This invention relates to a torque wrench of a type in which a load-engaging member rotatably mounted in the head of a hollow wrench body has an arm positioned to swing against a shoulder of a spring-loaded retractable cam means to retract the cam means when the load torque reaches a predetermined magnitude. The invention is directed to certain problems encountered in the actual use of such a torque wrench and other problems relating to the fabrication and assembly of the wrench.

An important problem in the actual use of such a torque wrench is that when the spring-loading of the cam means is overcome at the desired torque for which the wrench is set, the resistance by the wrench to the applied manual force drops abruptly and the operator's hand naturally follows up by swinging the wrench further in the load-applying direction. The range of follow-up at low resistance by the wrench extends over only a small arc because the cam-actuating arm immediately reaches a limit position to cause the wrench to act in the same manner as a solid one-piece wrench. Thus in the final act of tightening a nut, the wrench is moved through three stages: first, the approach stage in which the desired torque magnitude is attained; next, the short yielding stage or stage of free movement of the wrench; and third, the final impact stage wherein the momentum of the swinging wrench and an appreciable part of the operator's weight are applied abruptly to the work through the unlocked wrench. This final impact stage causes additional tightening of the nut and thus defeats the purpose of accurately predetermining the torque that is to be applied to the work.

The invention solves this problem by a combination of two provisions. One provision is to increase the range of the yielding action of the wrench by increasing the range of movement of the cam-actuating arm beyond the point at which the spring pressure on the cam means is overcome. The other provision is to shape and dimension the spring-loaded cam means for continuing the resistance by the spring to this movement of the arm over the additional or extended range. Thus the drop in resistance to manual force that initiates the yielding stage is greatly reduced. This lessened abruptness in the drop in resistance together with the increased extent of the arc of the yielding stage makes it an easy matter for the operator to terminate the involuntary follow-up movement before the third impact stage is reached. This shape and dimension also serves to return the arm to the original starting point after break-through is accomplished and hand pressure is released. With the impact stage eliminated, the work is tightened precisely to the torque magnitude for which the wrench is set.

A second problem is to provide a simple and accurate procedure for calibrating and recalibrating the wrench so that the torque mechanism of the wrench can be adjusted precisely in accord with any particular coil spring that is used in conjunction with the retractable cam means. A special feature is the provision for calibration at both ends of the range of torque values, one provision for calibration being at one end of the coil spring and the other provision being angular adjustment of the cam-actuating arm.

The invention is further characterized by rapid, accurate manual adjustability over an extensive range of torque values and the provision of a simple, effective and highly convenient means to lock the torque adjustment at any selected value over this range. In this regard a feature of the invention is a lock for this purpose that may be quickly and easily actuated by simple thumb pressure.

A still further feature of the invention is the manner which friction is minimized in the operation and adjustment of the wrench. The work-engaging member is mounted in the wrench head by an efficient thrust and radial bearing assembly. The cam-actuating arm carries a roller for cooperation with the cam means and the cam means itself is an elongated body that is mounted on balls for minimum resistance to the cam action. A further provision in this regard is that one end of the coil spring thrusts against a ball bearing that minimizes the frictional resistance involved in changing the torque adjustment of the wrench.

The various features and advantages of the invention will be apparent from the following detailed description considered with the accompanying drawings.

In the drawings, which are to be regarded as merely illustrative:

Figure 1 is a longitudinal sectional view of the presently preferred embodiment of the invention;

Figure 2 is a fragmentary view of the wrench partly in side elevation and partly in section, the wrench being rotated on its longitudinal axis 90° from the position shown in Figure 1;

Figure 3 is a side elevation of the wrench in the same position as shown in Figure 2, with the locking collar on the wrench retracted to its unlocking position;

Figure 4 is a fragmentary view similar to Figure 3, showing the locking collar returned to its locking position;

Figure 5 is an enlarged fragment of Figure 1 showing the construction of the locking mechanism;

Figure 6 is a fragmentary side elevation of the shank portion of the wrench body showing circumferentially spaced longitudinal grooves that are employed in the locking mechanism;

Figure 7 is a transverse section taken as indicated by the line 7—7 of Figure 6;

Figure 8 is an elevation at the handle end of the wrench as viewed along the line 8—8 of Figure 1;

Figure 9 is a side elevation of a resilient ring that is employed in the locking mechanism; and

Figure 10 is a side elevation of a resilient retaining ring that prevents inadvertent separation of the wrench.

General arrangement

The presently preferred embodiment of the invention shown in the drawings includes a hollow wrench body having a head 29 and a tubular shank 22 integral therewith. Rotatably mounted in the head 29 is a load-engaging member 24 in the form of a hub having an axial extension 25 of square cross section for releasable engagement with conventional socket members. For this purpose, the axial extension 25 is provided with the usual detent ball 26 under pressure by a small coil spring 28 (Figure 8).

The load-engaging member 24 has a cam-engaging arm 30 extending radially therefrom into the shank 22. This arm is forked at its inner end to carry a roller 32 on an axle pin 34 for cooperation with a cam means or element 35. The cam element 35 has a cam shoulder 36 and is the forward end portion of an elongated cam body 38. The cam body 38 is slidable longitudinally in the tubular shank 22 and for this purpose is provided with
a plurality of small balls 40 which rotate in corresponding sockets in the cam body and make rolling contact with the surrounding wall of the tubular shank. In the construction shown there are two pairs of the balls 40, one at each end of the cam body 38, the two pairs at diametrically opposite locations on the circumference of the cam body.

Retraction of the cam body 38 in response to the load torque is opposed by a relatively heavy coil spring 45 and the extent to which this spring is compressed against the cam body may be varied by rotation of a cylindrical means in the form of a knurled tubular handle 46 that is telescoped over the end of the tubular shank 22. The magnitude of the critical torque is indicated by the micrometer scale shown in Figures 3 and 4 and the handle 46 may be locked against rotation at any selected torque adjustment by means of a manually operable locking collar 48.

In the normal position of the cam-actuating arm 30 prior to the attainment of the torque for which the wrench is adjusted, the roller 32 bears against the cam shoulder 36 with the cam shoulder blocking the tendency of the section in reaction to the applied load. When the predetermined torque is reached, the arm 30 overcomes the resistance of the spring 45 and the roller 32 climbs the cam shoulder 36 to cause retraction of the cam body 38 in opposition to the spring.

Figure 2 shows the position of the roller 32 as it passes over the crest of the shoulder 36. From this point the roller moves along a cam surface 50 that is inclined to cause continued retraction of the cam body 38. Thus the spring 45 continues to offer resistance of moderate degree to the continued swinging movement of the arm 30 and this moderate resistance together with the extension of the range of yielding action makes it possible for the operator to avoid the usual third impact stage, as heretofore explained. When the operator subsequently releases his grip on the wrench, the spring pressure causes the inclined cam surface 50 to return the arm 30 to its starting position.

**Structural details**

The head 20 of the hollow wrench body is of cylindrical configuration with a lateral opening 52 through which the cam-actuating arm 30 extends. One end of the head 20 is closed by a threaded plug 54 having a diametrical slot 55 for rotation by a screwdriver and normal use of this slot is filled with a low-melting alloy 56 to discourage tampering. The other end of the head 20 is formed with an inwardly directed radial flange 58 to confine a suitable bearing such as a needle bearing 60. The needle bearing 60 embraces a cylindrical portion 62 of the hub-engaging member. The opposite end of the load-engaging member 24 is reduced in diameter as shown at 65 and is embraced by a second bearing 66. Preferably this smaller end of the load-engaging member 24 is formed with a small socket to seat a small ball 68 which functions as a thrust bearing in abutment against the inner surface of the threaded plug 54.

As shown in Figure 1, the load engaging member 24 is suitably adapted for fixed engagement by a collar 70 that is integral with the cam-actuating arm 30. In the construction shown, the load-engaging member and the collar are cast for this purpose. This construction makes it possible to connect the arm 30 with the load-engaging member 24 with the square axial extension 25 of the load-engaging member at approximately any angle desired relative to the radial direction of the arm. The snap ring 64 engages the load-engaging member 24 in abutment against the serrated collar 70 to anchor the load-engaging member against axial movement relative to the collar.

The normal position of the arm 30 and the normal position of the roller 32 relative to the cam shoulder 36 prior to the attainment of a predetermined torque load is determined by a self-locking set screw 72 in a threaded cross bore in the arm, this set screw protruding from the arm into abutment with the inner wall of the tubular shank 22. This set screw is accessible through an aperture 75 in the tubular shank (Figure 2), which aperture is normally closed and concealed by an outer circumferential band 76. As shown in Figure 1, the band 76 may be anchored by a small screw 77 that extends through the band and into the shank wall.

One end of the coil spring 45 surrounds a centering boss 89 of the cam body 38 and the other end surrounds a similar centering boss 92 on an adjustable screw means in the form of an adjustment bushing 84. The adjustment bushing 84 is peripherally threaded for engagement with an internal screw thread 85 of the tubular shank 22 so that rotational adjustment of the bushing varies the degree to which the coil spring 45 is compressed and thus varies the load torque at which the spring pressure is overcome by the cam-actuating arm 30.

One of the features of the invention is the provision of a thrust bearing at one end of the coil spring 45 to minimize frictional resistance to rotational adjustment of the adjustment bushing 84. In the present embodiment of the invention, a ball thrust bearing 86 surrounds the centering boss 82 for this purpose, one race of the ball thrust bearing being backed against the adjustment bushing 84 and the other race being in abutment with the coil spring 45.

The adjustment bushing 84 is operatively connected to the knurled tubular handle 46 to be rotated by the handle and is adjustable relative to the handle to permit calibration. In the construction shown, the adjustable bushing 84 has a shank or stem 88 integral therewith which is formed with slot 89 at its end for rotation by a screwdriver. The stem 88 has an external screw thread 90 which engages a similar internal screw thread of a ring member 92 in the end of the tubular handle 46. The ring member 92, which preferably is externally serrated as shown in Figure 8, is brazed to the surrounding tubular handle 46. Preferably the screw thread 90 of the adjustment bushing stem 88 is of finer pitch than the internal screw thread 85 of the tubular shank 22 that is engaged by the adjustment bushing 84.

The adjustment bushing 84 is releasably locked against rotation relative to the ring member 92 by a screw threaded locking member in the form of a locking plug 95 that threads into the ring member and is formed with a hexagonal opening 96 for engagement by a suitable tool. When the wrench is completely calibrated, the hexagonal opening 96 is filled with a low melting alloy 98 to discourage tampering. Preferably a flexible split ring 100, shown in Figure 10, is positioned inside the end of the tubular shank 22, as shown in Figure 1, to block inadvertent complete withdrawal of the adjustment bushing 84.

For the purpose of releasably locking the tubular handle 46 at selected positions of rotation relative to the tubular shank 22, the tubular shank is provided with a series of circumferentially spaced longitudinal locking grooves 105, as indicated in Figures 6 and 7, there being in this instance ten such grooves. For selective cooperation with the locking grooves 105, the tubular handle 46 has an aperture 104, as best shown in Figure 5, to receive a locking ball 105, the diameter of the locking ball being sufficiently greater than the thickness of the wall of the tubular handle to extend into the locking grooves 105 selectively for positive engagement therewith. At the locking position of the locking collar 106, as shown in Figures 1, 2, 4 and 5, the locking collar confines the locking ball 105 in engagement with a selected locking groove 106. At the alternate release position of the locking collar 106, an inner circumferential recess or releasing groove 106 of the locking collar registers with the aperture 104 to permit the locking ball 105 to re-
tract outwardly from engagement with the tubular shank 22.

Preferably suitable detent means is provided to hold the locking collar at its two alternate positions in a releasable manner. For this purpose, a resilient split ring 108 shown in Figure 9 yieldingly embraces the tubular handle 46 between two spaced shallow grooves 112 around the circumference of the tubular handle, the surface of the tubular handle being smoothly curved between these grooves as shown in Figure 5. Thus the resilient split ring 108 serves as detent means to releasably retain the locking sleeve 48 at either of its two limit positions.

This particular embodiment of the invention has a range of torque adjustment from 100 inch-pounds to 750 inch-pounds and one complete rotation of the adjustment bushing 84 by the tubular handle 46 represents a change of 50 inch-pounds. Thus each of the longitudinal locking grooves 102 represents an increment of 5 inch-pounds since there are ten of the locking grooves around the circumference of the tubular shank. The micrometer scale for indicating the torque adjustment of the wrench includes a long leg 113 on the tubular shank 22 to be used in conjunction with a series of scale marks 114 around the forward rim of the tubular handle 46, there being ten of these scale marks, each representing an increment of 5 inch-pounds. Also on the tubular shank 22 is a series of axially spaced scale marks 115 each representing the advance accomplished by one complete rotation of the tubular handle 46, an advance that represents 50 inch-pounds. Thus the torque adjustment of the wrench may be set and locked at any multiple of 5 inch-pounds between 100 inch-pounds at the low end of the scale and a magnitude of 750 inch-pounds at the high end of the scale.

The manner in which the invention serves its purpose may be readily understood from the foregoing description.

In the recommended calibration procedure the wrench is first set for torque adjustment of 100 inch-pounds on the micrometer scale, this adjustment being shown in Figure 4. A qualified torque testing device is then employed for guidance in rotational adjustment of the adjustment bushing 84. To make this adjustment, the locking plug 95 is loosened or removed to permit the use of a screwdriver in the slot 89 in the end of the stem 88 for the purpose of rotating the adjustment bushing 84 until the actual torque resistance of the wrench is 100 inch-pounds. With the stem 88 stationary, the handle 46 is then rotated for screw travel along the stem until the position of the handle relative to the scale indicates a torque of 100 inch-pounds. The locking plug 95 is then tightened in the ridge 92 against the end of the stem 88 to interlock the adjustment bushing 84 with the tubular handle 46 in a fixed manner.

The next step in the calibration procedure is to set the wrench at 750 inch-pounds on the torque scale and again to apply the torque tester to ascertain the actual torque resistance of the wrench. If the adjustment is required, the small screw 78 is loosened to permit axial displacement of the outer band 76 for access to the interior of the tubular shank 22. A suitable tool is then inserted through the shank aperture 75 for adjustment of the set screw 72. The set screw 72 is rotated to shift the relation of the roller 32 relative to the cam shoulder 36 until the torque resistance of the wrench is found to be exactly 750 inch-pounds. If this last adjustment at the high end of the torque scale is only minor, the result on the adjustment at the lower end of the scale will be negligible. It is advisable, however, to check both ends of the scale and to make the adjustments alternately until the desired accuracy of calibration is attained. Usually the radius of the point of contact of the roller 32 with the cam shoulder 36 at the final adjustment is approximately 45° from the axis of the tubular shank 22.

It is a simple matter to move the locking collar 48 quickly by thumb pressure between its two positions whenever it is desired to change the torque setting of the wrench. This feature is a time-saving convenience.

When the torque resistance of the load reaches the magnitude for which the wrench is adjusted, the arm 30 overcomes the spring resistance to force the cam body 38 to retract. The roller 32 climbs the crest of the cam shoulder 36 and then rolls along the cam surface 50 until the roller reaches a limit position against the inner wall of the tubular shank 22. This additional range of movement of the cam-actuating arm 30 is a substantial arc and, of course, the length of the corresponding arc at the end of the wrench handle is at least twice as long. The fact that there is a substantial range of travel of the roller 32 after it climbs the cam shoulder 36 and the further fact that the cam surface 50 is inclined for continued moderate spring resistance to this movement, makes it possible for the operator to control the follow-up movement of the wrench and avoid the previously described third impact stage that characterizes conventional torque wrenches of this general type.

Frictional resistance to operation and adjustment of the wrench is avoided by the various described anti-friction expedients, including the bearings associated with work-engaging member 24, the roller 32 at the end of the cam-actuating arm 30, the balls 40 in the periphery of the cam body 38 and the thrust bearing 56 at the end of the coil spring 45.

My description in specific detail of the presently preferred embodiment of the invention will suggest various changes, substitutions and other departures from our disclosure within the spirit and scope of the appended claims.

I claim:

1. In a torque wrench wherein a work-engaging member rotatably mounted in the hollow body of the wrench has an arm for swinging movement against a shoulder of a cam element for indication of a predetermined torque by retraction of said cam element against the resistance of a spring, the improvement which consists in providing freedom for a range of continued swinging movement of said arm past said shoulder and of providing said cam element with a cam surface for continuous contact with said arm through said range, said cam surface being inclined relative to the direction of retraction of said cam element to cause continued spring resistance to retraction of the cam element to lessen the drop in the resistance of the wrench to continued manual movement when said predetermined torque is reached, thereby to retard the continued manual movement of the wrench by the operator to permit the operator to terminate the continued manual movement substantially within said range.

2. In a torque wrench having a hollow body comprising a head, a tubular shank integral with said head and a tubular handle telescoped on said shank and rotatable thereon to vary the torque adjustment of the wrench, means for releasably lock said handle at selected rotary positions relative to said shank, said locking means comprising: a plurality of circumferentially spaced longitudinal locking grooves in the periphery of said shank; a locking aperture in the tubular wall of said handle to register with said locking grooves selectively; a locking element in said locking aperture of greater radial dimension than the aperture to occupy both the aperture and a selected locking groove relative to said shank; and a locking collar embracing said handle in the region of said locking aperture, said
locking collar having an inner releasing recess and being moveable axially between a locking position at which it covers said locking aperture to prevent radial retraction of a cam element and said release position in which said inner releasing recess registers with said locking aperture to permit radial retraction of the locking element to a release position.

3. A combination as set forth in claim 2 in which said locking element is a ball member.

4. A combination as set forth in claim 2 in which said detent means comprises: a pair of axially spaced circumferential detent grooves in the periphery of said tubular handle; an inner circumferential groove in said locking collar to register with said detent grooves selectively; and a resilient detent ring yieldingly embracing said tubular handle for releasable engagement with said grooves, the radial dimension of said ring being greater than the depth of said detent grooves and the radial dimension of said inner circumferential groove being sufficient for retraction of said ring out of engagement with said detent grooves.

5. A combination as set forth in claim 4 in which said detent means comprises: a pair of axially spaced circumferential detent grooves in the periphery of said tubular handle; an inner circumferential groove in said locking collar to register with said detent grooves selectively; and a resilient detent ring yieldingly embracing said tubular handle for releasable engagement with said grooves, the radial dimension of said ring being greater than the depth of said detent grooves and the radial dimension of said inner circumferential groove being sufficient for retraction of said ring out of engagement with said detent grooves.

6. In a torque wrench having a hollow body comprising a head and a tubular shank integral therewith and wherein a work-engaging member journaled in said head has an axially extending threaded portion within said shank means cooperative with said arm for predetermined reseating means for engagement of the head of the wrench to the shank, a rotary element integrally connected between said body and the surrounding the shank wall at longitudinally spaced points to maintain clearance between the body and the shank wall and to minimize frictional resistance to longitudinal movement of the body; a rotate means on said arm forming the free end thereof; a cam element carried by the forward end of said body, said cam element having a shoulder normally engaging said rotate means to block swing movement of said arm in reaction to the torque load on said work-engaging member; a coil spring in said shank having one end exerting pressure against the end of said body and adjustable screw and nut confining the other end of said spring for variable compression of the spring.

7. In a torque wrench wherein a work-engaging member rotatably mounted in the hollow body of the wrench has an arm for swinging movement against a shoulder of the wrench member for indication of a predetermined torque; by retraction of said cam element against the resistance of a spring, the improvement which consists in a screw threaded into a transverse threaded bore in said arm to thrust against an inner surface of said hollow body to hold the arm in a normal position against said shoulder with the arm partially climbing the shoulder and thereby partially retraction of the cam element in opposition to said spring, whereby said screw may be adjusted to adjust said arm for calibration of the torque resistance of the wrench.

8. In a torque wrench having a hollow body comprising a head, and a tubular shank integral with said head and wherein a work-engaging member rotatably mounted in said head has an arm extending into said tubular shank for swinging movement against a shoulder of a cam element for indication of a predetermined torque by retraction of the cam element against the pressure of a coil spring, means to vary the pressure exerted by said coil spring thereby to vary the torque load at which said cam element retracts, said varying means including: cylindrical means rotatably embracing said tubular shank and overhanging the outer end thereof; peripherally threaded means inside said tubular shank in threaded engagement with the shank and in abutment against said spring, whereby rotation of the threaded means relative to the shank varies the degree to which said spring is compressed, said peripherally threaded means having a stem in threaded engagement with said cylindrical means; a screw threaded locking member for bringing said locking means and said stem to immobilized said peripherally threaded means relative to said cylindrical means; and a torque scale representing different longitudinal positions of said cylindrical means relative to said shank, whereby said peripherally threaded means may be shifted longitudinally relative to said spring for a given torque value, said cylindrical means may then be shifted longitudinally relative to said stem by screw action until said scale indicates said given value and then said screw threaded locking member may be tightened to immobilize said cylindrical means relative to said stem.

9. A combination as set forth in claim 8 in which said cylindrical means has an internal thread in engagement with a thread on said stem and said locking member is in threaded engagement with said internal thread for binding action against said stem.

10. A combination as set forth in claim 8 in which said internal screw thread is of finer pitch than the peripheral thread of said peripherally threaded means.

11. In a torque wrench having a hollow body with a head portion, a rotatable load-engaging member, and said stem comprising means for bringing said load-engaging member relative to said body when the load torque is below a predetermined magnitude, means to journal said load-engaging member in said head portion, comprising: a bearing surrounding said load-engaging member in abutment against an inner shoulder at one end of said head portion; a screw threaded closure at the opposite end of said head portion; and a single ball member interposed between said closure and the end of said load-engaging member at the axis thereof to serve as a thrust bearing to hold the load-engaging member against axial movement towards said opposite end of the head portion.

12. In a torque wrench having a hollow body comprising a head, and a tubular shank integral with said head and wherein a work-engaging member rotatably mounted in said head has an arm extending into said tubular shank for swinging movement against a shoulder of a cam element for indication of a predetermined torque by retraction of the cam element against the pressure of a coil spring, means to vary the pressure exerted by said coil spring thereby to vary the torque load at which said cam element retracts, said varying means including: cylindrical means rotatably embracing said tubular shank and overhanging the outer end thereof; screw means inside said shank in threaded engagement with the shank and in abutment against said spring to vary the pressure exerted by the spring; a tubular handle rotatably telescoped over said shank, said tubular handle being in threaded engagement with said screw means for longitudinal adjustment of the handle relative to the screw means; releasable means to lock said handle against rotation relative to said screw means at selected positions of adjustment of the handle relative to the screw means so that rotation of the handle operates said screw means to change the pressure of said spring and the rotation of the handle shifts the handle longitudinally relative to said shank; and scale means to indicate the position of said handle relative to said shank in terms of torque values.

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