 710 519 A2.
Translation of EP 0 710 518 A2.
Translation of EP 0 618 029 A1.

Primary Examiner—Steven C. Bishop
Attorney, Agent, or Firm—Dority & Manning, P.A.

[57] **ABSTRACT**

Chuck for use with manual or powered driver having rotatable shaft, the chuck including a body member and jaws slidably positioned in angled passageways formed in the body. The chuck further includes a nut rotatably mounted relative to the body member and in engagement with threads on the jaws. A generally cylindrical front sleeve member is disposed in driving engagement with the nut and overlying the nose section of the body so that when the front sleeve member is rotated with respect to the body, the jaws will be moved thereby to grip the shaft of a tool. A spring member is biased to engage the sleeve member and is disposed selectively rotatably with respect to the nut. When the nut is tightened, the spring member becomes locked to the body member and restrains the nut from loosening during vibration of the chuck in use for its intended purpose.

33 Claims, 3 Drawing Sheets



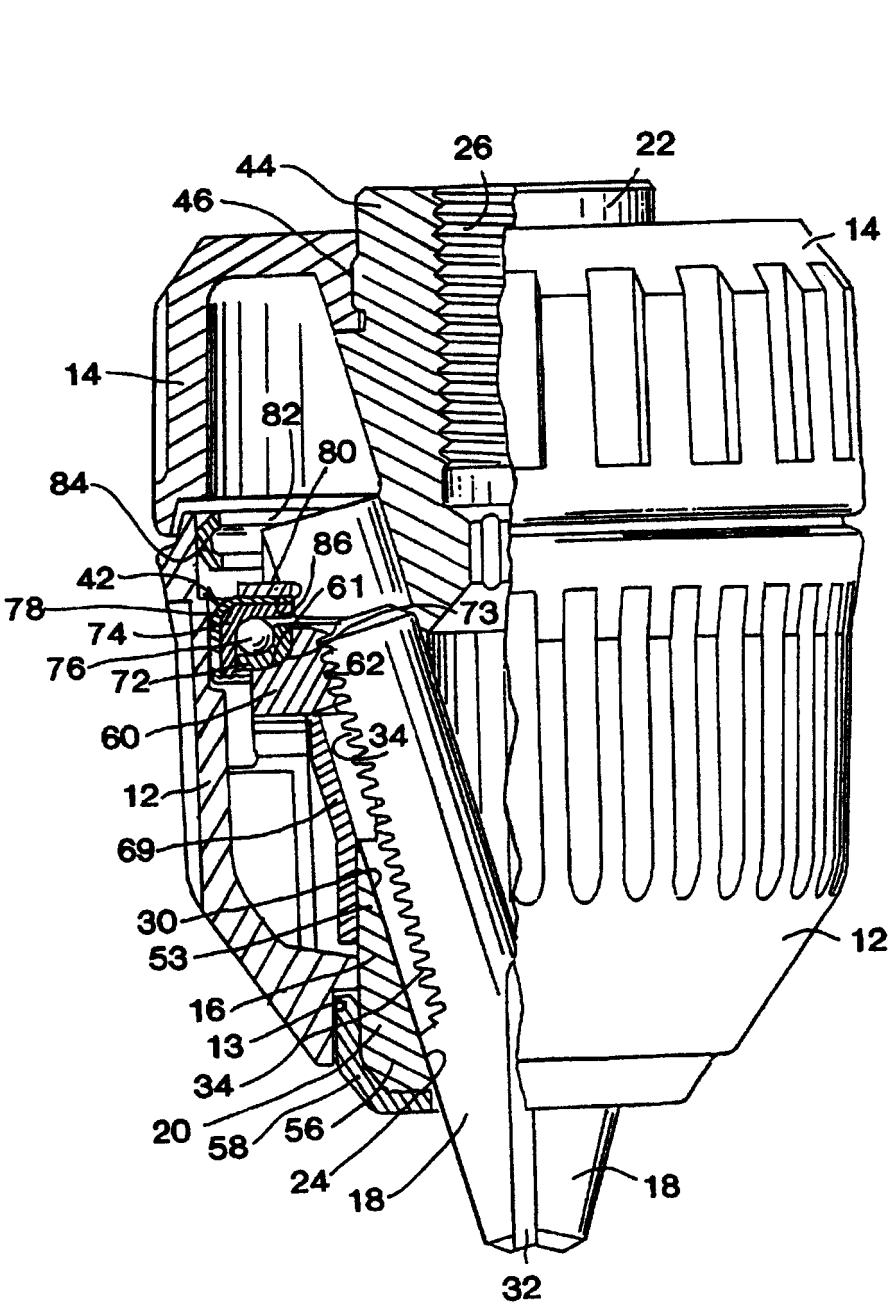

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FIG. 1

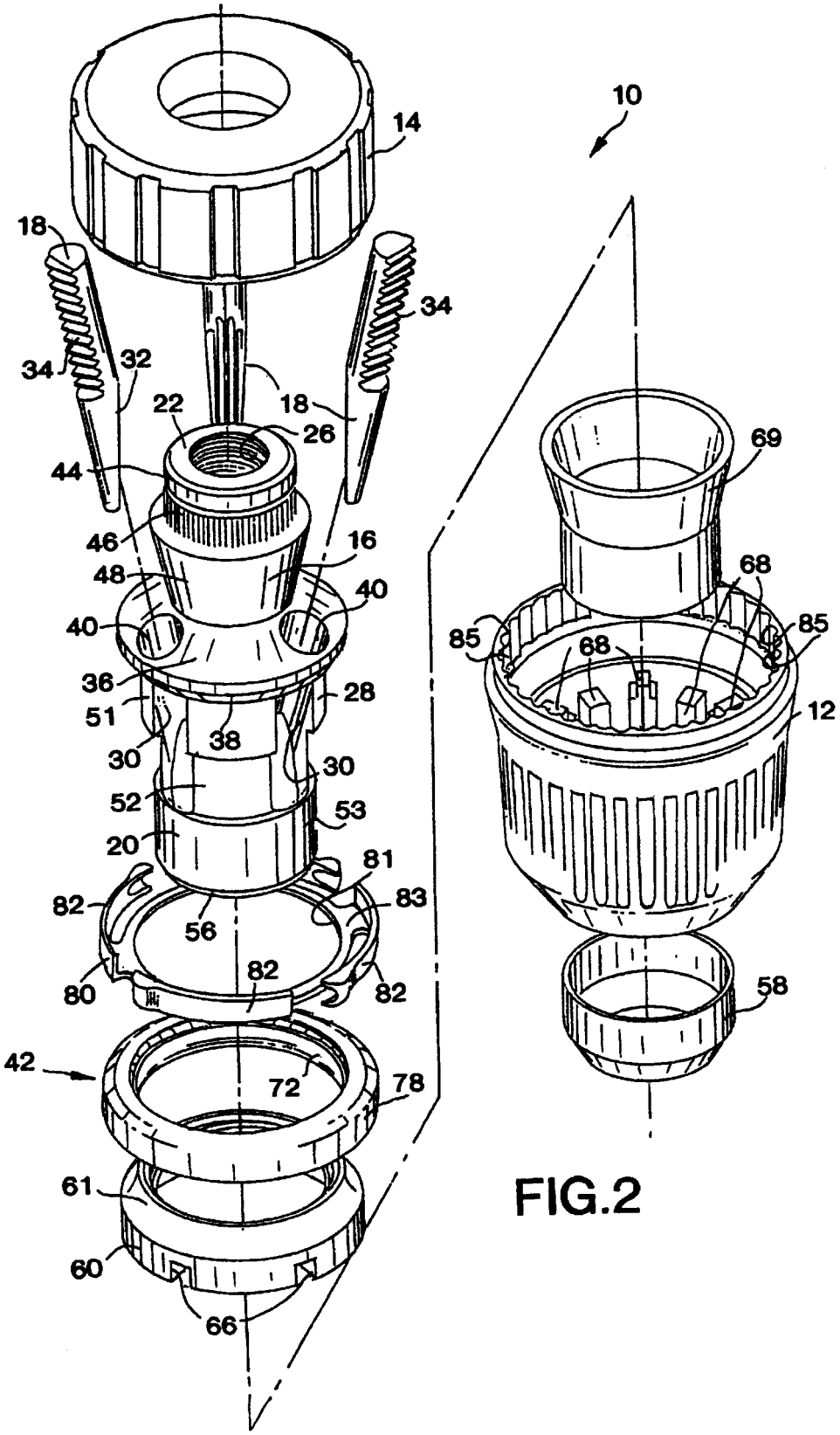
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FIG.2

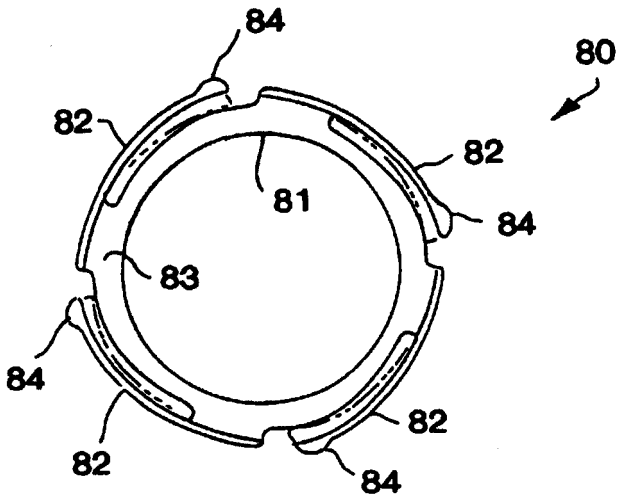

FIG.3

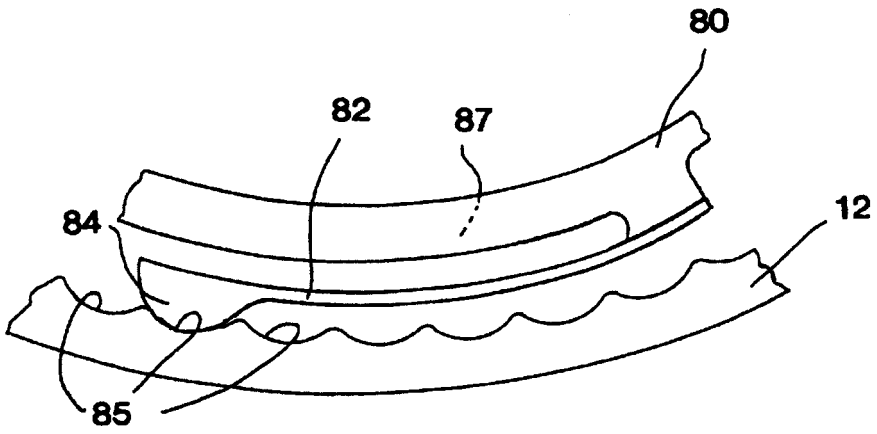

FIG.4

CHUCK

This is a continuation of application Ser. No. 08/514,515, filed Aug. 11, 1995, which was abandoned upon the filing hereof.

BACKGROUND OF THE INVENTION

The present invention relates generally to chucks for use with drills or with electric or pneumatic power drivers. More particularly, the present invention relates to a chuck of the keyless type which may be tightened or loosened by hand or by actuation of the driver motor.

Both hand and electric or pneumatic tool drivers are well known. Although twist drills are the most common tools used with such drivers, the tools may also comprise screwdrivers, nut drivers, burrs, mounted grinding stones and other cutting or abrading tools. Since the tools may have shanks of varying diameter or the cross-section of the tool shank may be polygonal, the device is usually provided with a chuck which is adjustable over a relatively wide range. The chuck may be attached to the driver by a threaded or tapered bore.

A wide variety of chucks have been developed in the art. In the simplest form of chuck, three jaws spaced circumferentially approximately 120 degrees apart from each other are constrained by angularly disposed passageways in a body attached onto the drive shaft and configured so that rotation of the body in one direction with respect to a constrained nut engaging the jaws, forces the jaws into gripping relationship with the cylindrical shank of a tool, while rotation in the opposite direction releases the gripping relationship. Such a chuck may be keyless if it is rotated by hand. One example of such a chuck is disclosed in U.S. Pat. No. 5,125,673 entitled "Non-Impact Keyless Chuck" commonly assigned to the present assignee, and whose entire disclosure is incorporated herein by this reference.

Despite the success of keyless chucks such as set forth in U.S. Pat. No. 5,125,673, varying configurations of keyless chucks are desirable for a variety of applications. Of course, it would also be desirable to have a keyless chuck that requires fewer components and/or lower manufacturing cost.

In a conventional chuck used to secure a drill engaged in hammer drilling for example, the vibration that results from use of the tool, can cause the jaws to loosen their grip around the shaft of the tool. This can have undesirable consequences, both for the work piece and for the operation of the tool.

SUMMARY OF THE INVENTION

The present invention recognizes and addresses the foregoing considerations, and others of prior art constructions and methods.

Accordingly, it is an object of the present invention to provide an improved chuck wherein vibration during use does not cause the jaws to loosen their grip around the shaft of the tool.

It is also an object of the present invention to provide an improved keyless chuck.

It is another object of the present invention to provide a keyless chuck that allows for efficient tightening of the nut on the jaws during operation.

It is another object of the present invention to provide a keyless chuck that has a minimum number of individual components that must be assembled.

These and other objects are achieved by providing a chuck for use with a manual or power driver having a rotatable drive shaft, the chuck comprising a generally cylindrical body member having a nose section and a tail section. The tail section has an axial bore formed therein to mate with the drive shaft of the driver, and the nose section has an axial bore formed therein and a plurality of angularly disposed passageways formed therethrough and intersecting the axial bore. The chuck further includes a plurality of jaws slidably positioned in each of the angularly disposed passageways, each of the jaws having a jaw face formed on one side thereof and threads formed on the opposite side thereof. The chuck also includes a nut rotatably mounted with respect to the body member and in engagement with the threads on the jaws. The chuck also includes a generally cylindrical front sleeve member in driving engagement with the nut and overlying the nose section of the body member whereby when the front sleeve member is rotated with respect to the body member, the jaws will be moved thereby. The chuck further includes a spring member disposed selectively rotatably with respect to the nut. The front sleeve member can engage the spring member via at least one of a plurality of indentations configured in an inner surface of the sleeve member. The spring member can have at least one arm biased toward the front sleeve member, and this arm can have at least one boss configured to engage the front sleeve member. Thus, a restraining torque acts to prevent relative rotation between the spring member and the front sleeve (and the nut operatively connected to the front sleeve). The body member of the chuck can include a thrust receiving portion. The spring member can be disposed between the nut and the thrust receiving portion of the body member so that a rearward axial thrust locks the spring member nonrotatably relative to the body member when the nut is rotated to tighten the jaws about the shaft of the tool in the desired manner. The spring member can be rotatably disposed with respect to the nut by means of a bearing assembly disposed between the nut and the spring member. The bearing assembly can include a friction-reducing surface formed as a coating disposed on at least one of the spring member and the nut. Alternatively, the chuck can include a self-contained anti-friction bearing assembly disposed adjacent the thrust receiving portion.

Other objects, features and aspects of the present invention are discussed in greater detail below.

BRIEF DESCRIPTION OF THE DRAWINGS

A full and enabling disclosure of the present invention, including the best mode thereof, to one of ordinary skill in the art, is set forth more particularly in the remainder of the specification, including reference to the accompanying figures, in which:

FIG. **1** is a front plan view, partly in section, of a chuck in accordance with an embodiment of the present invention;

FIG. **2** is an elevated perspective assembly view of the chuck body and certain other parts illustrated in FIG. **1**;

FIG. **3** is a detailed enlarged top plan view of a component in accordance with an embodiment of the present invention; and

FIG. **4** is a partial top plan view of the component of FIG. **3** engaging the sleeve member as in FIG. **1**.

Repeat use of reference characters in the present specification and drawings is intended to represent same or analogous features or elements of the invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

It is to be understood by one of ordinary skill in the art that the present discussion is a description of exemplary embodi-

ments only, and is not intended as limiting the broader aspects of the present invention, which broader aspects are embodied in the exemplary construction.

Referring to FIG. **1**, a chuck **10** in accordance with the present invention is illustrated. Chuck **10** includes a front sleeve member **12**, an optional rear sleeve member **14**, a body member **16**, and a plurality of jaws **18**. Referring to FIGS. **1** and **2**, body member **16** is generally cylindrical in shape and comprises a nose or forward section **20** and a tail or rearward section **22**. As shown in FIG. **1**, an axial bore **24** is formed in the nose section **20** of the body member **16**. Axial bore **24** is somewhat larger than the largest tool shank that the chuck is designed to accommodate. A threaded bore **26** is formed in tail section **22** of body **16** and is of a standard size to mate with the drive shaft of a powered or hand driver (not shown). While a threaded bore **26** is illustrated, such bore could be replaced with a tapered bore of a standard size to mate with a tapered drive shaft. The bores **24**, **26** may communicate at the central region **28** of body member **16**.

A separate passageway **30** is formed in body member **16** to accommodate each jaw **18**. A plurality of jaws **18** and corresponding passageways are provided. Referring to FIG. **1**, when three jaws **18** are employed, each jaw **18** is separated from the adjacent jaw by an arc of approximately 120 degrees. The longitudinal axes of the passageways **30** and the jaws **18** are angled with respect to the longitudinal axis of the chuck but intersect the chuck axis at a common point ahead of the chuck body **16**. Each jaw **18** has a tool engaging face **32**, which is generally parallel to the longitudinal axis of the chuck body **16**, and threads **34** on its opposite or outer surface. Threads **34** of any suitable type and pitch may be utilized within the scope of the present invention as would be readily apparent to one skilled in the art.

As illustrated in FIGS. **1** and **2**, body member **16** includes a thrust ring member **36** which, in a preferred embodiment, is integral therewith and constitutes the thrust-receiving portion **36** of body member **16**. Although not presently preferred, thrust ring member **36** may be a separate component from the body member. As shown in FIG. **1**, thrust ring member **36** includes a ledge portion **38**, which can be adapted for engagement with the shroud or outer race of a self-contained anti-friction bearing assembly **42** as will be described in more detail below. Thrust ring member **36** includes a plurality of jaw guideways **40** formed around the circumference in alignment with passageways **30** to permit movement (retraction and extension) of the jaws **18** through guideways **40**.

Referring to FIGS. **1** and **2**, tail section **22** of body member **16** can include a rear cylindrical portion **44** with a knurled surface **46** thereon for receipt of optional rear sleeve **14** to be pressed thereon if so desired. As shown in FIG. **2**, body **16** further includes a first tapered portion **48** extending from rear cylindrical portion **44** to the region of thrust ring **36**. A first central cylindrical portion **51** extends from the region of thrust ring **36** to a second central cylindrical portion **52** having a diameter less than first central cylindrical portion **51**. A front cylindrical portion **53** extends from one end of second central cylindrical portion **52** to a beveled nose portion **56** that is adapted to receive a nosepiece **58** for maintaining the front sleeve **12** in driving engagement with a nut as will be set forth in more detail below. Alternatively, a snap ring or the like could be utilized to maintain the front sleeve **12** in place or the front sleeve **12** could be pressed on or otherwise secured to the nut (described below).

The present invention further includes a nut **60** rotatably mounted with respect to body member **16** and in engagement with threads **34** on jaws **18**. As shown in FIG. **1**, nut **60** includes threads **62** for mating with threads **34** on jaws **18** whereby when nut **60** is rotated with respect to body **16**, the jaws **18** will be advanced or retracted in a particular direction along the longitudinal axis of the passageways **30**. This direction has a component along the longitudinal axis of the body member **16**. As shown in FIG. **2**, nut **60** may include drive slots **66** for mating with drive ribs **68** on front sleeve **12**. In this way nut **60** is keyed to front sleeve **12** so that when front sleeve **12** is rotated, nut **60** will rotate therewith and move jaws **18** as set forth above. In a preferred embodiment, nut **60** is configured in the form of a one piece nut, but could be formed in two or more pieces that could be joined together or merely concentrically disposed.

As shown in FIG. **1**, a nut retainer member **69** is configured and disposed so as to cooperate with front cylindrical portion **53** of body member **16** in a manner that retains nut **60** from moving axially toward nose section **20** of body member **16**. As shown in FIG. **2**, nut retainer **69** is generally configured with a cylindrically shaped section joined to a section shaped in a truncated conical form.

In further accordance with the present invention, a spring member is provided. As shown in FIGS. **1** and **2**, a spring member **80** is configured and disposed about body member **16**. As shown in FIGS. **2** and **3**, an inner surface of an annular ring portion **83** of spring member **80** defines a centrally disposed opening **81** that permits spring member **80** to be disposed about body member **16**. As shown in FIGS. **1** and **2**, annular ring portion **83** of spring member is configured and disposed to rest against ledge **38** of thrust ring **36**, and the diameter of opening **81** is large enough so as not to impede movement of jaws **18** through guideways **40** in thrust ring **36** of body member **16**.

As shown in FIGS. **1** and **4**, spring member **80** includes at least one arm **82** resiliently biased toward front sleeve member **12** and carrying on the free end of arm **82** at least one boss **84** configured to engage front sleeve member **16**. As shown in FIG. **4**, a plurality of indentations **85** are configured and disposed in an inner surface near the rear edge of front sleeve member **16** so as to engage and receive the corresponding boss **84** disposed at the free end of arm **82** of spring member **80**. As shown in FIGS. **2** and **3**, spring member **80** has a plurality of arms **82** and associated bosses **84**, four being shown symmetrically disposed circumferentially around the outer periphery of spring member **80**.

As schematically denoted by the dashed outline of arms **84** in FIG. **3**, each arm **82** resiliently deflects radially (in a general sense) inwardly toward the center of opening **81** and radially (again in a general sense) outwardly away from opening **81**. In this way, arms **82**, bosses **84** and indentations **85** are configured so that a circumferential force is needed to overcome the engagement. Thus, the engagement between indentations **85** and corresponding received bosses **84** provides a restraining torque. So long as this engagement does not slip during manual movement of nut **60** by rotation of sleeve member **12**, then front sleeve member **12**, nut **60** and spring member **80** rotate in unison rather than relative to one another.

As nut **60** is rotated so that jaws **18** are increasing the forward gripping force applied to the shaft of a tool, a corresponding axial force is increasingly exerted rearwardly through jaws **18** to nut **60**. This rearward axial force is transmitted through nut **60** to body member **16**, and particularly to ledge **38** of thrust ring **36** of body member **16**. Moreover, as shown in FIGS. **1** and **2**, spring member **80** is disposed between nut **60** and thrust-receiving portion **36** of

body member **16**. More specifically, annular ring portion **83** of spring member **80** provides the vehicle for transmitting the axial force rearwardly from nut **60** to ledge **38** of thrust ring **36** of body member **16**. Accordingly, this rearward axial force results in a frictional force between ledge **38** of thrust ring **36** of body member **16** and annular ring portion **83** of spring member **80**.

This resulting frictional force between ledge **38** of thrust ring **36** of body member **16** and annular ring portion **83** of spring member **80** is directed circumferentially in a direction opposite to the direction that front sleeve **12** and nut **60** are being manually rotated by the user. Accordingly, this resulting frictional force acts to restrain circumferential movement of spring member **80** with respect to thrust ring **36** of body member **16**. Thus, when the jaws **18** are tightened around the shaft of a tool in the desired manner, the resulting frictional force prevents further rotation of spring member **80** with respect to body member **16**. In this manner, spring member **80** becomes locked to body member **16** and therefore becomes selectively disposed nonrotatably with respect to body member **16**.

In a conventional chuck used to secure a drill engaged in hammer drilling for example, the vibration that results from use of the tool tends to cause the nut and front sleeve member to move in the direction of least resistance and, therefore, to cause the jaws **18** to loosen (i.e., release) their grip around the shaft of the tool. However, in accordance with the chuck of the present invention, the tension in the resilient arm **82** of spring member **80** and the configuration of bosses **84** in relation to the configuration of indentations **85**, can be controlled to produce a restraining torque that counteracts such release torque. Thus, before front sleeve **12** can rotate with respect to spring member **80** (and with respect to body member **16** secured to spring member **80** by the aforementioned rearwardly acting axial force), the magnitude of the release torque allowed by the vibrations acting on the chuck must exceed the restraining torque that prevents spring member **80** from rotating relative to front sleeve member **12**. The desired magnitude of this restraining torque is such as to prevent such vibrations from causing front sleeve member **12** (and nut **60** keyed thereto by the interaction of drive slots **66** and drive ribs **68**) to rotate relative to body member **16**. This ensures that jaws **18** do not loosen their desired grip around the tool shaft during such vibration of the tool when in use for its intended purpose such as hammer drilling or any other application that involves vibrations. Upon application of a torque to the front sleeve member **12** that exceeds the restraining torque, then the front sleeve member **12** and the nut **60** keyed thereto will be selectively rendered rotatable with respect to the spring member **80**, which will be fixed nonrotatably to the body member **16** by means of the frictional restraining force resulting from the rearwardly applied axial thrust that pins annular ring portion **83** of spring member **80** against the thrust-receiving portion **36** of body member **16**.

As noted above, spring member **80** is rotatably disposed with respect to nut **60**. This is desirably accomplished by means of a bearing assembly disposed between the nut and the spring member. In one alternative embodiment, the bearing assembly includes a surface bearing between one surface of nut **60** and one surface of spring member **80**. As shown in FIG. **1**, a forwardly disposed surface **86** of annular ring portion **83** of spring member **80** is disposed to face a rearwardly facing surface **61** of nut **60**. In the view shown in FIGS. **2–4**, the opposite surface of annular ring portion **83** than the surface of ring portion **83** actually shown in these Figs., is one of the surfaces that would be disposed to bear against the rearwardly facing, i.e., lower, surface **61** of nut **60** in this surface bearing embodiment.

Desirably, at least one friction-reducing composition would be disposed between the opposed surfaces of nut **60** and spring member **80** disposed in this surface bearing relationship. The at least one friction-reducing composition can be deployed as a coating or layer of solid film lubricant that is applied by being sprayed on one of the bearing surfaces of nut **60** and then cured thereon. In an alternative embodiment, the components with the surfaces may be dipped or spray tumbled. A composition suitable for the friction-reducing composition is the PERMA-SLIK® lubricant distributed by E/M Corporation of West Lafayette, Ind. The PERMA-SLIK® lubricant can be applied to each desired surface according to the instructions provided by the manufacturer. Applicants believe that a preferred cured film thickness for each such layer of the solid film lubricant is between 0.0001 and 0.0005 inches. Further details concerning solid film lubricants can be learned from commonly assigned co-pending application Ser. No. 08/472,253, which is hereby incorporated herein by reference.

Referring to FIGS. **1** and **2**, an alternative embodiment of the bearing assembly disposed between nut **60** and spring member **80** can include a self-contained bearing assembly, generally designated by the numeral **42**. As shown in FIG. **1**, self-contained bearing assembly **42** includes an inner race **72**, an outer race **74** and bearing elements **76** maintained therebetween. In a preferred embodiment, bearing elements **76** are ball bearings. Self-contained bearing assembly **42** may further include a shroud **78** surrounding the inner and outer races **72**, **74** for maintaining the bearing assembly as a self-contained component. As shown in FIG. **1**, inner race **72** includes an arcuate surface **73** that is dimensioned and configured to mate with a corresponding rearwardly-facing arcuate seating surface **61** formed as part of nut **60**. Nut **60** is received for support on inner race **72** and is not in frictional contact with body **16** as in some prior art devices. Such mating relationship assists in alignment and minimization of both axial and radial stresses when the chuck is operated, as well as minimizing or eliminating frictional contact or rubbing between nut **60** and body **16**. Further, such a relationship assists in maintaining the nut centered during tightening so as to provide more even tightening of the chuck and reducing run-out. This arrangement also maintains optimum thread engagement with each jaw, further increasing efficiency and reducing stress in both jaw and nut threads. In a preferred embodiment, self-contained bearing assembly **42** is an angular thrust bearing.

In a preferred embodiment as set forth above, front sleeve member **12** is adapted to be loosely fitted over nose section **20** of chuck **10**. Multiple drive ribs **68** of front sleeve **12** engage drive slots **66** of nut **60** so that front sleeve **12** and nut **60** will be operatively connected or keyed together, i.e., when front sleeve **12** is rotated, nut **60** will rotate therewith. As shown in FIG. **1**, front sleeve **12** may include an annular ledge portion **13** disposed about nose section **20** of body member **16**. A nosepiece **58** is dimensioned and adapted to be pressed onto beveled nose portion **56** of nose section **20** to maintain front sleeve **12** on chuck **10**. It should be appreciated that nosepiece **58** could also be secured to body **16** by snap fitting, threading or the like. Nosepiece **58** is exposed when the chuck is assembled and, in one embodiment, may be coated with a non-ferrous metallic coating to prevent rust and to enhance its appearance. Examples of suitable coatings include zinc or nickel, however, it should be appreciated that any suitable coating could be utilized.

Nosepiece **58** serves to maintain front sleeve member **12** in position on chuck **10** and in driving engagement with nut **60**. Further, while a nosepiece and driving slot arrangement is illustrated, it should be appreciated that any suitable method of operative connection between the front sleeve and the nut could be utilized within the scope of the present invention.

In addition, nosepiece **58** serves the dual purpose of providing an aesthetically pleasing cover for nose portion **56** that will resist rust. This provides the advantage of an aesthetically pleasing appearance without the necessity to coat the entire body member **16**. If desired, the rear sleeve member **14** may be omitted and the front sleeve member **12** extended to the tail end of body **16**. This alternative is particularly feasible when a spindle lock or the like is provided on the driver or when the driver is used to tighten or loosen the jaws.

The exterior circumferential surface of the front sleeve member **12** may be knurled or may be provided with longitudinal ribs or other protrusions to enable the operator to grip it securely. In like manner, the outer circumferential surface of the rear sleeve member **14**, if employed, may be knurled or ribbed if desired. The front and rear sleeves may be fabricated from a structural plastic such as polycarbonate, a filled polypropylene, for example, glass filled polypropylene, or a blend of structural plastic materials. Other composite materials such as, for example, graphite filled polymerics also would be suitable in certain environments. As will be appreciated by one skilled in the art, the materials from which the chuck of the present invention is fabricated will depend on the end use of the chuck, and the above are provided by way of example only.

It will be appreciated that rear sleeve member **14** is fixed to body member **16**, while front sleeve member **12** is operatively associated with nut **60** and rotatable with respect to body member **16**. Because of the interaction between threads **34** on jaws **18** and threads **62** on nut **60**, relative movement of the front and rear sleeve members, **12** and **14**, causes jaws **18** to be advanced or retracted, depending upon the direction of relative movement.

While the above description is set forth with respect to a keyless chuck, it should be appreciated that the principles of the present invention are equally applicable to a keyed chuck, and such is within the scope of the present invention.

These and other modifications and variations to the present invention may be practiced by those of ordinary skill in the art, without departing from the spirit and scope of the present invention, which is more particularly set forth in the appended claims. In addition, it should be understood that aspects of the various embodiments may be interchanged both in whole or in part. Furthermore, those of ordinary skill in the art will appreciate that the foregoing description is by way of example only, and is not intended to be limitative of the invention so further described in such appended claims.

What is claimed is:

1. A chuck for use with a manual or powered driver having a rotatable drive shaft, said chuck comprising:

a) a generally cylindrical body member having a nose section and a tail section, said tail section having an axial bore formed therein to mate with the drive shaft of the driver, said nose section having an axial bore formed therein and a plurality of angularly disposed passageways formed therethrough and intersecting said axial bore of said nose section;

b) a plurality of jaws, a separate one of said jaws being slidably positioned in one of each of said angularly disposed passageways, each of said jaws having a jaw face formed on one side thereof and threads formed on the opposite side thereof;

c) a generally cylindrical front sleeve assembly rotatable mounted about said nose section and in engagement with said threads on said jaws whereby when said front sleeve assembly is rotated with respect to said body member, said jaws will be moved thereby; and

d) a spring member disposed in association with one of said front sleeve assembly and said body member so that said spring member rotates therewith, said spring member being configured to rotationally lock to the other of said front sleeve assembly and said body member and, when so locked, to resist rotation of said one of said front sleeve assembly and said body member, said one of said front sleeve assembly and said body member being configured to rotate with respect to said spring member, when said spring member is locked, upon application of sufficient torque to said one of said front sleeve assembly and said body member to overcome said resistance of said spring member.

2. A chuck for use with a manual or powered driver as stated in claim **1** and further including a rear sleeve member secured to said tail section of said body member.

3. A chuck for use with a manual or powered drive as stated in claim **1**, wherein said front sleeve assembly is maintained on said body member and in engagement with said nut by a rust resistant nosepiece.

4. A chuck for use with a manual or powered driver as stated in claim **1**, wherein said spring member is disposed in association with said one of said front sleeve assembly and said body member so that said spring member rotates therewith when said jaws are freely movable in a forward direction and wherein said spring member is configured to rotationally lock to the other of said front sleeve assembly and said body member when forward movement of said jaws is resisted by a tool shaft gripped by said jaws.

5. A chuck for use with a manual or powered driver as stated in claim **1**, wherein said spring member is disposed in association with said front sleeve assembly so that said spring member rotates with said front sleeve assembly about said body member when said jaws are freely movable in a forward direction and wherein said spring member is configured to rotationally lock to said body member when forward movement of said jaws is resisted by a tool shaft gripped by said jaws, said spring member being configured to resist rotation of said front sleeve assembly when said spring member is locked to said body member and said front sleeve member being configured to rotate with respect to said spring member upon application of sufficient torque to said front sleeve member to overcome said resistance of said spring member.

6. A chuck for use with a manual or powered driver as stated in claim **4**, wherein said front sleeve assembly engages said spring member by at least one of a plurality of indentations configured in an inner surface of said sleeve assembly.

7. A chuck for use with a manual or powered driver as stated in claim **6**, wherein said spring member includes at least one arm having at least one boss configured to be received in at least one of said plurality of indentations configured in said sleeve assembly.

8. A chuck for use with a manual or powered driver as stated in claim **5**, wherein said spring member has at least one arm biased toward said front sleeve assembly, said at least one arm having at least one boss configured to engage said front sleeve assembly.

9. A chuck for use with a manual or powered driver as stated in claim 1, wherein said front sleeve assembly includes a nut rotatably mounted with respect to said body member and in engagement with said threads on said jaws, and a generally cylindrical front sleeve member disposed in driving engagement with said nut.

10. A chuck for use with a manual or powered driver as stated in claim 9, wherein said nut is a one piece nut.

11. A chuck for use with a manual or powered driver as stated in claim 9, wherein said nut includes drive slots for receipt of drive ribs on said front sleeve member.

12. A chuck for use with a manual or powered driver having a rotatable drive shaft, said chuck comprising:

a) a generally cylindrical body member having a nose section and a tail section, said tail section having an axial bore formed therein to mate with the drive shaft of the driver, said nose section having an axial bore formed therein and a plurality of angularly disposed passageways formed therethrough and intersecting said axial bore of said nose section, said body member including a thrust receiving section;

b) a plurality of jaws, a separate one of said jaws being slidably positioned in one of each of said angularly disposed passageways, each of said jaws having a jaw face formed on one side thereof and threads formed on the opposite side thereof;

c) a nut rotatably mounted with respect to said body member and in engagement with said threads on said jaws;

d) a spring member disposed selectively rotatably with respect to said nut, wherein said spring member is rotatably disposed with respect to said nut by means of a bearing assembly disposed between said nut and said spring member; and

e) a generally cylindrical front sleeve member engaging said spring member, said sleeve member being configured and disposed in driving engagement with said nut and overlying said nose section of said body member whereby when said front sleeve member is rotated with respect to said body member, said jaws will be moved thereby.

13. A chuck for use with a manual or powered driver as stated in claim 12, wherein said bearing assembly includes at least one friction-reducing surface disposed between said nut and said spring member.

14. A chuck for use with a manual or powered driver as stated in claim 13, wherein said at least one friction-reducing surface is formed as a coating disposed on at least one of said spring member and said nut.

15. A chuck for use with a manual or powered driver as stated in claim 12, wherein said bearing assembly is a self-contained bearing assembly including an inner race, an outer race, and bearing elements maintained between said races.

16. A chuck for use with a manual or powered driver as stated in claim 15, wherein said bearing elements are ball bearings.

17. A chuck for use with a manual or powered driver as stated in claim 15, wherein said self-contained bearing assembly includes a shroud at least partially surrounding said inner and outer races for maintaining said bearing assembly self-contained.

18. A chuck for use with a manual or powered driver as stated in claim 17, wherein said body member includes a thrust receiving portion disposed adjacent said shroud of said self-contained bearing assembly.

19. A chuck for use with a manual or powered driver as stated in claim 18, wherein said thrust receiving portion is unitary with said body member.

20. A chuck for use with a manual or powered driver as stated in claim 18, wherein said thrust receiving portion includes a ledge portion and wherein said self-contained bearing assembly is received on said ledge portion.

21. A chuck for use with a manual or powered driver as stated in claim 15, wherein each of said nut and said inner race includes a corresponding arcuate seating surface for mating with one another.

22. A chuck for use with a manual or powered driver as stated in claim 12, wherein said bearing assembly is an angular thrust bearing.

23. A chuck for holding the shaft of a tool to be used with a manual or powered driver having a rotatable drive shaft, said chuck comprising:

a) a generally cylindrical body member having a nose section and a tail section, said tail section having an axial bore formed therein to mate with the drive shaft of the driver, said nose section having an axial bore formed therein and a plurality of angularly disposed passageways formed therethrough and intersecting said axial bore of said nose section;

b) a plurality of jaws, a separate one of said jaws being slidably positioned in one of each of said angularly disposed passageways, each of said jaws having a jaw face formed on one side thereof and threads formed on the opposite side thereof;

c) a thrust receiving portion fixed on said body member;

d) a self-contained anti-friction bearing assembly disposed adjacent said thrust receiving portion;

e) a nut rotatably mounted on said bearing assembly and in engagement with said threads on said jaws;

f) a generally cylindrical front sleeve member configured and disposed in driving engagement with said nut and overlying said nose section of said body member whereby when said front sleeve member is rotated with respect to said body member, said jaws will be moved thereby; and

g) a spring member configured and disposed about said body member such that when said jaws are desirably gripping the shaft of the tool, said spring member becomes locked to said body member and a predetermined restraining torque must be overcome before said nut can rotate with respect to said body member.

24. A chuck for use with a manual or powered driver having a rotatable drive shaft, said chuck comprising:

a) a generally cylindrical body member having a nose section and a tail section, said tail section having an axial bore formed therein to mate with the drive shaft of the driver, said nose section having an axial bore formed therein and a plurality of angularly disposed passageways formed therethrough and intersecting said axial bore of said nose section;

b) a plurality of jaws, a separate one of said jaws being slidably positioned in one of each of said angularly disposed passageways, each of said jaws having a jaw face formed on one side thereof and threads formed on the opposite side thereof;

c) a generally cylindrical front sleeve assembly rotatably mounted about said nose section and in engagement with said threads on said jaws whereby when said front sleeve assembly is rotated with respect to said body member, said jaws will be moved thereby;

d) a thrust receiving member secured to said body member in at least a rearward axial direction and adjacent said front sleeve assembly, said thrust receiving member being configured to receive rearward axial thrust from said front sleeve assembly when forward movement of said jaws is resisted by a tool shaft gripped by said jaws and to convey said rearward axial thrust to said body member; and

e) a spring member disposed between said front sleeve assembly and said thrust receiving member so that said spring member is rotationally locked to one of said front sleeve assembly and said thrust receiving member by said rearward axial thrust, said spring member being biased against the other of said front sleeve assembly and said body member so that said spring member is rotated therewith absent said rearward axial thrust.

25. A chuck for use with a manual or powered driver as stated in claim **24**, wherein said spring member is disposed between said front sleeve assembly and said thrust receiving member so that said spring member is rotationally locked to said thrust receiving member by said rearward axial thrust and wherein said spring member is biased against said front sleeve assembly so that said spring member is rotated with said front sleeve assembly absent said rearward axial thrust.

26. A chuck for use with a manual or powered driver as stated in claim **24**, wherein said thrust receiving member is unitary with said body member.

27. A chuck for use with a manual or powered driver as stated in claim **24**, wherein said front sleeve assembly includes a nut rotatably mounted with respect to said body member and in engagement with said threads on said jaws, and a generally cylindrical front sleeve member rotatably disposed with respect to said spring member and disposed in driving engagement with said nut.

28. A chuck for use with a manual or powered driver having a rotatable drive shaft, said chuck comprising:

a) a generally cylindrical body member having a nose section and a tail section, said tail section having an axial bore formed therein to mate with the drive shaft of the driver, said nose section having an axial bore formed therein and a plurality of angularly disposed passageways formed therethrough and intersecting said axial bore of said nose section, said body member including a thrust receiving portion;

b) a plurality of jaws, a separate one of said jaws being slidably positioned in one of each of said angularly disposed passageways, each of said jaws having a jaw face formed on one side thereof and threads formed on the opposite side thereof;

c) a generally cylindrical front sleeve assembly rotatably mounted about said nose section and in engagement with said threads on said jaws whereby when said front sleeve assembly is rotated with respect to said body member, said jaws will be moved thereby; and

d) an annular spring member disposed about said body member in association with said front sleeve assembly so that said annular spring member rotates with said front sleeve assembly about said body member when said jaws are freely movable in a forward direction, said annular spring member being configured to rotationally lock to said body member when forward movement of said jaws is resisted by a tool shaft gripped by said jaws.

29. A chuck for use with a manual or powered driver as stated in claim **28**, wherein said annular spring is biased against said front sleeve assembly so that rotation of said front sleeve assembly urges rotation of said annular spring, and so that, upon locking of said annular spring to said body member, said annular spring resists rotation of said front sleeve assembly with respect to said body member.

30. A chuck for use with a manual or powered driver as stated in claim **28**, wherein said front sleeve assembly includes a nut rotatably mounted with respect to said body member and in engagement with said threads on said jaws, and a generally cylindrical front sleeve member rotatably disposed with respect to said spring member and disposed in driving engagement with said nut.

31. A chuck for use with a manual or powered driver having a rotatable drive shaft, said chuck comprising:

a) a generally cylindrical body member having a nose section and a tail section, said tail section having an axial bore formed therein to mate with the drive shaft of the driver, said nose section having an axial bore formed therein and a plurality of angularly disposed passageways formed therethrough and intersecting said axial bore of said nose section, said body member including a thrust receiving portion;

b) a plurality of jaws, a separate one of said jaws being slidably positioned in one of each of said angularly disposed passageways, each of said jaws having a jaw face formed on one side thereof and threads formed on the opposite side thereof;

c) a generally cylindrical front sleeve assembly rotatably mounted about said nose section and in engagement with said threads on said jaws whereby when said front sleeve assembly is rotated with respect to said body member, said jaws will be moved thereby; and

d) a spring member disposed about said body member and including an annular portion disposed between said front sleeve assembly and said thrust receiving portion so that said spring member is rotationally locked to said thrust receiving portion by rearward axial thrust from said front sleeve assembly when forward movement of said jaws is resisted by a tool shaft desirably gripped by said jaws, and at least one arm attached to said annular portion and biased against said sleeve assembly so that said spring member rotates with said front sleeve assembly about said body when said jaws are freely movable in a forward direction and resists rotation of said front sleeve assembly when said spring member is rotationally locked to said thrust receiving portion so that sufficient torque must be applied to said front sleeve assembly to overcome said resistance in order to rotate said front sleeve assembly with respect to said spring member.

32. A chuck for use with a manual or powered driver as stated in claim **31**, wherein said front sleeve assembly includes a nut rotatably mounted with respect to said body member and in engagement with said threads on said jaws, and a generally cylindrical front sleeve member rotatably disposed with respect to said spring member and disposed in driving engagement with said nut.

33. A chuck for use with a manual or powered driver as stated in claim **32**, wherein said front sleeve member engages said arm by at least one of a plurality of indentations configured in an inner surface of said sleeve member.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 5,816,582
DATED : October 6, 1998
INVENTOR(S) : Stephen W. Steadings et al.

It is certified that error appears in the above-indentified patent and that said Letters Patent is hereby corrected as shown below:

In the claims

In Column 8, Line 26, please change "1" to --9--.

Signed and Sealed this

Fourteenth Day of March, 2000

Attest:

Attesting Officer

Q. TODD DICKINSON

Commissioner of Patents and Trademarks