

PATENT SPECIFICATION (11)

1 502 650



1 502 650

- (21) Application No. 36929/75 (22) Filed 8 Sept. 1975 (19)
 (31) Convention Application No. 506 915 (32) Filed 17 Septt. 1974 in
 (33) United States of America (US)
 (44) Complete Specification published 1 March 1978
 (51) INT. CL.² B25B 21/00
 (52) Index at acceptance
 B3N 2A2 2AX 2E2 3HX

(54) POWER WRENCHES

(71) We, N-S-W CORPORATION, a Corporation organised and existing under the laws of the State of Texas, United States of America, of 5601 Bintliff Street, Houston, Texas 77036, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to tools for rotatably driving screw-threaded fasteners. Such tools are popularly called "power wrenches".

Power wrenches for fasteners such as nuts and bolts are described in U.S. Patents 3,706,244 and 2,972,918. The patented tools are especially adapted for fasteners arranged in a circle in flanges. There is a need for power wrenches which are readily adaptable for use on fasteners arranged in a straight line or in non-circular arrangements. The power wrench actuator is usually a fluid-operated cylinder having a rod which engages a lever arm at a substantially right angle. By limiting the rotation of the lever arm to a small angle in response to a full stroke of the push rod, and by making the exact right angle to become established at the push rod's mid-stroke, the torque can be fairly accurately measured by measuring only the applied pressure in the cylinder.

When a tool is designed for a specific arrangement of fasteners the desired (right) angle can be built into the tool. However, attempts to use the specifically designed tool for other arrangements of fasteners will most likely change this desired angle by an amount which is not easy to measure.

The consequences of being unable to retain the desired angle are two fold; maximum torque is not obtained per unit of pressure applied to the hydraulic cylinder, and torque measurements cannot be sufficiently accurately made by simply measuring the pressure in the fluid-operated cylinder. There is therefore a need for power wrenches which are adjustable to accommodate different arrangements of fasteners without disturbing the desired right angle relation-

ship between the push rod and the lever arm.

According to the present invention, there is provided a tool for rotatably driving a screw-threaded fastener, comprising a collar having an arm secured thereto and extending laterally therefrom, a driver for engagement with the fastener, the driver being received in co-operating engagement with the collar and being freely rotatable relative to and co-axially with the collar in each of mutually opposite directions of rotation, a lever associated with the driver for turning the driver on its axis, a double-acting linear actuator pivotally mounted on the arm and adapted and arranged for engagement with the lever so that, in use, operation of the actuator effects rotation of the driver by way of the lever, and locating means connected to the arm for locating the arm against angular shifting about the axis of the collar when the tool is in use, the arrangement being such that, in use, where said fastener is one of a plurality of mutually adjacent fasteners and the driver engages said one fastener, and an abutment on the locating means engages an adjacent fastener, driving torque induced in the said one fastener is reacted by transverse shear forces induced in the said one fastener by way of the collar and the driver and in the said adjacent fastener by way of the locating means and said abutment.

An embodiment of the present invention will now be described, by way of example, with reference to the accompanying drawings in which:

Fig. 1 is a plan view of one embodiment of a tool in accordance with this invention, the tool being positioned for loosening a screw-threaded fastener;

Fig. 2 is a plan view of the tool of Fig. 1 shown positioned for tightening the fastener;

Fig. 3 is a view in elevation of the tool shown in Fig. 1;

Fig. 4 is a schematic showing of the fluid-operated actuator;

Fig. 5 is a plan view of another embodiment of a tool in accordance with this in-

vention, the tool being positioned for loosening one of the fasteners;

Fig. 6 is a plan view of the tool of Fig. 5 shown positioned for tightening one of the fasteners; and

Fig. 7 is a view in elevation of the tool shown in Fig. 5.

The embodiment of the tool shown in Figs. 1—3 is generally designated as 10, and the modified embodiment shown in Figs. 5—7 is generally designated as 10¹. Each tool is shown as being positioned over an irregular arrangement of screw-threaded fasteners comprising nuts 12 and bolt 14. To drive rotatably a particular nut, there is provided a cylindrical driver 16 (Fig. 3) defining a socket 17. The length of driver 16 will depend on the structure containing the threaded fasteners and on the kind of obstacles surrounding them. The entire power tool 10 is thus elevated from the plane containing the threaded connectors.

To rotate driver 16, there is provided a lever generally designated as 20, having an arm 22. One end of arm 22 has a socket 24 and the other end has a removable head 26. Socket 24 operatively engages a male hex pin 27 of the driver 16. Head 26 has two plates 28, 28¹ (Fig. 3) which form therebetween a channel 30 of width sufficient to allow the movement therein of a force-producing member. Each outward side of plates 28, 28¹ is provided with notches 28a—e which lie in a common plane and are generally arranged in an arcuate pattern relative to the axis of rotation of the driver 16. The ridges 29 between the notches 28a—e are rounded and somewhat inclined to facilitate movement of a cross-pin from one notch to the next as will be subsequently described.

Since the application of a pushing or pulling force on the head 26 is accompanied by reaction stresses which may be in the form of tension, compression, or moments acting on the tool there is provided a reaction assembly, generally designated 31. The reaction assembly provides a two-point reaction structure and serves as a support for an actuator used to produce the force on the head 26.

The preferred reaction assembly 31 comprises a collar 32 (Fig. 3) which fits around the driver 16 to allow relative rotation therebetween. The nut 12 being rotated serves as a first reaction point. Extending laterally from collar 32, is an arm or beam 33 which is connected to a locating means for locating the beam 33 against angular shifting about the axis of the collar 32. The locating means, described more fully later herein, includes an abutment member 34 having a plain socket 35 for placing over an adjacent nut 12 serving as a second reaction point.

Mounted on top of the beam 33 is a linear

actuator generally designated as 40. The actuator may be powered by any power means, although the preferred embodiments of this invention employ a fluid-operated cylinder 41 having a double-acting piston 42 (Fig. 4) from which extends outwardly a push rod 43 that fits inside channel 30 of the head 26. The cylinder 41 is controlled by two fluid lines 44, 45, each being adapted to receive alternately fluid pressure from a conventional fluid pressure source (not shown). The amount of pressure receiver can be varied to obtain the desired torque value. Suitable pressure gauges 46, 46¹ in lines 44, 45, respectively, measure the pressures applied to the piston 42. Meters 46, 46¹ are preferably calibrated in units of torque.

The tip of the push rod 43 is provided with a cross-pin 48 having a diameter such that it can freely move into and out of the notches 28a—e. A handle 49 allows an operator to manipulate the push rod. Pin 48 transmits force to that ridge 29 which is engaged by pin 48. This force can be a pulling or pushing force.

The base 50 (Fig. 4) of the cylinder is pivotally mounted on an upright post 51 (Fig. 3) reinforced by a brace 52. Extending laterally from post 51 is a mounting eye 53 adapted to receive a hinge pin 54. Eye 53 loosely fits inside a cross-channel 55 in base 50.

The main difference between the two illustrated embodiments 10 and 10¹ of the subject invention lies in the construction of the means for locating the beam 33 angularly with respect to the axis of the collar 32. In the power tool 10 illustrated in Figs. 1—3, such locating means comprises a pivoted link, generally designated as 60, and includes two plates 61, 62 (Fig. 3). A pivot pin 63 extends through one end of each plate and through a hole 64 in beam 33. A plurality of such holes 64, longitudinally spaced-apart, can be provided in beam 33 to selectively accept pivot pin 63. The adjacent ends of plates 61, 62 are fixedly secured to the abutment member 34 whose socket 35 loosely fits around an adjacent nut 12.

In the embodiment of the power tool 10¹ illustrated in Figs. 5—7, the abutment member 34 is slidably connected to the beam 33 by a slide member 66 defining a U-channel 67 (Fig. 7) for slidably receiving the beam 33 therethrough. Slide 66 forms an integral part with the abutment member 34 for simplicity of construction.

The operation of both power tools 10 and 10¹ will be better understood by designating certain critical points of the tools. Accordingly, points A—E respectively designate (Figs. 1 and 5) the centres of driver 16, cross-pin 48, hinge pin 54, pivot pin 63, and abutment member 34. In the power tool 130

10¹, point D does not exist as there is no pivot pin 63.

OPERATION OF THE PREFERRED EMBODIMENTS

General Operation:

In the power tool 10 (Figs. 1—3), it is desired to produce a torque about a point A by means of a force applied at B along the line of force BC. Points A, C and D are collinear and point E can rotate with radius DE about D to vary the distance AE, which is the distance between the first and second reaction points A and E. Shifting of point E allows power tool 10 to be adjusted to suit different arrangements of fasteners. The fluid-operated cylinder 41, by means of a controllable fluid pressure, produces the desired force along line BC, which can be a pulling or pushing force. This force produces a torque at A which is reacted by shear forces induced in the fasteners at A and E. The reaction forces are not transmitted, as in known power wrenches, directly to the flange or other structure containing the fasteners.

The magnitude of the torque produced by the force applied by push rod 43 can be varied by varying the hydraulic pressure in line 45 (Fig. 4) applied against piston 42 in cylinder 41. The accuracy of the torque's measurements provided by gauges 46, 46¹ is dependent upon the perpendicularity between the line of force BC and the moment arm AB. When power tool 10 is designed, the lengths of AC and BC are selected so that the triangle ABC will be a right triangle when the push rod 43 is at its mid-stroke. Since the deviation of the push rod from its mid-stroke position is kept purposely small by providing a plurality of notches 28, it can be assumed for all practical purposes that the triangle ABC remains a right triangle. In this fashion, maximum torque will be obtained per unit of applied force. Adjustment of the position of point E does not disturb the desired perpendicularity between AB and BC.

Loosening Operation:

Prior to starting the operation of power tool 10 (Fig. 1) the push rod is contracted and the head 26 assumes the position as indicated by the solid lines. Pressure on line 45 starts the first cycle and causes an extension of the push rod which applies a force along the line of force BC which causes point B to rotate in a counterclockwise direction about point A with a radius AB. For each cycle, i.e. full extension of the push rod, the head 26 will rotate counterclockwise, say 12°, in the direction of the arrow. Pressure on line 44 will end the first cycle by retracting the push rod, causing pin

48 to move down from the first notch 28a to the second notch 28b. A second extension of the push rod will again cause the head 26 to rotate counterclockwise by 12° and a second notch 28b down to the third notch 28c. After five cycles, pin 48 falls into the last notch 28e and then the head 26 assumes the position as shown by the dotted lines in Fig. 1.

Thus, for five strokes of the piston the head 26 will have rotated counterclockwise by an angle of 60°. If the nut 12 is not then sufficiently loosened, head 26 is manually returned to its original position, as shown by the solid lines in Fig. 1, and a given number of cycles is repeated to obtain another angular rotation of nut 12. It is of course possible to rotate the head 26 by an angle less than 60°, say 36°, by only executing three full piston strokes instead of five. As thus far described, the power tool 10 has been working in its "push" mode.

Tightening Operation:

In Fig. 2 the head 26 is turned over from its position shown in Fig. 1 and its initial position for tightening is indicated by the solid lines. To operate the power tool 10 in its "pull" mode (Fig. 2), prior to starting a cycle of operation, pin 48 is made to lie in the first notch 28a and the push rod is fully extended. The first cycle of operation is started by applying pressure on line 44, thereby retracting the push rod and pulling on the head 26. In response to the first full retraction of the push rod 43, head 26 will rotate about 12° in a clockwise direction, as shown by the arrow. The first full extension of the push rod will cause pin 48 to move over into the next notch 28b thereby completing the first cycle. The second retraction of the push rod will cause the head 26 to rotate again by about 12° in a clockwise direction. After executing five such cycles, the head 26 will have rotated by about 60° in a clockwise direction. Thus, after five complete cycles of rotation the head 26 will assume a position as shown by the dotted lines in Fig. 2. If nut 12 is not then sufficiently tightened, the process can be repeated, as before, to obtain additional discrete angular rotation of the head 26.

Operation of the other embodiment 10¹:

Whereas in power tool 10 (Fig. 1), the position of point E is adjustable by rotation about point D (which *per se* is adjustable on line AC), in power tool 10¹ (Fig. 5) the position of point E is adjustable by sliding along line AC. Yet irrespective of such adjustments, the construction of the tool is such that the line of force BC will remain substantially perpendicular to the line AB. In all other respects, the operation of power

tool 10¹ is the same as the operation of power tool 10.

In a modification of the construction described above, the lever 20 is mounted in such a fashion that it can not come apart from the driver 16, thereby affording a unitary construction for the power tools 10 and 10¹. A power tool of unitary construction is especially desirable for use underwater by divers having limited visibility.

The power tools of the present invention require no special set-ups since irrespective of the position of the point E, the desired perpendicularity between AB and BC is maintained. In a further modification, the actuator 40 can be positioned on the opposite side of the reaction beam thereby avoiding obstructions in some situations.

WHAT WE CLAIM IS:—

1. A tool for rotatably driving a screw-threaded fastener, comprising a collar having an arm secured thereto and extending laterally therefrom, a driver for engagement with the fastener, the driver being received in co-operating engagement with the collar and being freely rotatable relative to and co-axially with the collar in each of mutually opposite directions of rotation, a lever associated with the driver for turning the driver on its axis, a double-acting linear actuator pivotally mounted on the arm and adapted and arranged for engagement with the lever so that, in use, operation of the actuator effects rotation of the driver by way of the lever, and locating means connected to the arm for locating the arm against angular shifting about the axis of the collar when the tool is in use, the arrangement being such that, in use, where said fastener is one of a plurality of mutually adjacent fasteners and the driver engages said one fastener, and an abutment on the locating means engages an adjacent fastener, driving torque induced in the said one fastener is reacted by transverse shear forces induced in the said one fastener by way of the collar and

the driver and in the said adjacent fastener by way of the locating means and said abutment.

2. A tool according to Claim 1, wherein said lever defines a series of notches which are spaced angularly with respect to the axis of the driver, and the actuator is adapted for engagement with said notches individually.

3. A tool according to Claim 1 or 2, wherein the locating means is adapted and arranged to permit adjustment of the position of the abutment generally longitudinally with respect to the arm.

4. A tool according to Claim 3, wherein the locating means comprises a slide member carrying said abutment and slideably mounted on the arm for permitting said adjustment of the position of the abutment.

5. A tool according to Claim 3, wherein the locating means comprises a link carrying said abutment and pivotally connected to the arm for permitting said adjustment of the position of the abutment.

6. A tool according to any one of the preceding claims, wherein said abutment comprises a socket for positioning over the head of a fastener.

7. A tool for rotatably driving a screw-threaded fastener, substantially as hereinbefore described with reference to and as shown in Figures 1 to 4 or Figures 5 to 7 of the accompanying drawings.

FORRESTER, KETLEY & CO.,

Chartered Patent Agents,

Forrester House,

52 Bounds Green Road,

London, N11 2EY.

and also at

Rutland House,

148 Edmund Street,

Birmingham, B3 2LD.

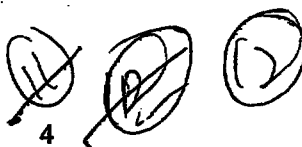
and

Scottish Provident Building,

29 St. Vincent Place,

Glasgow, G1 2DT.

Agents for the Applicants.



tool 10¹ is the same as the operation of power tool 10.

4
5
10 In a modification of the construction described above, the lever 20 is mounted in such a fashion that it can not come apart from the driver 16, thereby affording a unitary construction for the power tools 10 and 10¹. A power tool of unitary construction is especially desirable for use underwater by divers having limited visibility.

15 The power tools of the present invention require no special set-ups since irrespective of the position of the point E, the desired perpendicularity between AB and BC is maintained. In a further modification, the actuator 40 can be positioned on the opposite side of the reaction beam thereby avoiding obstructions in some situations.

20 **WHAT WE CLAIM IS:—**

1. A tool for rotatably driving a screw-threaded fastener, comprising a collar having an arm secured thereto and extending laterally therefrom, a driver for engagement with the fastener, the driver being received in co-operating engagement with the collar and being freely rotatable relative to and co-axially with the collar in each of mutually opposite directions of rotation, a lever associated with the driver for turning the driver on its axis, a double-acting linear actuator pivotally mounted on the arm and adapted and arranged for engagement with the lever so that, in use, operation of the actuator effects rotation of the driver by way of the lever, and locating means connected to the arm for locating the arm against angular shifting about the axis of the collar when the tool is in use, the arrangement being such that, in use, where said fastener is one of a plurality of mutually adjacent fasteners and the driver engages said one fastener, and an abutment on the locating means engages an adjacent fastener, driving torque induced in the said one fastener is reacted by transverse shear forces induced in the said one fastener by way of the collar and

the driver and in the said adjacent fastener by way of the locating means and said abutment.

2. A tool according to Claim 1, wherein said lever defines a series of notches which are spaced angularly with respect to the axis of the driver, and the actuator is adapted for engagement with said notches individually.

3. A tool according to Claim 1 or 2, wherein the locating means is adapted and arranged to permit adjustment of the position of the abutment generally longitudinally with respect to the arm.

4. A tool according to Claim 3, wherein the locating means comprises a slide member carrying said abutment and slideably mounted on the arm for permitting said adjustment of the position of the abutment.

5. A tool according to Claim 3, wherein the locating means comprises a link carrying said abutment and pivotally connected to the arm for permitting said adjustment of the position of the abutment.

6. A tool according to any one of the preceding claims, wherein said abutment comprises a socket for positioning over the head of a fastener.

7. A tool for rotatably driving a screw-threaded fastener, substantially as hereinbefore described with reference to and as shown in Figures 1 to 4 or Figures 5 to 7 of the accompanying drawings.

FORRESTER, KETLEY & CO.,

Chartered Patent Agents,

Forrester House,

52 Bounds Green Road,

London, N11 2EY.

and also at

Rutland House,

148 Edmund Street,

Birmingham, B3 2LD.

and

Scottish Provident Building,

29 St. Vincent Place,

Glasgow, G1 2DT.

Agents for the Applicants.