Jan. 12, 1965 B. GRABOVAC 3,165,014

PREDETERMINED TORQUE RELEASE WRENCH

Filed Aug. 14, 1961 2 Sheets-Sheet 1

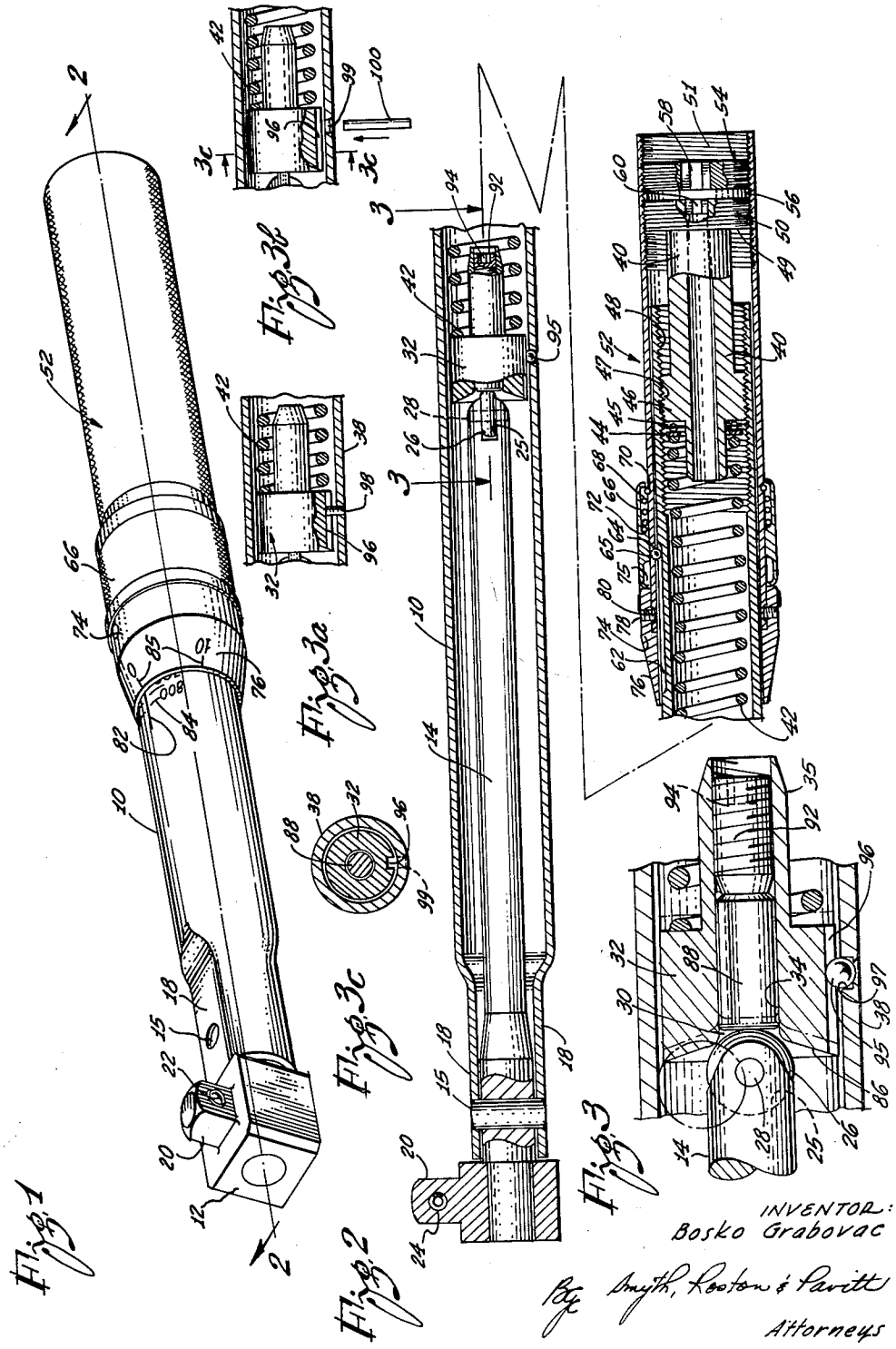


Fig. 1

Fig. 3c

Fig. 3b

Fig. 3a

Fig. 2

Fig. 3

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Filed Aug. 14, 1961 2 Sheets-Sheet 2

Fig. 4

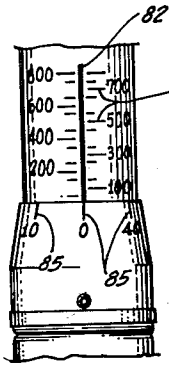


Fig. 10

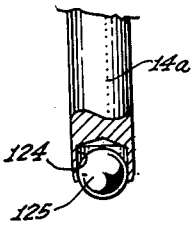


Fig. 5

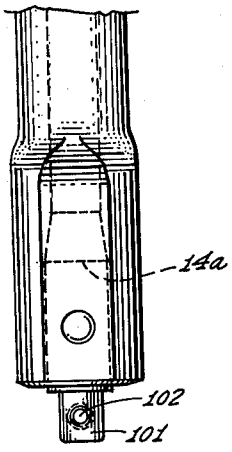


Fig. 6

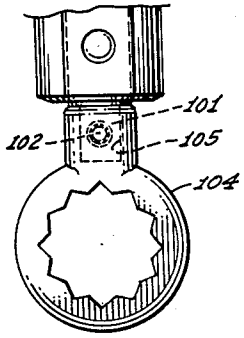


Fig. 7

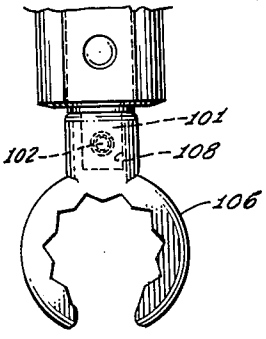


Fig. 8

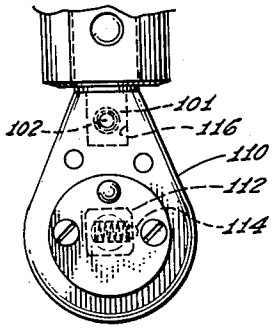
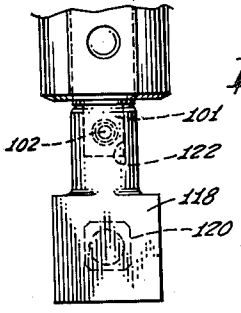


Fig. 9



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3,165,014

PREDETERMINED TORQUE RELEASE WRENCH

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Filed Aug. 14, 1961, Ser. No. 131,127
12 Claims. (Cl. 81—52.5)

This invention relates to an adjustable predetermined torque wrench of the type in which an arm carrying the applied load overcomes the resistance of a spring-pressed shoulder when the applied load reaches a preselected magnitude. The invention is directed to needs for certain improvements, which needs have become increasingly important.

One need is to provide an adjustable torque wrench which may be used to apply torque in either rotary direction. In using conventional adjustable torque wrenches, some kind of manipulation is usually required to change from one direction of torque release to the opposite direction. The manipulation may consist of manual adjustment of a reversing mechanism or may consist of disengaging and reversing the wrench itself. In either event, the manipulation requires time and attention on the part of the operator.

Another need is reduction in cost both by way of simplification of structure and by way of simplification of the assembly procedure. In general, prior art torque release wrenches have numerous working parts and the assembly procedures are necessarily complicated by tedious calibration operations. There is also need for a long run reduction in cost by increased durability of the wrench structure.

The present invention has a number of features which work together to meet these needs for improvement over prior art torque release wrenches. One feature is the use of a spring-pressed two-way cam for cooperation with the load-bearing arm. A roller on the end of the arm is normally seated in a valley or recess of the cam and when the critical torque is reached the roller retracts the cam against spring pressure by traversing one or the other of the two opposite cam shoulders in accord with the rotary direction of application of the wrench. Thus the wrench may be operated in both rotary directions with equal facility and with the same accuracy without requiring disengagement of the wrench from the work and without requiring manipulation of any reversing mechanism.

When the wrench is in service, the torque setting of the wrench is varied by varying the spring pressure against the two-way cam. In assembling the wrench, however, the torque setting is calibrated by varying the configuration of the two-way cam and particularly the configuration of the valley or recess in which the roller is normally seated. For this purpose a portion of the valley or recess of the cam is formed by means that is adjustable by screw thread action. The fact that the configuration of the two-way cam can be varied by adjusting the depth of the cam recess in the factory assembly of the wrench is economically important because it permits wide tolerance with respect to the characteristics of the spring that is used to resist torque. A given torque resistance may be provided with a weak spring by deep adjustment of the cam recess or may be provided with a stronger spring by making shallow adjustment of the cam recess.

With reference to reducing wear and reducing interference with accuracy by wear, one feature of one practice of the invention is the use of a circular cam with a generally conical working surface and the provision for rotational shift of the circular cam for wear distribution over the conical working surface. Wear is also reduced by using hardened impact means.

Simplification of the structure is made possible by the basic concept of using a two-way cam to eliminate the necessity for a multiple part reversing mechanism. The number of working parts of the wrench is reduced to the minimum with corresponding reduction in weight. Cost reduction is further made possible by the fact that many of the parts may be used for torque wrenches of different sizes.

The use of a conical cam simplifies assembly because there is nothing critical about the orientation of the circular cam relative to the load-bearing arm or the roller on the load-bearing arm. As will be explained, a further feature in this regard is the concept of flattening a portion of the tubular shank of the wrench to make possible an exceedingly simple but efficient pivotal mounting for the load-bearing arm. Assembly is further simplified by so constructing the wrench that all of the necessary calibration adjustments may be made from the handle end of the wrench, the interior of the wrench being fully accessible from the handle end for this purpose.

A further feature of the invention is the provision of interchangeable heads. Thus, by simply changing heads, the wrench may be equipped with square drive heads of different sizes, or may be used as an open end wrench, or may be used as a box head wrench, or may be used as a ratchet wrench.

The various features and advantages of the invention may be understood by reference to the following detailed description and the accompanying drawings.

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

FIG. 1 is a perspective view of a selected embodiment of the invention;

FIG. 2 is a longitudinal sectional view taken as indicated by the line 2—2 of FIG. 1;

FIG. 3 is an enlarged fragmentary section taken as indicated by the line 3—3 of FIG. 2 and showing how the roller on the end of the load-bearing arm is normally seated in the central recess of the conical cam;

FIG. 3*a* is a fragmentary section similar to FIG. 3 showing a modification of the structure;

FIG. 3*b* is a similar fragmentary section showing another modification of the structure;

FIG. 3*c* is a transverse section taken on the line 3*c*—3*c* of FIG. 3*b*;

FIG. 4 is a fragmentary elevational view showing the scale arrangement on the wrench for indicating different torque settings;

FIG. 5 is a fragmentary plan view of a modified form of the invention which is adapted to use a number of different working heads selectively;

FIG. 6 shows the modified form of the invention equipped with a box wrench head;

FIG. 7 is a similar view showing the modified wrench equipped with an open end wrench head;

FIG. 8 is a similar view showing the modified wrench equipped with a ratchet head;

FIG. 9 is a similar view of the modified form equipped with a square drive head; and

FIG. 10 is a fragmentary side elevation of a modified arm that may be used in another embodiment of the invention.

The selected embodiment of the invention shown in FIGS. 1–4 includes a hollow body which forms a tubular shank 10. A wrench head 12 at the working end of the tubular shank 10 is mounted on the outer end of a relatively long arm 14 that extends into the tubular shank and an intermediate part of the arm is pivotally connected to the tubular shank by a suitable cross pin 15. In the region of the cross pin 15 the tubular shank 10 is flattened on its opposite sides as indicated in FIGS. 1 and 2 whereby the arm 14 is confined between two flat

walls 18. The two flat walls 18 are parallel with the plane of rotation of the arm 14 and the local portion of the arm is of circular cross sectional configuration to make line or tangential contact with the two flat walls. This arrangement for pivotally mounting the arm 14 in the tubular shank 10 is exceedingly simple structurally and has the further important advantage of making the arm freely swingable with only insignificant frictional resistance.

The wrench head 12 is of conventional construction with a lateral extension 20 of square cross section for releasable engagement with conventional socket members. For this purpose, the lateral extension 20 is provided with the usual detent ball 22 under pressure by a concealed spring 24.

The inner end of the arm 14 is formed with a slot 25 in the plane of rotation of the arm and a rotary means in the form of a roller 26 is journaled in the slot by a suitable axle pin 28. Normally the roller 26 seats in a central recess 30 of a circular cam body 32. In this particular embodiment of the invention the cam body 32 has an axial bore 34 to form the central recess 30 and further has a short tubular shank portion 35 which, in effect, forms a rearward extension of the axial bore. The cam body 32 is yieldingly urged towards the roller 26 on the arm 14 by a helical spring 42 that surrounds the shank portion 35 and is maintained under compression by the tubular spring seat 40. In the construction shown, the coil spring 42 backs against a washer 44, the washer 44 backs against a roller bearing 45, and the roller bearing in turn backs against the tubular spring seat 40.

The tubular spring seat 40 has an enlarged portion 46 with an outer screw thread 47 in engagement with an inner screw thread 48 of the hollow wrench body. The tubular spring seat 40 also has an enlarged rear portion 49 which has an outer screw thread 50 in engagement with an internal screw thread 51 of a tubular handle 52. The tubular handle 52 is rotatably mounted on the wrench shank 10. The tubular spring seat 40 is locked to the tubular handle 52 by means of a locking bushing 54. With the tubular spring seat 40 locked to the tubular handle 52, the pressure exerted by the helical spring 42 against the cam body 32 may be varied by rotation of the handle.

In the construction shown, a flat washer 56 is interposed between the locking bushing 54 and the tubular spring seat 40. To lock the tubular spring seat 40 against rotation relative to the tubular handle 52, the locking bushing 54 is tightened against the flat washer 56. To facilitate manual rotation of the locking bushing 54 it is formed with a hexagonal axial aperture 58 for engagement by an Allen wrench. In like manner the enlarged rear end of the tubular spring seat 40 is provided with a similar hexagonal axial aperture 60.

For the purpose of releasably locking the tubular handle 52 at selected positions of rotation relative to the tubular shank 10 of the wrench, to hold the helical spring 42 under selected degrees of compression, the tubular shank is provided with a series of circumferentially spaced longitudinal locking grooves 62, there being in this instance, five such longitudinal grooves equally spaced about the outer circumference of the wrench shank. For selective cooperation with the locking grooves 62 the tubular handle 52 has an aperture 64 to receive a locking ball 65. The diameter of the locking ball is sufficiently greater than the thickness of the wall of the tubular handle 52 to extend into the locking grooves 62 selectively for positive engagement therewith. The locking ball 65 is controlled by a knurled locking collar 66. The inner circumference of the locking collar 66 is cut away to provide room for a concealed helical spring 68, one end of which abuts a snap ring 70 and the other end of which abuts an inner circumferential shoulder 72 of the locking collar. At the normal position of the locking collar 66, with the locking ball confined in its locking position, the helical spring 68 yieldingly holds the locking collar against an index collar 74 on the forward end of the tubular handle 52. When the locking collar 66 is manually retracted against the resistance of the helical spring 68, an inner circumferential recess or groove 75 of the locking collar registers with the locking ball 65 to permit the locking ball to retract radially outward from engagement with the longitudinal locking groove 62 in which it is seated. When the tubular handle 52 is rotated to a new rotary position with corresponding shift of the locking ball 65 to a new locking groove 62, the locking collar is released to return to its normal position under the pressure of the helical spring 68 with consequent camming of the locking ball into positive engagement with the new locking groove.

The index collar 74 has a leading tapered surface 76 adjacent the peripheral surface of the tubular shank 10 of the wrench. The index collar is mounted on the tubular handle 52 in a manner that permits rotational adjustment relative to the handle. In the construction shown, the index collar 74 has a pair of diametrically opposite set screws 78 that extend into a circumferential groove 80 in the tubular handle. At the time of assembly these two screws are tightened.

In this particular embodiment of the invention, the wrench has a range of torque adjustment from 100 inch-pounds to 750 inch-pounds, and one complete rotation of the tubular handle 52 causes the tubular spring seat 40 to advance along the inner screw thread 48 of the tubular shank 10 of the wrench for a distance that represents a change of 50 inch-pounds. Thus each of the five longitudinal locking grooves 62 represents an increment of 10 inch-pounds.

As shown in FIGS. 1 and 4, the tubular shank 10 of the wrench has a longitudinal index mark 82 which is flanked by staggered lateral scale marks 84. Each of the scale marks 84 represents an advance accomplished by one complete revolution of the tubular handle 52 and therefore represents a change in torque resistance of 50 inch-pounds. The tapered surface 76 of the index collar 74 is provided with a series of equally circumferentially spaced index marks 85 which are numbered 0, 10, 20, 30 and 40. One of these index marks 85 registers with the longitudinal index mark 82 whenever the locking ball 65 is in positive engagement with one of the longitudinal locking grooves 62 of the shank 10 of the wrench.

The cam body 32 has a conical cam face 86 and an axial member 88 mounted in the axial bore 34 of the cam body is set inward from the conical cam face to form the previously mentioned central recess 30 in which the roller 26 is normally seated. The axial member 88 may be regarded as an adjustable section of the cam body.

Any suitable means may be provided for adjustment of the axial member 88 longitudinally to vary the configuration of the cam body and specifically to vary the depth of the central recess 30 of the cam body. In the construction shown, the axial body 88 is a short, hardened rod which backs end-to-end against a set screw 92 that is threaded into the rear end of the tubular shank portion 35 of the cam body 32. The set screw 92 has a hexagonal socket 94 to receive an Allen screw for rotary adjustment.

A feature of this embodiment of the invention is that the hexagonal aperture 60 of the locking bushing 54 is larger than the hexagonal aperture 58 of the spring seat 40, the hexagonal aperture 58 of the spring seat 40 is larger than the hexagonal socket of the set screw 92, and the two hexagonal apertures 60 and 58 along with the flat washer 56 provide an axial passage into the butt end of the rotary handle 52 that leads to the set screw 92. This arrangement makes it possible to use a small Allen wrench to adjust the set screw 92 without loosening the locking bushing 54, to use a larger Allen wrench to adjust the tubular spring seat without removing the locking bushing, and to use a still larger Allen wrench for independently rotating the locking bushing.

It is apparent that the tubular spring seat 40 forms a portion of the axial passage for access to the set screw

92. The tubular shank portion 35 of the cam body 32 also serves as a guide for the helical spring 42.

It has been found that there are certain optimum dimensional relationships for parts of the described wrench mechanism. The diameter of the roller 26 should be approximately twice the diameter of the axial bore 34 of the cam body 32. The rim or periphery of the roller 26 should be laterally curved as shown in FIG. 2 and the radius of the lateral curvature of the roller should approximate the radius of the axial bore 34. The rim of the axial bore 34 around the recess 30 should be curved in cross section and the radius of this curvature should be approximately ½ the radius of the axial bore 34. When the roller 26 is at its normal position seated in the recess 30, the extent to which the roller protrudes into the recess should be no more than slightly less than half the diameter of the roller and should be no less than approximately one-ninth of the diameter of the roller. In the initial embodiment of the invention, the diameter of the axial bore 34 is approximately 0.1875 inch; the diameter of the roller 26 is approximately 0.365 inch; the transverse curvature of the rim of the roller 26 has a radius of approximately 0.09375 inch; the rim of the axial bore 34 is rounded to a radius of approximately 0.046 inch.

It has been found desirable to make some provision for holding the cam body 32 against rotation when the set screw 92 is being adjusted by an Allen wrench. In FIGS. 2 and 3 this provision consists of a ball 95 slidingly engaging a longitudinal groove 96 in the periphery of the cam body 32. The ball is retained in an aperture 97 in the wall of the hollow body of the wrench, the rim of the aperture being peened or staked to retain the ball.

FIG. 3*a* shows a modification of the feature. A pin 98 is permanently mounted in the wall of the hollow wrench body in sliding engagement with the longitudinal groove 96.

FIGS. 3*b* and 3*c* show another modification in which the wall of the hollow body is provided with a small aperture 99 that is left open. When desired, any suitable means such as a small pin 100 may be temporarily inserted through the aperture 99 into engagement with the cam body 32 to hold the cam body against rotation. One advantage of this arrangement is that normally the cam body is free to rotate for wear distribution.

The manner in which the described wrench construction serves its purpose may be readily understood from the foregoing description. The factory calibration of the wrench starts with the locking bushing 54 and the flat washer 56 removed to expose the hexagonal aperture 60 of the tubular spring seat 40. With the guidance of a suitable torque-measuring instrument, an Allen wrench is engaged with the hexagonal aperture 60 for rotational adjustment of the tubular spring seat 40 relative to the wrench shank 10 to cause the cam body 32 to yield against the resistance of the spring 42 when the applied torque reaches precisely 100 inch-pounds. To hold this adjustment, the locking bushing 54 is tightened against the flat washer by means of another larger Allen wrench to lock the tubular spring seat 40 to the tubular handle 52. The tubular handle is then rotated to advance the tubular spring seat 40 relative to the wrench shank 10 until the zero index mark 85 on the index collar 74 registers with the longitudinal index mark 82 and the scale mark 750 and on the wrench shank 10 to indicate a torque of 750 inch-pounds. With the guidance of the torque measuring instrument, a small Allen wrench inserted into the butt end of the wrench is used to rotate the set screw 92 to make the yielding retraction of the cam body, i.e. the breaking point of the wrench, occur at exactly 750 inch-pounds. To advance the set screw 92 is to advance the hardened rod in the axial bore to reduce the depth of the central recess 30 thereby to lower the breaking point; to retract the set screw to retract the hardened rod increases the depth of the central recess 30 to raise the breaking point. The handle 52 is then rotated back until the torque scale again reads 100 inch-pounds and the tubular spring seat 40 is again adjusted, if necessary, to cause the breaking point to occur precisely at 100 inch-pounds. In this way the calibration adjustment is made alternately at the upper and lower ends of the torque scale until the desired accurate calibration is achieved. When satisfactory calibration has been achieved with the locking bushing 54 tightened against the flat washer 56, the butt end of the rotary handle 10 is potted, i.e. filled with a potting resin in a well known manner.

A feature of the invention is the provision of the independently adjustable index collar 76 for rotational shift of the index marks 85. Since the tubular spring seat 40 is advanced and retracted by a relatively coarse screw thread, it is improbable that the desired scale mark 85 on the rotary handle 46 will register precisely with the longitudinal index mark 82 on the wrench shank when correct adjustment of the tubular spring seat and the set screw 92 are achieved. It is a simple matter, however, to loosen the two set screws 78 for final rotational adjustment of the index collar 74 for precise registration of the desired index mark 85 on the index collar with the longitudinal index mark 82 on the wrench shank.

When the wrench is employed to apply torque to a work piece, the applied torque causes the arm 14 to seat on one side or the other of the central recess 30 in abutment with the rounded rim of the axial bore 34. If the rotary direction of the applied torque is reversed, the roller 26 shifts to the opposite side of the recess 30. When the torque is reached for which the wrench is adjusted, the cam body 32 yields against the resistance of the spring 42 and the arm 14 swings with a snap across the radius of the cam body into impact with the inner circumferential wall of the wrench shank 10. This snap action is distinctly felt by the operator and produces an audible signal that is readily heard.

FIGS. 5–9 show how the described wrench construction may be modified to make it possible to use a number of different wrench heads interchangeably. As shown in FIG. 5, the outer end of the arm 14*a* which corresponds to the previously described arm 14 is formed with an axial extension 101 that is square in cross section to receive the socket of any one of a set of interchangeable wrench heads, the axial extension being provided with a spring-pressed detent ball 102 in a well known manner. FIG. 6 shows a box head 104 formed with a socket 105 for releasable engagement with the axial extension 101. FIG. 7 shows an open-end wrench head 106 formed with a socket 108 in releasable engagement with the axial extension 101. FIG. 8 shows a ratchet head 110 with a rotary axial extension 112 of square cross section, the rotary axial extension being provided with the usual spring-pressed detent ball 102 for releasable engagement with various socket members. The ratchet head 110 is formed with a socket 116 for releasable engagement with the axial extension 101 of the wrench. FIG. 9 shows a drive head 118 with an axial extension or square drive 120, the head being formed with a socket 122 for releasable engagement with the axial extension 101 of the wrench. A number of different drive heads 118 may be provided with square drives 120 of different dimensions.

In each instance the distance of the axis of the drive head from the fulcrum of the arm 14 at the cross pin 15 is the same as in the first embodiment of the invention shown in FIGS. 1 and 2.

FIG. 10 shows how the construction of the wrench may be modified by substituting an arm 14*a* for the previously described arm 14. The arm 14*a* is formed with a socket 124 on its leading end to confine a hard metal ball 125 for cooperation with the circular cam body 32. The steel ball 125 may rotate in the socket to function in the same manner as the previously mentoned roller 26 that it replaces. If desired, however, the steel ball may be immobilized in the socket.

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

I claim:

1. In a torque wrench having a hollow body and having a work-engaging member rotatably mounted on said body, said work-engaging member being operatively connected to a swingable arm inside the body, means cooperative with said arm for predetermined resistance to swinging movement of the arm away from a normal position, said cooperative means comprising: rotary means journaled on the end of said arm; a cam inside said body, said cam having an axial bore; an axal member in said bore defining with the cam an axial recess in which said rotary means is normally seated, said cam being movable to retract in response to cam action by swinging of the arm in either of two opposite directions, said axial member being adjustable axially to vary the depth of said recess; and spring means opposing retraction of the cam thereby opposing swinging movement of the arm in the two opposite directions.

2. In a torque wrench having a hollow body and having a work-engaging member rotatably mounted on the body, said work-engaging member being operatively connected to a swingable arm inside the body, means cooperative with said arm for predetermined resistance to swinging movement of the arm away from a normal position, said cooperative means comprising: an element with a hard curved surface mounted on the end of said arm; a cam inside said body, said cam having an axial bore; an axial member in said bore defining with the cam an axial recess in which said element is normally seated, said cam being movable to retract in response to cam action by swinging of the arm in either of two opposite directions, said axial member being adjustable axially to vary the depth of said recess; and spring means opposing retraction of the cam thereby opposing swinging movement of the arm in the two opposite directions, the diameter of the curvature of said element being on the order of two times the diameter of said bore.

3. A combination as set forth in claim 2 in which said element is a roller and the perpheral surface of said roller is transversely curved with the radius of curvature approximately equal to the radius of said bore.

4. A combination as set forth in claim 1 in which said axial member is screw-threadedly adjustable by a tool and in which said hollow body has an axial passage for access by the tool through the end of the body.

5. In a torque wrench having a hollow body and having a work-engaging member rotatably mounted on the body, said work-engaging member being operatively connected to a swingable arm inside the body, means cooperative with said arm for predetermined resistance to swinging movement of the arm away from a normal position, said cooperative means comprising: a hard curved element on the end of said arm; a cam inside said hollow body, said cam having an axial bore and being axially movable in the hollow body; a coil spring pressing the cam against the element; a tubular seat for said spring, a forward portion of the tubular seat being in screw-threaded engagement with the interior of said body for axial adjustment relative to the body to variably stress said spring; a tubular handle embracing said body with an end portion of the handle extending beyond the end of the body and with the handle rotatable and longitudinally movable relative to the body, a rearward portion of said tubular seat being in screw-threaded engagement with said handle for axial adjustment between the tubular seat and the handle in the course of the assembly of the wrench; a locking member in screw threaded engagement with the interior of said handle to lock the tubular seat to the handle after the wrench is assembled, said locking member being apertured for access to said tubular seat by a tool; and manually operable means to releasably latch said handle to said body at selected rotary positions of adjustment of said tubular seat relative to the wrench body.

6. In a torque wrench wherein a work-engaging member rotatably mounted on a hollow body of the wrench has an arm for swinging movement against a shoulder of a cam member with the cam member backed against a spring and the spring backed against a spring seat, the spring seat being axially adjustable relative to the hollow body by screw-threaded action and being united for that purpose with a rotary handle that is telescoped over the hollow body, the hollow body having longitudinal index means and the rotary handle having circumferentially spaced index marks for cooperation therewith to indicate the values of torque resistance, the improvement comprising: a collar on said rotary handle with said circumferentially spaced index marks on the collar, said collar being rotatable relative to the rotary handle; and means to immobilize said collar relative to the rotary handle whereby in the procedure of calibrating the wrench, the spring seat may be adjusted for a given torque resistance value and then said collar may be rotatably adjusted to register the correct index mark on the collar with the longitudinal index means on the body of the wrench.

7. In a torque wrench having a hollow body and having a work-engaging member rotatably mounted on the body, said work-engaging member being operatively connected to a swingable arm inside the body, means cooperative with said arm for predetermined resistance to swinging movement of the arm away from a normal position, said cooperative means comprising: a roller journaled on the end of said arm; a cam inside said body forming two opposite cam shoulders in the directions respectively of the opposite swinging movements of the arm, said cam having an axial bore and being axially movable in the hollow body; an axial means in said bore defining with the cam an axial recess in which said roller is normally seated, said axial means being screw-threadedly adjustble relative to the cam to vary the depth of said recess and being formed with a socket to receive a first tool for adjustment; spring means in said hollow body pressing said cam axially against the roller; seat means for said spring, said seat means being screw-threadedly connected with said hollow body for rotation relative to the hollow body to vary the stressing of said spring means, said seat means having an axial passage therethrough for access to said axial means, a portion of said passage being non-circular for engagement by a second tool for adjustment of the seat means, said passage being larger in cross section than said socket to clear the first mentioned tool and manually releasable means screw-threadedly connected with said hollow body for abutment against said seat means to lock the seat means against rotation relative to the body, said manually releasable means having an axial aperture of non-circular configuration to receive a third tool for adjustment thereof; said aperture being larger in cross section than said passage to clear the second tool.

8. In a torque wrench having a hollow body and having a work-engaging member rotatably mounted on the body, said work-engaging member being operatively connected to a swingable arm inside the body, means cooperative with said arm for predetermined resistance to swinging movement of the arm away from a normal position, said cooperative means comprising: rotary means journaled on the end of said arm; a cam inside said body forming a recess in which said rotary means is normally seated and further forming two opposite cam shoulders flanking said recess in the directions respectively of the opposite swinging movements of the arm, said cam being movably mounted in said body to retreat in response to cam action by movement of the rotary means in either of said two opposite directions, said cam comprising at least two separate parts screw-threadedly connected together whereby one of the parts may be rotated relative to the other part for screw adjustment to vary the configuration of

said recess thereby to vary the resistance of the cam to retraction by swinging movement of the arm; means to prevent rotation of said other part of the cam to facilitate the screw-threaded adjustment of the cam; and spring means opposing retraction of the cam thereby opposing swinging movement of the arm in the two opposite directions.

9. A combination as set forth in claim 8 in which said means to prevent rotation of said part of the cam comprises: a longitudinal peripheral groove in the cam and means extending inward from the wall of said hollow body into sliding engagement with said groove.

10. A combination as set forth in claim 8 in which said means to prevent rotation of said other part of the cam includes a longitudinal peripheral groove in said other part and an aperture in the adjacent wall of the hollow body whereby a tool may be inserted through said aperture into sliding engagement with said groove.

11. In a torque wrench having a hollow body and having a work-engaging member rotatably mounted on the body, said work-engaging member being operatively connected to a swingable arm inside the body, means cooperative with said arm for predetermined resistance to swinging movement of the arm away from a normal position, said cooperative means comprising: rotary means journaled on the end of said arm; a circular cam inside said body with a central circular recess in which the rotary means on the end of the arm is normally seated, said circular cam being movable to retract in response to cam action by swinging of the arm in either of two opposite directions, said cam comprising at least two separate parts including an axial part of the cross-sectional dimension of said recess and registered with the recess, at least one of said parts being adjustable to vary the configuration of the recess thereby to vary the resistance to swinging movement of the arm.

12. In a torque wrench having a hollow body and having a work-engaging member rotatably mounted on the body, said work-engaging member being operatively connected to a swingable arm inside the body, means cooperative with said arm for predetermined resistance to swinging movement of the arm away from a normal position, said cooperative means comprising: a hard curved element mounted on the end of said arm; a cam inside said body, said cam having an axial bore and being axially movable in the hollow body; an axial member in said bore defining with the cam an axial recess in which said element is normally seated, said axial member being screw-threadedly adjustable relative to the cam to vary the depth of said recess, said axial member being screw-threadedly adjustable by a tool, said hollow body having an axial passage for access by the tool through the end of the body; spring means in said hollow body pressing said cam axially against said element; seat means for said spring means, said seat means being screw-threadedly connected with the hollow body for rotation relative thereto to vary the stressing of the spring means, said seat means being hollow to form a portion of said passage; manual means exposed to the exterior of the hollow body for rotation of said seat means, said manual means having an inner screw thread, said seat means having an outer screw thread engaging said inner screw thread of the manual means for adjustment of the seat means relative to the manual means; a screw threaded member in engagement with said inner screw thread of the manual means releasably locking the seat means against rotation relative to the manual means, said screw threaded member having an aperture forming a portion of said passage; and manually releasable latch means to latch said manual means against rotation.

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