

Oct. 11, 1966

J. H. BENT

3,277,670

AUTOMATIC RELEASE PNEUMATIC TOOL

Filed Sept. 24, 1963

3 Sheets-Sheet 1

Fig. 1.

Fig. 3.

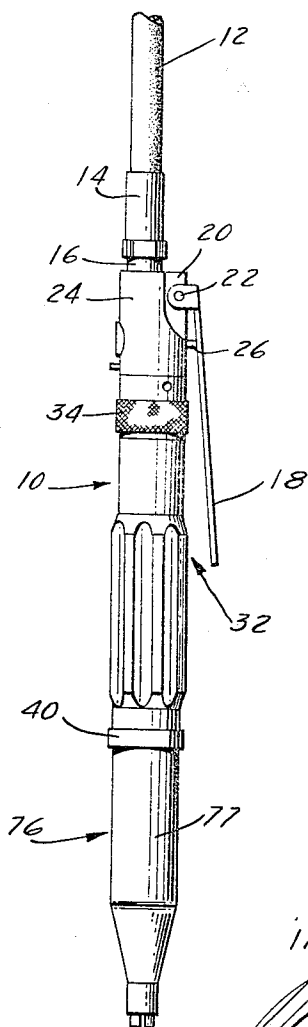
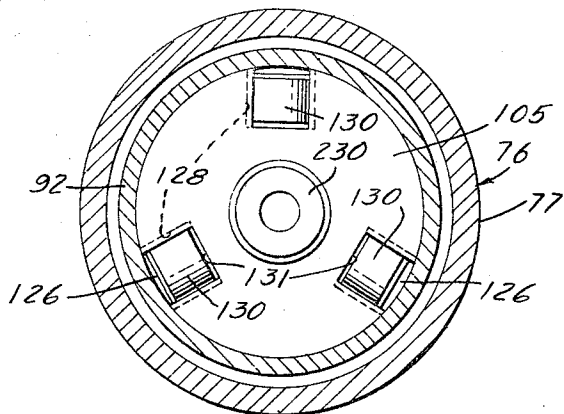


Fig. 4.

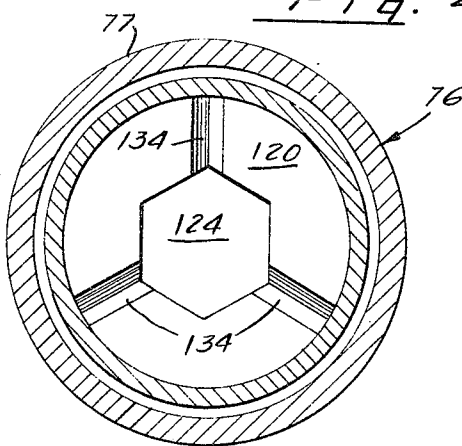
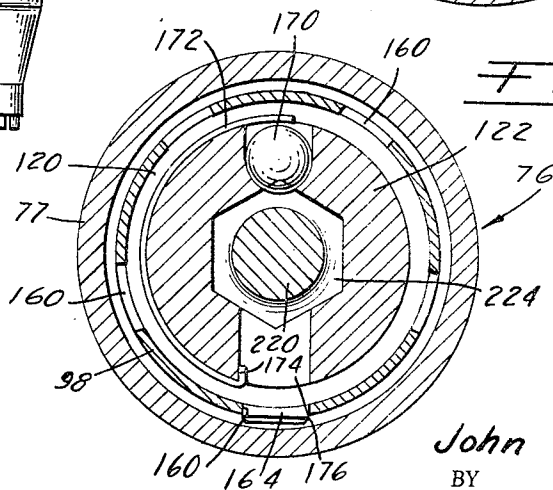


Fig. 5.



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3 Sheets-Sheet 2

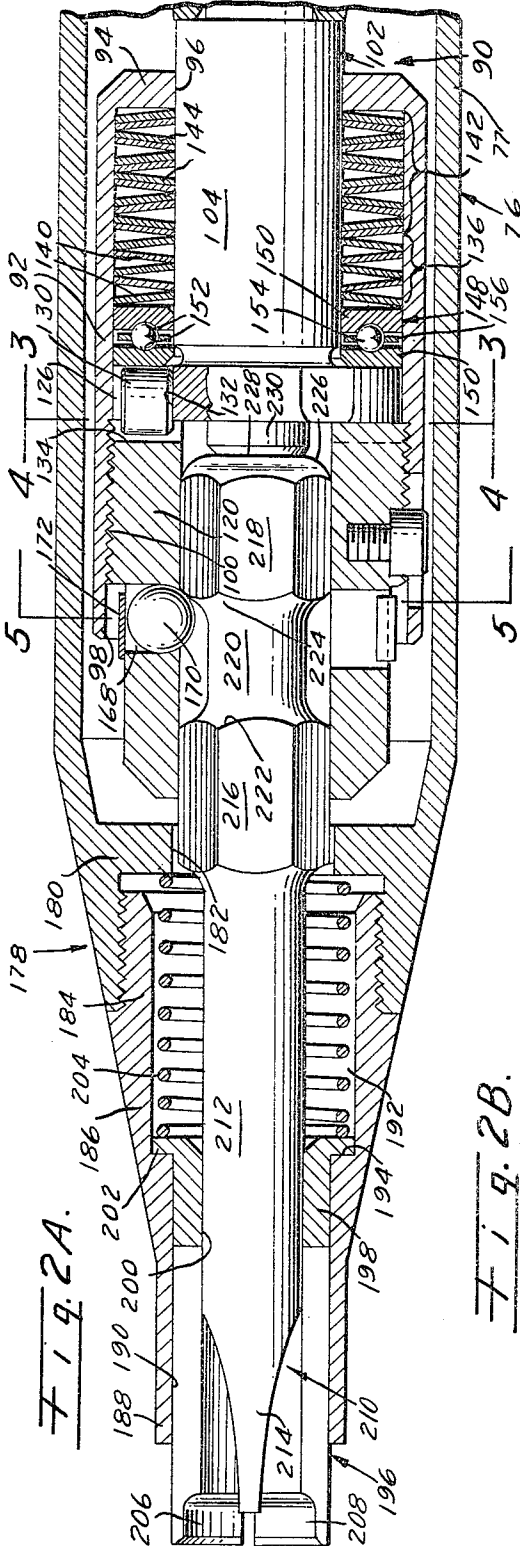
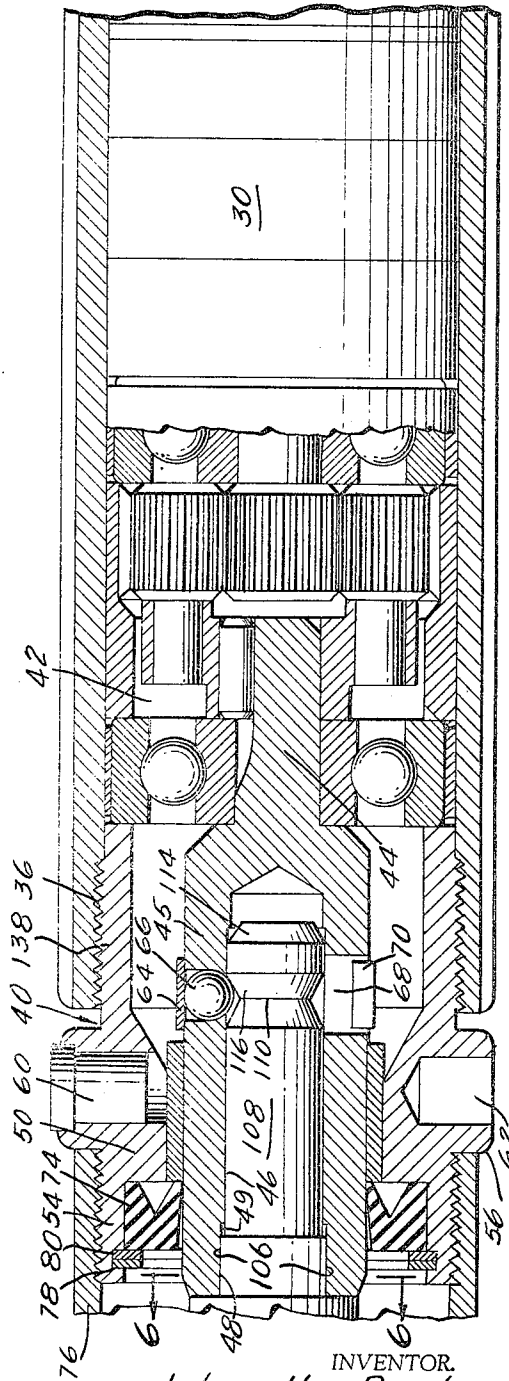


Fig. 2B.



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3 Sheets-Sheet 3

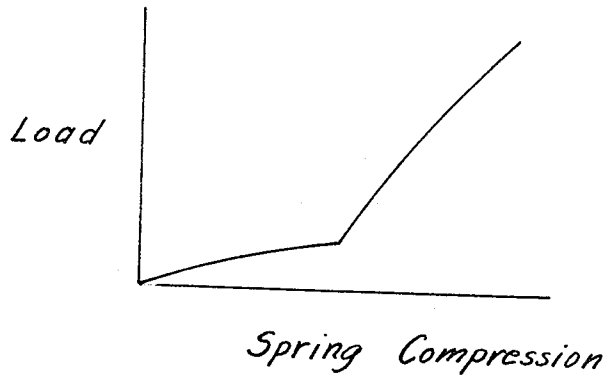


Fig. 7.

Fig. 8.

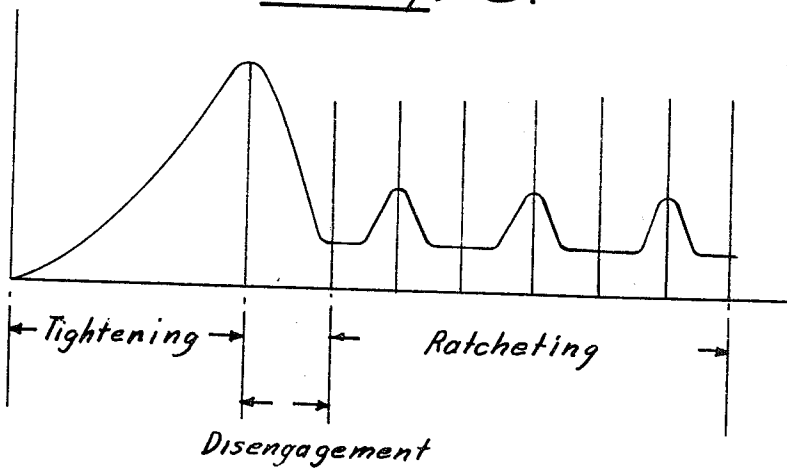
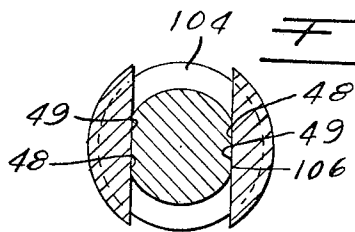


Fig. 6.

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AUTOMATIC RELEASE PNEUMATIC TOOL

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Filed Sept. 24, 1963, Ser. No. 311,111

1 Claim. (Cl. 64—29)

This invention relates generally to tools and relates more particularly to pneumatic screwdrivers and the like.

While the invention has particular utility in connection with pneumatically operated screwdrivers, and is shown and described in this connection, it is to be understood that its utility is not confined thereto.

There are various well known problems and difficulties involved in the provision of torque release of screwdrivers and like tools operated pneumatically and it is an object of the present invention to provide a pneumatic screwdriver or the like which will solve such problems and overcome such difficulties.

It is another object of the present invention to provide a pneumatic screwdriver that releases accurately on reaching a preset torque level.

It is still another object of the invention to provide mechanism of this character that has a snap action disengagement when a predetermined torque value is reached without further build up of torque.

It is a further object of the invention to provide mechanism of this character wherein the disengaging torque is adjustable.

It is a still further object of the invention to provide mechanism of this character having a clutch assembly that may be easily and quickly removed from and replaced in the tool.

A further object of the invention is to provide mechanism of this character that will give long, trouble-free service.

A still further object of the invention is to provide mechanism of this character having drive bits that may be readily snapped into the tool and readily be removed.

Another object of the invention is to provide mechanism of this character that is economical to use and has low air consumption.

Still another object of the invention is to provide mechanism of this character that will not overheat.

A still further object of the invention is to provide mechanism of this character that operates at a very low noise level.

It is another object of the invention to provide mechanism of this character that contributes to worker concentration and increased efficiency.

It is another object of the invention to provide mechanism of this character wherein friction is reduced to a minimum.

It is still another object of the invention to provide mechanism of this character which will tighten fasteners uniformly, that is, to the same tightness.

It is a further object of the invention to provide mechanism of this character having a variable spring rate to provide a low spring rate for low torque settings with a higher spring rate for higher torque settings.

It is a still further object of the invention to provide mechanism of this character having the same action in both directions so that the mechanism is equally suitable for right hand and left hand fasteners.

Another object of the invention is to provide mechanism of this character that permits a changeover for use on one type or size of fastener to another.

Still another object of the invention is to provide mechanism of this character in which such change over may be easily and readily made even by unskilled operators.

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A further object of the invention is to provide mechanism of this character that is simple in construction.

A still further object of the invention is to provide mechanism of this character having a minimum number of parts.

Another object of the invention is to provide mechanism of this character that is rugged and durable.

The characteristics and advantages of the invention are further sufficiently referred to in connection with the following detailed description of the accompanying drawings, which represent one embodiment. After considering this example, skilled persons will understand that variations may be made without departing from the principles disclosed and I contemplate the employment of any structures, arrangements or modes of operation that are properly within the scope of the appended claims.

Referring to the drawings, which are for illustrative purposes only:

FIG. 1 is a side elevational view of a pneumatically operated tool embodying the invention;

FIG. 2A is an enlarged longitudinal sectional view of the front portion of the invention taken on line 2A—2A of FIG. 1;

FIG. 2B is an enlarged longitudinal sectional view of a portion of the tool rearwardly of the portion shown in FIG. 2A and taken on line 2B—2B of FIG. 1;

FIG. 3 is a sectional view taken on line 3—3 of FIG. 2A;

FIG. 4 is a sectional view taken on line 4—4 of FIG. 2A;

FIG. 5 is a sectional view taken on line 5—5 of FIG. 2A;

FIG. 6 is a sectional view taken on line 6—6 of FIG. 2B;

FIG. 7 is a diagram showing the action characteristics of the springs; and

FIG. 8 is a diagram showing the action characteristics of the mechanism.

Referring more particularly to the drawings, there is shown in FIG. 1 a tool embodying the present invention, said tool being indicated generally at 10 and being connected to a flexible pneumatic conduit 12 by any suitable well known means, such as fitting 14 which has a threaded connection with a nipple 16 of the tool at the rear thereof.

There is a fluid control lever 18 pivoted at its rear end to a supporting part 20 of the tool by means of a pivot 22. Lever 18 controls air control valve, not shown, which is disposed within the hollow interior of the rear section 24 of the mechanism. This air control valve has a plunger 26 which extends through the wall of the rear section 24 and is engaged by lever 18 so that inward movement of the lever moves plunger inwardly for opening said air control valve, there being spring means, not shown, for returning the plunger 26 and lever 18 to their normal position whereat said control valve is closed.

Also housed within the rear section 24 is a reversing valve, also not shown, but having a control lever 28. Movement of the lever 28 in one direction will operate the reversing valve to effect operation of the motor 30 (FIG. 2B) in one direction while movement of the lever 28 in the opposite direction will set the reversing valve so as to effect operation of the motor in the opposite direction.

Motor 30 is operably mounted in the rear part of a tubular intermediate section 32 of the mechanism and rear section 24 is attached to the rear of the intermediate section 32 by means of an annular nut part 34 screw threaded onto an externally threaded portion at the rear of said intermediate section.

Intermediate section 32 is tubular or hollow and includes a forward end portion that has internal threads

36 threadably receiving an externally threaded tubular connecting part 38 of a connecting section, indicated generally at 40.

Motor 30 is secured in the intermediate section of the mechanism by any suitable means such as screws, not shown, and ahead of the motor 30 is a speed reduction gear system, indicated generally at 42 in FIG. 2B, which is operably connected with the motor 30. Gear system 42 has an output shaft 44 having a bearing 44a, said output shaft including an enlarged diameter forward end 45 from the forward or front end of which an axial bore 46 extends rearwardly. At the forward end of bore 46 there is a portion that is elongated radially to serve as a slot or socket 49 with oppositely arranged laterally spaced parallel walls 48, FIG. 6.

At the forward end of the tubular connecting part 38 there is an internal annular flange 50 in which a bushing 52 is secured by press fitting or other suitable means, said bushing providing a bearing in which the part 45 of the output shaft is rotatable.

Connecting part 40 has a tubular, externally threaded forward end 54 which extends forwardly from the flange 50. Intermediate the parts 38 and 54 there is an external flange 56 which has a radial bore 58 communicating with the interior of the tubular part 38 and in which a grease fitting 60 is secured. Flange 56 also has an inwardly extending hole 62 for a tool, such as a spanner wrench whereby the parts may be tightened or loosened when assembling or disassembling the mechanism.

Adjacent the rear of the part 45 there is a transverse bore 64 which is somewhat constricted at its inner end, said transverse bore 64 having a steel ball 66 disposed therein. The ball 66 has a somewhat greater diameter than the thickness of the wall of the part 45 so that the ball extends into the bore 46, the inner end of bore 64 being sufficiently smaller than the diameter of the ball so that the latter will be held against full entrance into the bore 46.

Opposite the bore 64 is a slot 68 through the wall of the part 45 and extending into said slot is an end portion 70 of a ball retaining leaf spring 72 which extends about the exterior of the part 45 a sufficient distance to be securely disposed on said part 45, said spring extending over the outer end of the transverse bore 64 for operably retaining the ball 66 therein.

Within the forward end portion of the connecting section 40 is a seal 74 providing a seal against the escape of lubricant into the hollow interior of the forward end section 76 of the mechanism which is defined by a cylindrical wall 77. Removable snap rings 78 of any well known type are disposed in an internal annular groove 80 in the forward end portion 54 of the connecting section for retaining the seal in position.

The forward or front end section 76 has a rear end portion which is internally threaded, as at 82 screwed onto the forward end part 54 of the connecting member 40.

Disposed in the forward or front end section 76 is a clutch assembly, indicated generally at 90, FIGS. 2A and 2B, which comprises a clutch sleeve 92 having an end wall 94 at its rear end, there being an axial opening 96 in said end wall 94. At the forward end of the housing there is a smooth bored forwardly extending flange 98 behind which is an internally threaded part 100.

Clutch 90 has a clutch driver, indicated generally at 102, comprising a shaft 104 with an integral roller disc 105 at the forward end. Shaft 104 extends rearwardly through the opening 96 in the rear wall 94 of the clutch sleeve and has flattened oppositely arranged, substantially parallel flattened sides 106, which extend into the socket 49 at the front end of the enlarged diameter portion 45 of the output shaft 44, the sides or walls 106 of the clutch driver shaft 104 being engaged by the walls 48 of said socket to provide a positive drive connection between the output shaft and the clutch driver.

Rearwardly of the shaft 104 is an axial extension 108 of reduced diameter which is slidably received in the bore 46 of the enlarged diameter part 45 of the output shaft 44 and adjacent the free end of said extension is annular groove 110 which is V-shaped in cross section and in which the ball 66 is received when said extension is fully received in said bore 46, said ball 66 serving as a releasable latching member yieldingly urged into latching position by spring 64. Outwardly or rearwardly of the groove 110 is a head 112 which has a rearwardly extending frusto-conical end 114 which serves as a cam to force ball 66 radially outwardly in bore 64 when the clutch stem 108 is inserted into bore 46 to operably connect the clutch driver 104 with the output shaft 44. The outer wall 116 of the groove 110 also serving as such a cam surface when the clutch driver is pulled forwardly for disconnection from the output shaft.

At the forward end of the clutch sleeve 92 is a bit holder, indicated generally at 118, said bit holder having an externally threaded head 120 which is screwed into the internally threaded forward end portion 100 of the clutch sleeve. Bit holder 118 includes a reduced diameter portion or bit sleeve 122 which extends forwardly of the head 120, said bit holder having an axial passage 124 therethrough which is non-circular. More particularly said passage 124 is hexagonal in cross section although it may be of other suitable shape.

Roller disc 104 has a plurality of roller receiving notches 126 which extend radially inwardly from the periphery of said disc 104, said notches having oppositely arranged side walls 128 which are concave in cross section, having the same curvature as the curvature of the rollers 130 operably disposed therein so that said rollers will roll under certain operating conditions to be described hereinafter. At the inner ends of said rollers said notches have inner walls 132 which are normal to the side walls 128 and which limit inward movement of said rollers.

While any suitable number of rollers may be used three rollers are provided in the presently disclosed arrangement and said rollers normally have small peripheral portions disposed in respective radially arranged grooves 134 in the head 120 of the bit holder 118, said grooves being V-shaped in cross section. More particularly the rollers 130 are engaged in said grooves to a depth just beyond the point of tangency. They give line contact and greatly increased durability.

Means is provided for yieldingly urging the rollers 130 into the grooves 134, said means comprising two sets of Belleville springs. One set of these springs is indicated at 136 and comprises a series of single springs 140 arranged in the usual manner in opposed sequence, the other set being indicated at 142 and comprises pairs of springs 144, said pairs of springs 144 being arranged in opposite sequence in the usual manner in which Belleville springs are arranged.

Interposed between the spring 140 at the forward end of the set of springs 136 and the rollers is a thrust bearing assembly, indicated generally at 148, which includes a pair of annular races 150 provided with oppositely facing recesses 152 in their inner sides to receive portions of ball bearings 154. Respective recesses 152 of the races 150 are aligned for operable reception of the balls, the depth of said recesses being such that the inner sides of the races are spaced apart longitudinally relative to the mechanism. The spacing of said races is such as to provide room for operable reception of an annular cage 156 which has annularly spaced openings therein for operable reception of said balls 154.

Thrust bearing assembly is received on the shaft 104 and the forward race bears on the rollers 130, the Belleville springs 140 and 144 are arranged in series and react between the end wall 94 of the clutch sleeve 92 and the thrust bearing 148 to thereby urge said rollers 130 into respective V-shaped notches 134.

Clutch sleeve 92 has a plurality of annularly spaced slots 160 which are elongated relative to the length of the clutch sleeve and said slots are of the same length and positioned the same distance from the forward end of the clutch sleeve. A screw 162 is disposed in a radially extending tapped bore provided therefor and said screw has a head 164 which is disposed in one of said slots. The slots are of sufficient length to permit the head 164 of the screw 162 to slide in the slot in which it is disposed so that there can be relative movement between the clutch sleeve and the bit holder. Screw head 164 is normally disposed in one of the slots intermediate the ends thereof and with this arrangement the clutch may be calibrated when the screw 162 is removed, by relative rotation of said clutch sleeve and the bit holder as these parts are screwed inwardly or outwardly relative to each other to thereby vary the effective force of the Belleville springs on the rollers 130. After the clutch has been calibrated the tapped bore for screw 162 is exposed through one of the slots 160. The screw 162 is then inserted through this slot and screwed into said tapped bore to retain the calibration of the clutch.

The bit sleeve 122 of the bit holder has a radial bore 168 therein which communicates with the interior passage 124 of the bit holder, said bore being slightly smaller in diameter at its inner end to prevent a ball 170 disposed in said bore 168 from passing into said passage 124 but permitting a portion of said ball to extend thereinto. An arcuately shaped retaining leaf spring 172, similar to the spring 72 has an inwardly turned end portion 174 disposed in a slot 176 in said bit sleeve opposite the bore so that a portion of said spring 172 extends over the outer end of bore 168 and yieldingly retains the ball 170 in said bore with an inner ball portion extending into the passage 124.

Adjacent its forward end the front section 76 has a frusto-conical forward end portion 178 in which is an annular internal flange 180 defining an axial opening 182. Ahead of the flange 180 the frusto-conical part 178 is internally threaded for reception of the externally threaded rear part 184 of a collet finder housing 186. The exterior of said housing 186 forms a smooth continuation of the exterior surface of the frusto-conical end 178 of the front end section 76, said housing 176 having a forward part 188 that is cylindrical. The housing 186 has an axial passage 190 which extends rearwardly from the forward end of the part 188 and which terminates at its rearward end in a cylindrical enlarged passage 192, there being a shoulder 194 normal to the axis of the housing 186 at the junction of said passage 190 and enlarged passage 192.

Within the passage 190 is slidably disposed a collet finder, indicated generally at 196, which includes a base 198 with an axial bore 200 therethrough having an annular flange 202 at the rear end thereof normally abutting against the shoulder 194 and yieldingly urges to this position by a spring 204 disposed in said passage 192 and reacting between said flange 202 and flange 180 at the forward end of the front section 76.

Collet finder 196 has a plurality of resilient fingers 206 which extend forwardly from the base 198 and which are annularly spaced apart, there being four fingers 206 shown although any other suitable number may be used. The inner sides of the fingers 206 are arcuately shaped in cross section to form a continuation of the bore 200 of the collet finder and at their forward ends of the inner sides of said fingers are arcuately enlarged at 208 to collectively form a socket for screw heads of the like.

Slidable in the bore 200 is slidably disposed a screw driver bit, indicated generally at 210, and including a shank 212 terminating at its forward end in the usual blade 214. The rear of the bit is provided with a pair of hexagonal elements 216 and 218 spaced apart by a connecting part 220 of smaller diameter than the narrow-

est transverse measurement of said elements 216 and 218. The facing ends 222 and 224 of said elements are concavely curved or rounded while the rear or free end of the element 218 is also rounded inwardly and outwardly at 226 to a flat end wall 228 normal to the axis of said bit, the latter wall engaging the forward end of a boss 230 at the forward end of the roller disc 105 which limits movement of said bit toward the disc 105.

Ball 170 engages the rounded shoulder 224 of the element 218 when the bit is operatively positioned as shown in FIG. 1, and yieldingly urges same against said boss 230. Because of the rounded character of the end 224 of boss 218 it serves as a cam so that the bit may be pulled outwardly of the passage 124 of the bit holder and the rounded outer end 226 of the element 218 provides a cam element for urging the ball outwardly when the bit is inserted into said bit holder. Further, the ball 168 will retain the bit in operable position in the bit holder but will permit ready insertion and removal of said bit.

It is to be understood, of course, that other sizes of screw driver bits may be used or other types of tools such as those having sockets, for example. It is also to be understood that the elements 216 and 218 have the same external cross sectional shape as the passage 124 so that the bit will be positively rotated when the bit holder is rotated.

The free end of the bit blade is normally spaced inwardly of the forward free end of the finger. When a screw or other fastener is to be screwed into or out of a threaded bore or the like the socket at the free end of the finder is placed over the screw head and forward pressure is exerted on the tool. This pressure results in the finder 196 moving inwardly against the force of spring 204 so that the blade 214 of the bit will enter the slot in the screw head and effect rotation of said screw either inwardly or outwardly depending upon the direction of rotation of the bit which, in turn, depends upon how the operator has positioned the reversing valve of the air or fluid motor.

The clutch 90 is of the detent type and is adapted to disengage accurately when a predetermined torque value is reached.

Normally the rollers 130 engage the respective grooves 134, said rollers being pre-loaded by the Belleville springs acting through the thrust bearing 148. As described above the effective force of the Belleville springs is adjustable so that the disengaging torque may be adjusted.

During operation, the driver applies a load against the rollers which transmit it to the driven element or bit holder. As the desired torque value is approached, the rollers begin to disengage from the grooves, but after a small amount of motion said rollers move outwardly of said grooves beyond the point of tangency. The torque required to disengage them further then reduces and continues to reduce until they are completely disengaged. The spring rate of the series of Belleville springs is such that the disengaging action of the rollers is under-compensated by said springs. That is, as the force urging the rollers out of said grooves reaches a predetermined value the rollers start to leave said grooves which effects a certain amount of compression of the springs thereby increasing the spring force urging the rollers into the grooves. However, the increase in the spring force as the rollers start to move out of the grooves does not increase enough to overcome the force urging the rollers out of the grooves and force the rollers back into the grooves. The net result then is that when disengagement starts it is a "snap" action without a further build up of torque.

The ball race which rests against or engages the rollers is free to rotate so that as the rollers disengage from the grooves 134 and rotation takes place between the clutch driver or driver element and the driven element, including the bit holder, the rollers are free to have a

true rolling action and hence do not slide on the parts engaged by said rollers. The race 150 engaging the rollers rotates in a direction opposite to that of the driver element during this part of the operation of the mechanism so that there is a minimum of friction or "drag."

After disengagement of the rollers and while the driven element is restrained from rotation by the resistance to rotation offered by the screw being driven, and the driver element continues to rotate, there is a "ratcheting" action by the clutch as the rollers pass over the grooves 134, the rotational velocity being such that the rollers never become fully seated in said grooves 134 during this operation so that the torque reaction on the driven element does not reach the level of the torque required for disengagement. Thus when the clutch is used in a tool to tighten a fastener or screw, the fastener is always tightened to the same torque and uniform tightness of the fasteners is always effected. The diagram of FIG. 8 shows the action of the mechanism.

The amount of motion required for disengagement of the rollers is transmitted to the Belleville springs and increases the spring load. In order to maintain the above described relationship between spring load and disengagement force, the spring rate must be low for low torque settings, but the spring and adjustment would be inconveniently long if this rate were used for high torque values. The variable spring rate provided by the two sets of springs overcomes this difficulty and solves the problem. The diagram of FIG. 7 illustrates the action of the springs.

The clutch provided by the present invention is symmetrical and is operable for right hand and left hand fasteners, the action being the same in both directions.

The clutch assembly is such that it may be rapidly and easily installed and rapidly and easily removed from the tool to facilitate change overs from one size of fastener to another or for laboratory recalibration of the clutches. The change over can be readily made by unskilled operators with assurance of the maintenance of the desired or required torque setting.

Further, the clutch releases accurately on reaching the pre-set torque level and screws are driven to proper torque without looseness or stripping.

The invention and its attendant advantages will be understood from the foregoing description and it will be apparent that various changes may be made in the form, construction and arrangement of the parts of the invention without departing from the spirit and scope thereof or sacrificing its material advantages, the arrangement hereinbefore described being merely by way of example, and I do not wish to be restricted to the specific form shown or uses mentioned except as defined by the accompanying claim, wherein various portions have been separated for clarity of reading and not for emphasis.

I claim:

In an automatically disengageable clutch:

(A) a hollow clutch sleeve with a wall at the rear end, said wall having an axial bore therethrough;

- (B) a clutch driver including a shaft in said clutch sleeve, said shaft rotatably and slidably extending through the opening in the rear end wall of said clutch sleeve, said shaft having a rear portion with flattened sides for reception in a socket of a drive shaft for effecting a positive drive connection between said drive shaft and said clutch driver shaft;
- (C) a stem extending from the outer end of said clutch driver shaft, said stem having an external peripheral V-shaped groove adjacent the free end thereof for engagement by a detent;
- (D) a roller holding disc at the inner forward end of said clutch driver shaft and integral therewith, said roller holding disc having three roller receiving notches extending radially from the periphery thereof and spaced annularly apart equal distances, the side walls of said notches being concave in cross section and facing each other;
- (E) a bit holder screw threaded into the forward end of said clutch sleeve, said clutch sleeve having a plurality of annularly spaced longitudinally extending slots therein;
- (F) an adjustment retaining screw threadably disposed in a tapped bore in said bit holder and having a head slidably disposed in one of said slots, the rear face of said bit holder being normal to the axis thereof and having three V-shaped, radially extending grooves therein for operable reception of respective rollers, said rollers being received in said grooves to a depth just beyond the point of tangency;
- (G) a thrust bearing on said clutch driver having oppositely arranged races, the front race engaging said rollers;
- (H) and means for pre-loading said rollers, said means comprising two sets of Belleville springs disposed on said clutch driver shaft between the rear wall of the clutch sleeve and the rearward race of said thrust bearing, said springs being arranged in series, one set of said springs comprising a series of single Belleville springs, the other set comprising a series of double Belleville springs, said bit holder including a bit retaining sleeve, there being an axial passage through said bit holder.

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