

Aug. 25, 1959

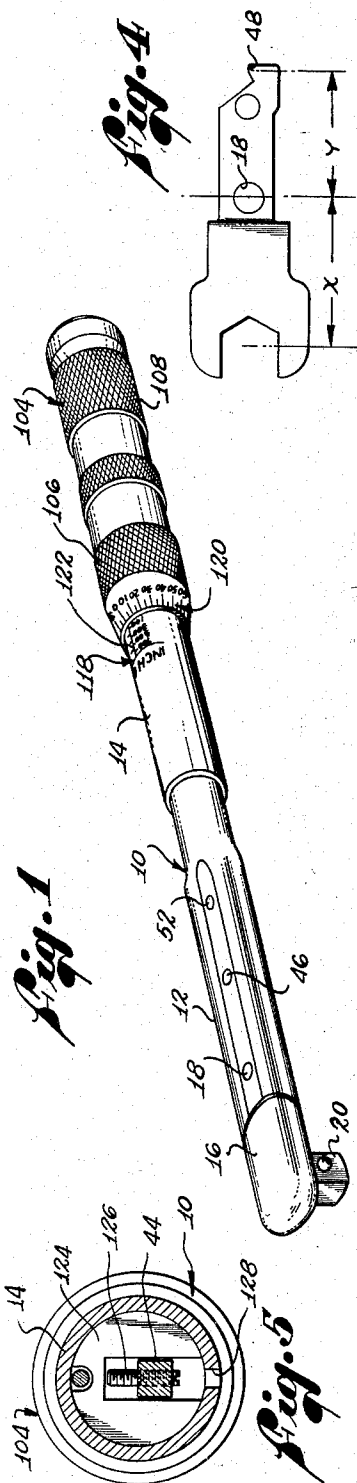
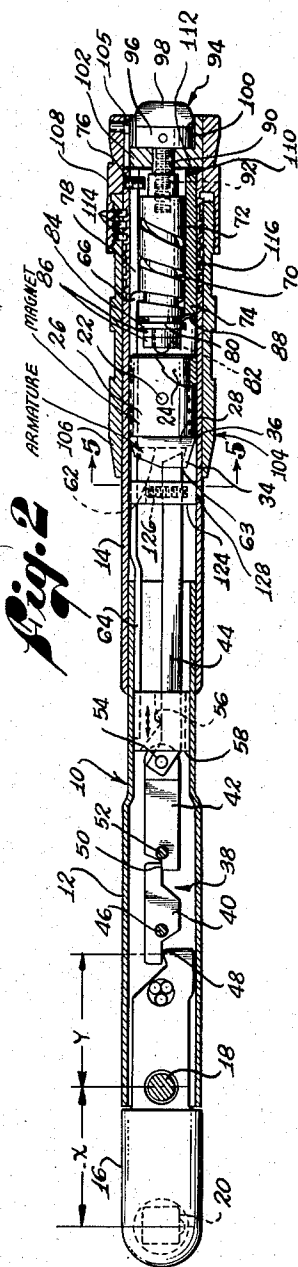
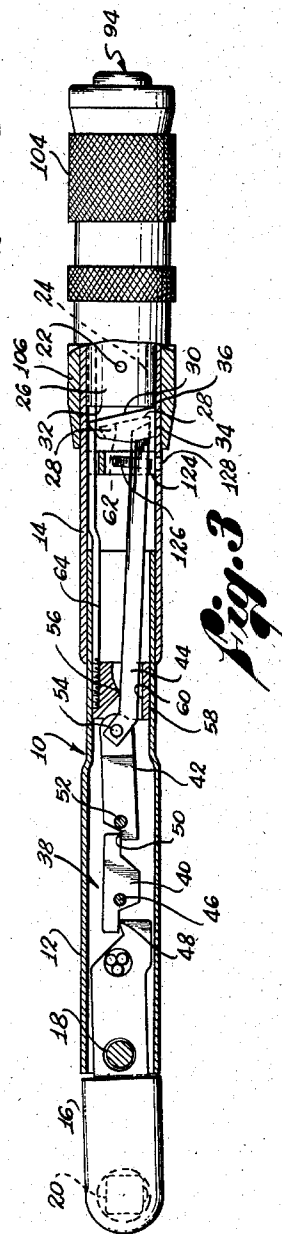
W. E. VAN HOOSE

2,900,855

MAGNETICALLY CONTROLLED, PREDETERMINED TORQUE RELEASE WRENCH

Filed July 29, 1957

2 Sheets-Sheet 1



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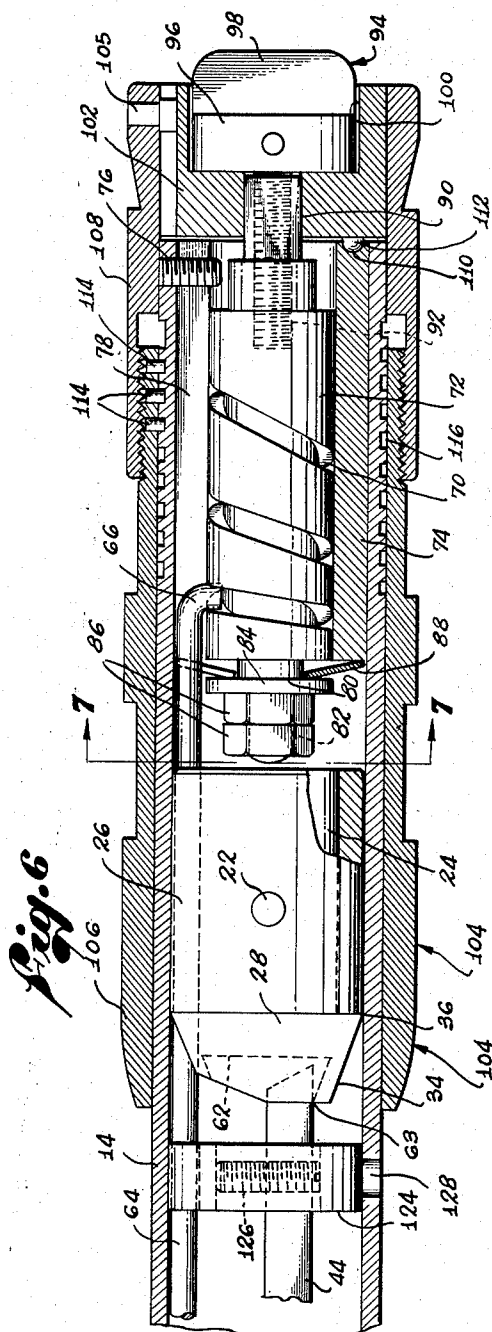
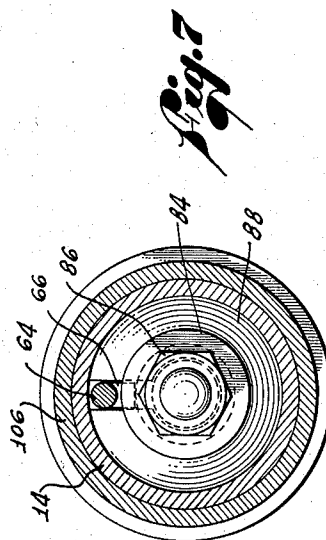
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MAGNETICALLY CONTROLLED, PREDETERMINED TORQUE RELEASE WRENCH

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2 Sheets-Sheet 2



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MAGNETICALLY CONTROLLED, PREDETERMINED TORQUE RELEASE WRENCH

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Application July 29, 1957, Serial No. 674,956

17 Claims. (Cl. 81—52.4)

This invention relates generally to torque applying tools, and more particularly to a magnetic torque limiting wrench.

The present torque limiting wrench may be considered as an improvement on the wrench disclosed in Patent No. 2,791,141, issued May 7, 1957, and entitled "Magnetic Control Means for Predetermined Torque Release Wrench."

Briefly, the wrench of the aforementioned patent comprises a generally tubular housing from one end of which projects a tang formed with a square stud for receiving a socket or other work engaging element. This tang has one end extending loosely into the adjacent end of the housing and is pivotally supported intermediate its ends on the housing so as to be capable of limited rocking movement. When the wrench is engaged with a workpiece, such as a nut or bolt, and a force is applied to the housing in a direction to exert a torque on the workpiece, the tang tends to pivot relative to the housing.

Operatively connected with the inner end of this tang, so as to be rocked by pivoting of the tang relative to the housing are pivotal linkage means including a final pivotal lever arm. This linkage means is so arranged that one end of the lever arm is swung in a given direction, transverse to the length of the housing, by pivoting of the tang on the housing in response to a torque applied to the workpiece. Mounted on this end of the lever arm is a magnetic armature which cooperates with a fixed permanent magnet within the housing to resist swinging of said one end of the lever arm in the given direction.

The magnetic means comprising the armature and magnet are so arranged that the armature is held in contact with the magnet, by magnetic attraction, until the force on the lever arm tending to move the armature in said given direction, away from the magnet, exceeds a predetermined value depending on the magnetic strength of the magnet. This predetermined force on the lever arm, of course, corresponds to a predetermined torque applied to the workpiece.

When this predetermined torque is exceeded, the magnetic field of the magnet is no longer capable of holding the armature in its normal position of contact with the magnet. The armature, and, therefore, the lever arm are suddenly released for movement in the aforesaid given direction away from the magnet. This release of the lever arm allows slight pivotal movement of the linkage means and the tang relative to the wrench housing which is readily detectable by a user of the wrench and provides an indication that the predetermined torque has been reached. Also, movement of the lever arm and armature in said one direction is terminated by engagement of the same with a stop within the wrench housing. The impact produced by this engagement creates an audible indication that the predetermined torque has been reached.

The lever arm is rockably supported, intermediate its ends, on a fulcrum which is adjustable lengthwise of the lever arm and housing to vary the mechanical advantage of the linkage means and, therefore, the force exerted on the armature, tending to break it away from the mag-

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net for a given torque applied to a workpiece. Thus, by proper adjustable positioning of the movable fulcrum along the lever arm, the wrench may be set to "release" at any desired torque value within the range of the wrench. The movable fulcrum is adjusted along the lever arm by means of a rotatable handle on the end of the housing remote from the tang. This handle is operatively connected with the fulcrum through a spiral thread and actuating rod arrangement in such manner that rotation of the handle in one direction imparts movement to the fulcrum in one direction along the lever arm, and the rotation of the handle in the opposite direction imparts movement to the fulcrum in the other direction along the lever arm.

The wrench is provided with a pair of fine and coarse scales which are calibrated in terms of torque value. One of these scales is read by means of an indicator which is operatively engaged with the spiral thread of the fulcrum adjusting means and which is moved along the latter scale in response to rotation of the spiral thread by rotation of the handle. The fine scale is read by cooperating scale marks on the handle and wrench which move past one another when the handle is turned.

While the wrench, just described, is completely capable of performing its intended function of enabling an adjustable, predetermined torque load to be applied to a workpiece, it was found to possess certain deficiencies which are overcome by the present wrench construction. The first of these deficiencies has to do with the initial calibration of the wrench and its range of available torque values. Thus, the patented wrench embodies no means for adjusting the force required to "release" the armature from its magnet. Accordingly, the torque release value of the wrench, for any given setting of the movable fulcrum relative to its lever arm, is fixed solely by the linkage means and is incapable of variation. It is clear, therefore, that the available range of torque values for a given wrench is fixed and invariable.

Such a fixed range of torque values is, of course, undesirable since the manufacture of wrenches having different ranges of torque values then requires that the linkage means of the different wrenches vary slightly. Such variation in the linkage means, of course, adds to the complexity and cost of the manufacturing operations.

An equally, if not more serious, deficiency of such a non-adjustable wrench construction is that initial calibration of the wrench is complicated. Thus, when calibrating a wrench, a known torque value is applied to the wrench with the coarse and fine scales set to indicate this known torque value and the wrench is then adjusted until separation of the armature from its magnet just occurs under this applied torque. This adjustment of the wrench is accomplished by adjusting the position of the fulcrum relative to the lever arm while the fulcrum adjusting means are retained in fixed position with the proper torque value indicated on the wrench scales. This adjustment of the fulcrum requires that the wrench be partially disassembled which, of course, is a time-consuming and troublesome operation. Moreover, it renders accurate calibration of the wrench exceedingly difficult to achieve.

A second deficiency of the patented wrench stems from the fact that movement of the armature relative to its magnet occurs along a direction line extending transverse to the length of the housing. This requires that the magnet be located with its axis also transverse to the length of the housing. The housing of the wrench is, therefore, necessarily formed with an enlarged portion for containing the transversely extending magnet and accommodating such transverse movement of the armature. This housing enlargement appreciably increases the cost and complexity of manufacture of the housing.

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Such an enlargement, also, detracts from the pleasing appearance of the wrench.

A third deficiency of the patented wrench is that one of the torque value indicating scales is an exponential scale. Exponential scales are difficult to read, so that the wrench is subject to improper use except by trained personnel. It is therefore desirable that wrenches of this type embody only linear scales which are readily readable by relatively untrained personnel.

A fourth deficiency of the patented wrench stems from the fact that the tang, for holding the work engaging element, is permanently fixed in the wrench housing. While the wrench is capable of receiving a limited number of different types of work engaging elements, such a permanent tang construction precludes the usage of a great number of other types of work engaging elements on the wrench which are desirable in many applications.

With the foregoing discussion in mind, a broad object of the present invention is the provision of a magnetic torque limiting wrench of the character described which avoids the foregoing and other deficiencies of the existing torque wrench of this type.

A more specific object of the invention is the provision of a magnetic torque limiting wrench having provision for adjustment of the force necessary to break away the armature from its magnet so as to enable adjustment of the range of torque values obtainable with the wrench.

Another object of the invention is the provision of a magnetic torque limiting wrench as in the foregoing wherein adjustment of the force necessary to break the armature away from its magnet is accomplished by varying the air gap between the magnet and armature when the latter is in normal, unreleased position, and wherein further such air gap adjustment is capable of accomplishment exteriorly of the wrench housing so as to appreciably simplify initial calibration of the wrench and achieve more accurate calibration.

Yet another object of the invention is the provision of a magnetic torque limiting wrench wherein movement of the armature during release of the wrench at a predetermined torque occurs longitudinally of the wrench housing, so that the latter may be of more simple and less costly design.

A further object of the invention is the provision of a magnetic torque limiting wrench of the character described which embodies a fine reading scale and a coarse reading scale, both of which have linear scale divisions so as to enable the wrench to be preset to a desired torque value with less chance of error by relatively untrained personnel.

Yet a further object of the invention is the provision of a magnetic torque limiting wrench of the character described wherein the tang, which receives the work engaging element, is removably mounted on the wrench housing so as to enable the wrench to be used with a greater variety of work engaging elements than has heretofore been possible.

A still further object of the invention is the provision of a magnetic torque limiting wrench of the character described which is relatively simple in construction, reliable in operation, relatively inexpensive to manufacture, and otherwise especially well suited to its intended function.

Other objects of the invention reside in various novel structural features and designs of the wrench.

Briefly, the foregoing and other objects and advantages are achieved in the illustrative embodiment of the invention by the provision of an elongate, generally tubular handle or housing in one end of which is loosely received a tang adapted to receive a work engaging element. This tang is pivotally supported intermediate its ends on the housing in such a manner as to be removable from the latter for replacement by tangs mounting a wide variety of work engaging elements.

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Concentrically positioned in the housing, adjacent the other end of the latter, is a fixed cylindrical magnet. Cooperating with this magnet is a generally disc-like armature which is located on the end of the magnet proximate to the tang. In the normal unreleased condition of the wrench, this armature is positioned substantially coaxial with the magnet and with a circular face thereof in close proximity to or contacting a circular end face of the magnet.

The peripheral surface of the armature is bevelled at one position so as to provide, in effect, a knife edge bearing in the plane of the aforementioned circular face of the armature about which the latter may rock. The armature is rockable in a direction substantially longitudinally of the housing, from its above-described normal position to a released position remote from the magnet in response to a predetermined torque applied to a workpiece by the work engaging member attached to the tang.

Operatively connecting the tang and armature in such manner that pivoting of the tang in one direction relative to the wrench housing causes rocking of the armature from its normal position to its released position, as described above, is a pivotal linkage or lever mechanism including a pivotal lever arm. This lever arm is rockably supported on a fulcrum which is adjustable along the lever arm. Adjustable positioning of the fulcrum relative to its lever arm is accomplished by rotation of a handle journaled on the end of the wrench housing remote from the tang. Adjustment of the fulcrum along the lever arm, of course, varies the effective mechanical advantage of the linkage mechanism and, accordingly, the force applied to the armature, tending to rock the latter, as described above, to its released position, for a given torque applied on a workpiece by the tang.

Operatively connecting this fulcrum and the rotary handle of the wrench are novel fulcrum adjusting means which are so designed as to enable the use of linear, coarse and fine reading scales. These linear scales are readily readable so as to permit accurate presetting of the wrench to a desired torque value by even relatively unskilled personnel. This fulcrum adjusting means embodies a ratcheting action so as to facilitate setting of the same to a desired torque value, as well as releasable lock means for locking the adjusting means in a desired setting.

The present wrench also embodies various other structural features which provide for a wrench of greater simplicity, lower cost, and superior design, as will become apparent as the description proceeds.

The invention may be best understood from the following detailed description thereof, taken in connection with the annexed drawings, wherein:

Fig. 1 is a perspective view of the present wrench;

Fig. 2 is an enlarged longitudinal section through the wrench of Fig. 1 showing the magnetic torque release means embodied therein in normal, unreleased position;

Fig. 3 is a view generally similar to Fig. 2 showing the magnetic torque release means in released position;

Fig. 4 is an enlarged view of an alternative form of torque applying member or tang which may be employed on the wrench;

Fig. 5 is an enlarged section taken along line 5—5 of Fig. 2;

Fig. 6 is an enlarged scale view of the rear end of the wrench in Fig. 2; and

Fig. 7 is a section taken along line 7—7 of Fig. 6.

Referring now to these drawings, the present wrench will be seen to comprise a wrench housing or handle 10 of substantially hollow tubular construction. Handle 10 comprises a forward tubular section 12 which is reduced slightly at its rear end and received within a rear tubular section 14. Handle sections 12 and 14 are rigidly united in any suitable manner.

Extending loosely into the forward end of the handle

10 is a torque applying member or tang 16. Tang 16 is pivotally supported, intermediate its ends, on the handle 10 by a removable pivot pin 18. The forward, extending end of tang 16 is formed with a square lug 20 for removably receiving a work engaging element, such as a socket, in the well-known manner. The axis of the lug 20 extends normal to the axis of the housing 10, as shown.

Stationarily fixed in the handle 10 adjacent its opposite end, as by a pin 22, is a cylindrical, permanent magnet 24 contained within a non-permeable sleeve 26. As shown, magnet 24 is arranged concentric with the handle 10.

Positioned at the forward end of the magnet 24 is an armature 28 of generally disc-like configuration. Armature 28 has a rear, circular face 30 opposing the forward face 32 of the magnet 24.

As may be seen most clearly in Fig. 2, a portion of the periphery of the armature is bevelled at 34 to form on the armature a generally knife edge 36 in the plane of the rear face 30 of the armature. This knife edge, which bears against the inner cylindrical wall of the rear handle section 14, forms a pivot about which the armature is adapted to rock between the position of Fig. 2, hereinafter referred to as the normal position, and the position of Fig. 3, hereinafter referred to as the released position of the armature.

During use of the wrench, as will be hereinafter more fully described, the handle 10 is rotated in a clockwise direction, as viewed in the drawings, about the axis of the tang lug 20 as a center, to apply a torque to a workpiece. The reaction torque on the tang, of course, tends to retain the latter stationary with the result that the force applied to the handle, to rotate the latter in the aforesaid clockwise direction, tends to cause pivoting of the tang 16, about the pivot 18, in a counterclockwise direction as viewed in the drawings. Operatively connecting the rear end of the tang 16 and the armature 28 in such a manner that this pivoting of the tang 16 in a counterclockwise direction causes rocking of the armature from its normal position of Fig. 2 to its release position of Fig. 3, is a linkage or lever mechanism generally indicated at 38. As will shortly become clear, the construction of this linkage mechanism is such that a very large mechanical advantage exists between the armature and the tang so that a very large torque tending to pivot the tang in a counterclockwise direction relative to the handle 10 results in a very much smaller torque tending to rock the armature 28 from its normal position to its released position.

Linkage mechanism 38 comprises first, second and third first-class levers or lever arms 40, 42 and 44, respectively. Lever 40 is hinged intermediate its ends on a pin 46 fixed in the handle 10 and has its forward end engaging over a rounded shoulder 48 formed on the rear end of tang 16. The rear end of the lever 40, similarly, engages over a shoulder 50 on the second or intermediate lever 42.

This intermediate lever 42 is hinged near its forward end on a pin 52 fixed in the handle 10, so that pivoting of the tang 16 in a counterclockwise direction about its pivot 18 rocks the first or forward lever 40 in a clockwise direction about its pivot pin 46, and results in rocking of the intermediate lever 42 in a counterclockwise direction about its pivot pin 52.

The rear end of the intermediate lever 42 is connected with the forward end of the third or rear lever arm 44 by a pin 54. This latter lever arm is rockably supported on a knife edged fulcrum 56. A cylindrical, generally sleeved section 58 is integrally formed with the fulcrum 56 and has a generally rectangular guideway 60 receiving the forward end of lever arm 44 for guiding the latter in its rocking movement.

The rear end of the rear lever arm 44 is bevelled slightly, as shown, and extends into an axial recess 62 in the forward face of the armature 28. The end of the lever

arm 44 bears on a fulcrum edge 63 formed on the axial wall of this recess opposite the bevelled face 34 of the armature, as shown. Thus, rocking of the intermediate lever arm 42 in a counterclockwise direction in response to counterclockwise pivoting of the tang 16 about its pivot 18, rocks the lever 44 in a clockwise direction on the fulcrum 56. This clockwise rocking of the rear lever 44, in turn, rocks the armature 28 from its normal position of Fig. 2 to its release position of Fig. 3, as described above.

It is clear from this description that the counterclockwise torque applied to the tang 16 tends to rock the armature 28 away from the magnet 24 and toward its release position of Fig. 3. Such rocking of the armature, of course, is restrained by the magnetic attraction of the armature to the magnet. If the effective torque tending to rock the armature 28 is insufficient to overcome this magnetic attraction, of course, the armature will be retained in its normal position. This retention of the armature in its normal position prevents rocking of the several levers in the linkage mechanism 38 and hence pivoting of the tang under the action of the counterclockwise torque applied thereto. If, however, the torque applied to the tang is gradually increased to a point whereat the effective torque tending to rock the armature exceeds the opposing torque on the armature developed by the magnetic attraction between the latter and the magnet, the armature will suddenly break away from the magnet and rock to its released position of Fig. 3. In use of the wrench, this sudden release or breaking away of the armature from the magnet 24 is utilized to provide an indication that a predetermined torque value has been reached.

Thus, the impact between the bevelled face 34 of the armature and the inner wall of the handle 10 following sudden release of the armature produces an audible click which informs the user of the wrench that the preset torque release value of the latter has been reached. Also, the slight rocking of the handle 10 relative to the tang 16, which is permitted by this release of the armature, may be felt by the user of the tool and affords an additional indication that the preset torque value has been reached.

In order to permit adjustment of the torque release value of the wrench, the fulcrum 56 is adjustable longitudinally of the lever arm 44, as described below, to vary the mechanical advantage of the linkage system 38. That is, it will be clear that the greater the spacing between the armature and the fulcrum 56 relative to the spacing between the fulcrum and the pivot pin 54, the less will be the torque tending to rock the armature 28 to released position for a given counterclockwise torque applied to the tang 16. Conversely, moving the fulcrum 56 toward the armature effects a gradual increase of the torque exerted on the armature 28 for a given counterclockwise torque applied to the tang 16. It will be seen, therefore, that movement of the fulcrum along the lever arm 44 permits adjustment of the torque release value of the wrench over a limited range.

To accomplish this adjustment of the fulcrum, the latter is threadedly engaged with an actuating rod 64, the rear end of which is bent at right angles, as shown at 66, and engaged in a spiral groove 70 formed in a spindle 72. Rod 64 is slidably received in a groove formed in the sleeve 26 surrounding the magnet 24 so as to accommodate movement of the fulcrum 56 and actuating rod 64 longitudinally of the handle.

Spindle 72, having the spiral groove 70 formed therein is rotatably received within a sleeve 74. Sleeve 74, in turn, is fitted in the rear end of the rear handle section 14 and retained against rotation therein by means of a set screw 76. Extending longitudinally of the sleeve 74 is a slot 78 in which the bent end portion 66 of the actuating rod 64 is slidable.

The forward end of the spirally grooved spindle 72 is reduced to form an annular shoulder 80 and a still

further reduced, threaded extension 82. Received on the threaded extension is a washer 84 which is held in position against the shoulder 80 by a pair of lock nuts 86. A spring washer 88 bears against the forward end of the sleeve 74 and extends into the annular groove defined between the washer 84 and the forward end of the main body of the spindle 72 to retain the latter against right-hand movement in the sleeve 74.

Extending from the right-hand end of the spiral spindle 72 is a squared extension 90 having an axial threaded bore for receiving the threaded shank 92 of the lock screw 94. Lock screw 94 further comprises a cylindrical head 96 at the right-hand end of the shank 92, which head is formed with a raised, finger-engaging rib 98 to permit the lock screw 94 to be turned.

The head 96 of lock screw 94 is received in a cylindrical recess 100 extending into the right-hand end of a cylindrical member 102. This member is axially slidable in the end of a rotatable sleeve handle 104, and is non-rotatably keyed to the latter by the pin 105 on the handle which slidably engages in the illustrated axially extending groove in the member 102. Handle 104, which is rotatably received over the rear end of the rear handle section 14, comprises a forward cylindrical section 106 which is threadedly engaged in a rear cylindrical section 108 of the handle.

It will be seen that since right-hand movement of the spindle 72 in the sleeve 74 is restrained by the spring washer 80, tightening of the lock screw 94 urges the forward face of the cylindrical member 102 against the rear end of the sleeve 74 and rear handle section 14. This effectively locks both the handle 104 and the spindle 72 against rotation relative to the wrench handle 10.

The rear annular face of the spindle sleeve 74 is formed with a series of angularly spaced recesses 110. Projecting from the forward face of the member 102 is a detent 112 which is engageable in the sleeve recesses 110 when the handle 104 is rotated on the wrench housing. The spring washer 80 tends to bias the spindle 72 toward the left relative to the spindle sleeve 74, when the lock screw 94 is slightly loosened. As the handle 104 is rotated under these conditions, therefore, the detent 112 rides from one of the recesses 110 to the next so as to provide, in effect, a ratcheting action between the wrench handle 10 and the rotatable handle 104.

Tightly fitted in holes in the forward section 106 of the handle 104 are a series of pins 114 which engage in a spiral groove 116 externally formed in the rear end of the after handle section 14. The pins 114 and groove 116 provide, in effect, a threaded connection between the wrench handle 10 and the rotatable handle 104, which causes axial movement of the latter handle on the wrench handle when the handle 104 is rotated. The member 102 and spindle 72, of course, rotate with the handle 104 but remain stationary in the longitudinal direction relative to the wrench handle 10, the slot and pin connection 105 accommodating axial movement of the handle 104 relative to the member 102.

Inscribed on the rear section 14 of the handle 10 is a coarse reading scale 118 calibrated in inch pounds of torque, as shown. The forward edge of the rotatable handle 104 moves along this scale 118 when rotated to provide a coarse reading of the torque release value of the wrench. Inscribed on the forward end of the rotatable handle is a second, fine reading scale 120 of the vernier type. Scale 120 has 100 scale divisions and is read by means of an indicia line 122 on the wrench handle 10.

As shown, the coarse reading scale is formed with a series of indicia lines labeled in increments of 100 inch pounds of torque. The pitch of the spiral groove 116 in the wrench handle 10 is such that the forward edge of the rotatable handle 104 is moved a distance equal to the spacing between adjacent ones of these 100 inch pound indicia lines during each revolution of the latter

handle. The scale 120, which has 100 scale divisions, enables the wrench setting to be read to one inch pound in the well-known manner.

When using the wrench, the operator rotates the handle 134 until the desired torque release value is indicated on the scales 118 and 120. This rotation of the handle 104 turns the grooved spindle 72, thus imparting linear motion to the actuating rod 64 and the fulcrum 56 along the rear lever 44.

Adjustment of the fulcrum, of course, varies the relative lengths of the lever arms of the latter lever so as to change the mechanical advantage of the linkage system 38, as was previously mentioned. This has the effect of changing the value of the counterclockwise torque which must be applied to the tank 16 in order to rock the armature 28 to its released position, and hence the torque release setting of the wrench. Scales 118 and 120 are calibrated in terms of inch pounds of torque applied to a workpiece about the axis of the tang stud 20 at the instant of release of the armature 28 from the magnet 24.

In order that a given angle of rotation of the spindle 72, and hence the handle 104, will effect the same change in the torque release setting of the wrench for any relative position of the fulcrum and the lever 44, the pitch of the spiral groove 70 in the spindle 72 varies progressively in accordance with an exponential function, as in the earlier mentioned patented wrench. This progressive pitch variation of the groove 70 enables each revolution of the handle 104 to effect a 100 inch pound change in the torque release value of the wrench so as to enable the scale 118 to be linearly calibrated in increments of 100 inch pounds, as shown.

In the prior wrench, as previously discussed, a pointer operatively engaged in the exponential groove of the fulcrum moving spindle cooperated with an exponential scale on the wrench handle to provide a coarse reading of the torque setting. Such an exponential scale is, however, undesirable for the reasons previously set forth. This deficiency of the patented wrench is avoided in this invention by the threaded connection 114, 116 of the rotary handle 104 to the wrench handle 10 and the provision of the linear coarse reading scale 118 which cooperates with the leading edge of the rotary handle to provide a coarse reading.

The reason why the coarse reading scale 118 may be linear rather than exponential, as in the patented wrench, will be apparent. Thus, as just mentioned, a linear relationship exists between the angular position of the handle 104 and the torque setting of the wrench. Owing to the constant pitch of the groove 116, forming a part of the threaded connection between the handle 104 and the handle 10, the linear position of the handle 104 is a linear function of its angular position, and, therefore, of the torque setting of the wrench. Since the torque setting indicated on the coarse reading scale 118 is a function of the linear position of the handle 104, the scale 118 may be linearly calibrated. Similarly, the torque setting indicated on the scale 120 is a function of the angular position of the handle 104 and, therefore, the latter scale 120 is also linearly calibrated.

As previously mentioned, the present torque wrench includes provision for adjustment of the spacing of air gap between the magnet 24 and the armature 28, in the normal or unreleased position of the latter, so as to facilitate initial calibration of the wrench and enable adjustment of its torque value range. To this end, there is tightly fitted within the after handle section 14 of the wrench, just forwardly of the armature 28, a generally C-shaped collar 124 through which the rear end of the lever 44 loosely extends, as shown most clearly in Fig. 5. The lever 44 carries an adjustable stop screw 126 in the plane of the collar 124. It will be clear from the drawings that the rear end of the lever 44 may be moved downwardly by adjustment of the stop screw 126 against the wall of the slot in the collar 124.

Such downward movement of the rear end of the lever 44, of course, rocks the armature 28 in a counterclockwise direction, as viewed in Fig. 2, away from the magnet 24 and toward the released position of the armature. This rocking of the armature, in effect, varies the air gap between the armature and the magnet in the normal position of the armature. The magnetic attraction between the magnet and armature, obviously, tends to rock the latter in a clockwise direction so as to retain the rear end of the lever 44 in its upper limiting position wherein the stop screw 126 abuts the collar 124. Thus, the air gap between the magnet 24 and the armature 28, in the normal or unreleased position of the latter, may be adjusted by turning of the stop screw 126 to vary the upper limiting position of the rear end of the lever 44.

Such variation of the air gap between the magnet and armature, of course, changes the counterclockwise torque which must be applied to the armature, to break it away from the magnet and hence the torque release value of the wrench for any given setting of the fulcrum 56. In other words, the greater the air gap between the magnet and armature, the less will be the torque or force which must be applied to the armature to move it to its released position of Fig. 3. The wrench handle 10 is provided with an opening 128 aligned with the stop screw 126 to accommodate adjustment of the latter without disassembly of the tool.

This adjustability of the air gap, and hence the torque release setting of the wrench for any given setting of the fulcrum 56, possesses a two-fold advantage. Thus, when initially calibrating the wrench, the latter is adjusted so that the scales 118 and 120 indicate a particular torque release value, say either the maximum or minimum torque release value of the wrench. A known torque, equal to the torque release setting indicated on the wrench, is then applied to the latter. The stop screw 126 is then simply adjusted by insertion of a suitable wrench through the axis opening 128 until the armature 28 just releases. If the remainder of the scale divisions are accurately spaced, no further adjustment of the wrench should be necessary. Thus, accurate calibration of the wrench may be achieved without disassembly thereof, as was required in the patented wrench for the reasons previously discussed.

A second advantage of such an adjustable air gap arrangement is that several identically constructed wrenches having the same linkage system 38, may be given different torque value ranges by adjustment of the stop screws in the different wrenches to provide different air gaps between their magnets and armatures in the normal positions of the latter. The variation in air gaps between the different wrenches, of course, does not vary the incremental change in torque value effected by each rotation of the handle 104, but rather merely changes the overall range of torque values of the different wrenches. Thus, assuming the movable fulcrums 56 in the several wrenches to be identically positioned, increasing the air gap in one wrench relative to that in another wrench has the effect of decreasing the torque release setting of the wrench for that fulcrum position in the one wrench relative to the other wrench. Similarly, decreasing the air gap in the one wrench has the effect of increasing the torque value of the torque release setting of the one wrench. Since the range of adjustment of the fulcrums in the two wrenches are equal, however, the difference between the maximum torque setting and the minimum torque setting remains the same in both wrenches, the range of one wrench being merely offset relative to the range of the other wrench.

It will be observed in Figs. 2 and 3 that since the armature 28 moves in a direction generally longitudinally of the handle 10, and the magnet 24 is concentric with the handle 10, no enlargement on the housing 10 is necessary to accommodate the magnet or movement of the armature as was required in the patented wrench.

The wrench handle 10, therefore, possesses a more pleasing appearance and is capable of less costly manufacture.

As previously indicated, the pivot 18 for the tang 16 is removable so as to enable replacement of the tang by another tang mounting or having provision for receiving a wide variety of different work engaging elements. The several tangs which are usable with the present tool, of course, will be so designed that spacing X between the pivotal axis of the tang and the torque axis of the tang and the spacing Y between the pivotal axis of the tang and the point of engagement 48 of the latter with the lever 40 is the same in all of the tangs, as may be observed in Figs. 2 and 4. Thus, one tang may be replaced by another without altering the calibration of the wrench. The present wrench is, therefore, capable of use with a greater variety of work engaging elements than the patented wrench. The relatively large mechanical advantage of the linkage system 38 due to the inclusion of the several levers therein will be apparent. This large mechanical advantage, of course, permits a relatively high, maximum torque release setting in the wrench, which may be varied in the manner described by increasing the air gap between the magnet 24 and armature 28.

It will be clear, therefore, that there has been described and illustrated a magnetic torque limiting wrench which is fully capable of attaining the objects and advantages preliminarily set forth. While a preferred embodiment of the invention has been disclosed for illustrative purposes, the invention should not be thought of as limited thereto but only by the spirit and scope of the following claims.

I claim:

1. A predetermined torque limiting wrench, comprising an elongate wrench handle, a torque applying member pivoted on the handle for turning on a transverse axis of the handle, said handle being rotatable in one direction about said axis to apply a torque load to a workpiece through said member, means connecting said handle and member for turning of the latter in said one direction with said handle until a predetermined applied torque load is reached, including a magnetically permeable armature element and a magnet element, one of said elements being fixed to said handle and the other element being supported on the handle for movement longitudinally of the latter between a first position proximate to said one element and a second position relatively remote from said one element, said armature element remaining in the magnetic field of said magnet element during movement of said other element between said positions, whereby said latter element is urged toward said first position by the magnetic attraction between said elements, and means operatively connecting said member and other element in a manner such that turning of said member relative to said handle in a direction opposite to said one direction causes movement of said other element toward said second position, whereby turning of said handle in said one direction relative to said member during the application of a torque load to the workpiece is prevented until said load becomes sufficient to overcome said magnetic attraction.

2. The subject matter of claim 1 wherein said other element includes means pivotally supporting the latter element on the housing for rocking between said positions about a transverse axis of the housing.

3. The subject matter of claim 2 wherein said means operatively connecting said member and other element comprises pivotal lever means including a pivotal lever pivotally engaged with said other element.

4. The subject matter of claim 3 wherein said other element includes a fulcrum edge engaging said lever.

5. The subject matter of claim 1 wherein said handle comprises a hollow tubular housing enclosing said elements and said other element is formed with a knife

edge engaging an interior wall of said housing for pivoting of said other element on the housing on a transverse axis of the housing between said positions.

6. The subject matter of claim 5 wherein said one element has a face in a transverse plane of the housing and said other element has a face movable into flat contact with said first-mentioned face, said knife edge being located substantially in the plane of the face of said other element and engaging said internal housing wall approximately at the intersection of the wall and said transverse plane, the magnetic attraction between said elements tending to retain said knife edge at said intersection during rocking of said other element.

7. The subject matter of claim 1 wherein said handle comprises a hollow tubular housing which encloses said elements and is generally cylindrical in cross-section, said one element comprising a cylinder substantially concentric with said housing, and said other element is generally disc-shaped.

8. The subject matter of claim 1 including adjustable stop means for limiting movement of said other element toward said one element to provide an adjustable air gap between said elements when said other element is in said first position.

9. The subject matter of claim 1 wherein said other element has a face engageable with said handle to produce an audible click upon movement of said other element to said second position.

10. A predetermined torque limiting wrench, comprising a tubular wrench housing, a torque applying member pivoted on the housing for turning on a transverse axis of the housing, said housing being rotatable in one direction about said axis to apply a torque load to a workpiece through said member, means within said housing connecting the latter and said member for turning of the latter in said one direction with the housing until a predetermined applied torque load is reached, including a magnetically permeable armature element and a magnet element, one of said elements being fixed in said housing and the other element being pivoted in the housing for movement between a first position proximate to said one element and a second position, relatively remote from said one element, said armature element remaining in the magnetic field of said magnet element during movement of said other element between said positions, whereby said latter element is urged toward said first position by the magnetic attraction between said elements, means operatively connecting said member and other element in a manner such that turning of said member relative to said housing in a direction opposite to said one direction causes movement of said other element toward said second position, whereby turning of said handle in said one direction relative to said member during the application of a torque load to the workpiece is prevented until said load becomes sufficient to overcome said magnetic attraction, and adjustable stop means for limiting movement of said other element in a direction toward said first position, whereby to provide an adjustable air gap between said elements when said other element is in said first position.

11. The subject matter of claim 10 wherein said means operatively connecting said member and other element comprises pivotal lever means including a pivotal lever operatively engaging said other element, said lever pivoting in a given direction during movement of said other element from said second to said first position, and said adjustable stop means comprises adjustable stop screw means acting between said housing and lever to limit pivoting of the latter in said given direction.

12. The subject matter of claim 10 wherein said means operatively connecting said member and other element comprises pivotal lever means including a pivotal lever operatively connected to said other element so as to pivot in a given direction when said other element rocks

in a direction toward said first position, said adjustable stop means comprising an adjustable stop screw on said lever engageable with said housing for limiting pivotal movement of the lever in said given direction.

13. In a predetermined torque limiting wrench, a wrench handle, a torque applying member movably supported on said handle, said member being operatively engageable with a rotatable workpiece and tending to move in a given direction relative to the handle in response to a torque applied to a workpiece by movement of the handle, presettable means for releasably retaining said member against movement relative to the handle, said means releasing said member for movement in said direction in response to a preset torque applied to a workpiece and comprising a lever, a fulcrum for said lever movable along the latter to vary the value of said preset torque, and means for moving said fulcrum along the lever including a rotatable handle threaded on said wrench handle, whereby rotation of said rotatable handle effects linear movement of the latter handle a distance proportional to its angle of rotation, mechanism operatively connecting the rotatable handle and fulcrum for moving the latter lengthwise of said lever a distance which is an exponential function of the angle of rotation of the rotatable handle, and linear scale means on said handles for indicating the extent of linear and rotational movement of the rotatable handle relative to the wrench handle.

14. The subject matter of claim 13 wherein said mechanism comprises a spindle journaled in said wrench handle, means connecting said rotatable handle and spindle for rotation of the latter with the rotatable handle, a spiral groove in said spindle, the pitch of which varies progressively in accordance with an exponential function, and an actuator engaging in said groove and connected to said fulcrum, whereby the latter is moved linearly by rotation of the spindle.

15. The subject matter of claim 14 including means for releasably locking said rotatable handle and spindle against rotation relative to the wrench handle.

16. A predetermined torque limiting wrench, comprising a wrench handle, a torque applying member pivoted on the handle, said handle being rotatable in one direction to apply a torque load to a workpiece through said member and tending to turn in said direction with respect to the member during the application of said torque load, magnetically controlled means connecting said handle and member for turning of the latter in said one direction with the handle until a predetermined torque load is reached, said magnetically controlled means including a magnet element and a magnetically permeable armature element in the magnetic field of said magnet element, one of which elements is fixed to said handle and the other of which elements is operatively connected to said member so as to be moved away from a normal position proximate to said one element upon turning of said handle in said one direction with respect to said member, stop means for limiting movement of said other element toward said one element to provide an air gap between said elements in the normal position of said other element, and means for adjusting said stop means to adjust the width of said air gap.

17. The subject matter of claim 16 wherein said handle comprises a hollow tubular housing enclosing said elements and stop means, and the wall of said housing has an access opening to said adjusting means for adjustment of the latter from the outside of the housing.

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