# United States Patent

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[54] **TURN-OF-THE-NUT WRENCH SHUTOFF SYSTEM**
**8 Claims, 4 Drawing Figs.**


[52] **U.S. Cl.** ..... **173/12,** 81/52.5, 192/150
[51] **Int. Cl.** ..... **B25b 23/14**
[50] **Field of Search** ..... 173/12; 192/150; 81/52.4, 52.5



[56] **References Cited**
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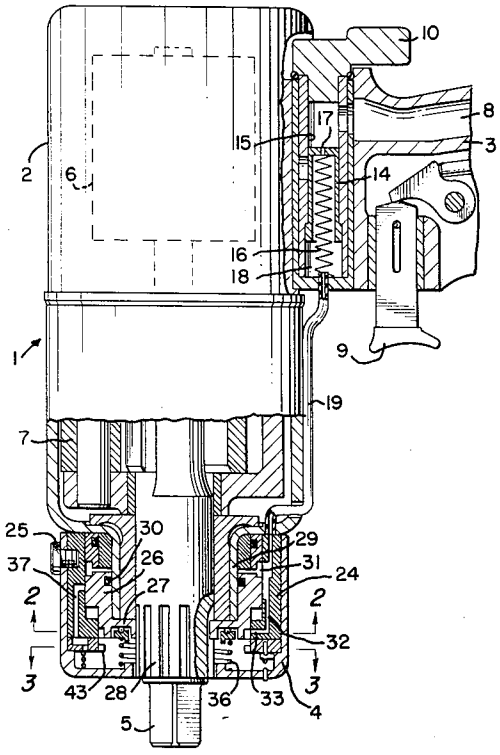
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**ABSTRACT:** A power wrench having a pressure operated shutoff valve moved to its closed position by a high-pressure signal. A mechanism measures the speed of the spindle and creates an intermediate pressure signal when the spindle speed is slowed to a selected slow speed. This intermediate pressure signal activates an angle measurement mechanism which begins measuring the angle of rotation of the spindle and in response to a selected angle creates a high-pressure signal operative to close the shutoff valve and stop the wrench.

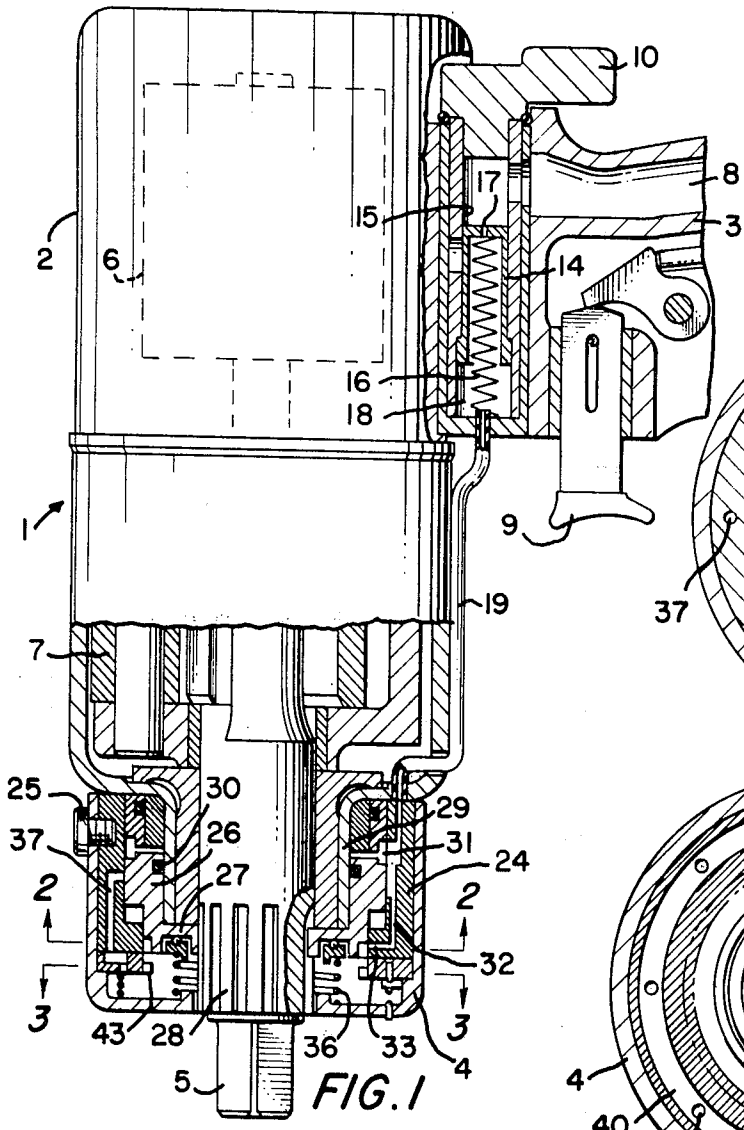



FIG. 1

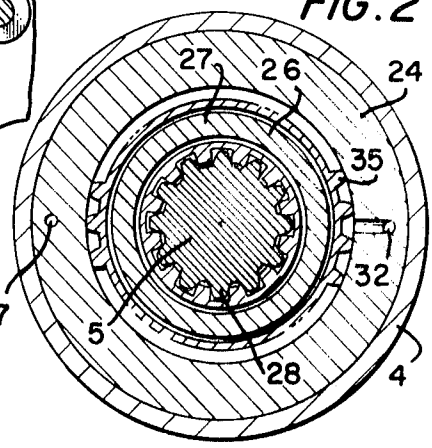



FIG. 2

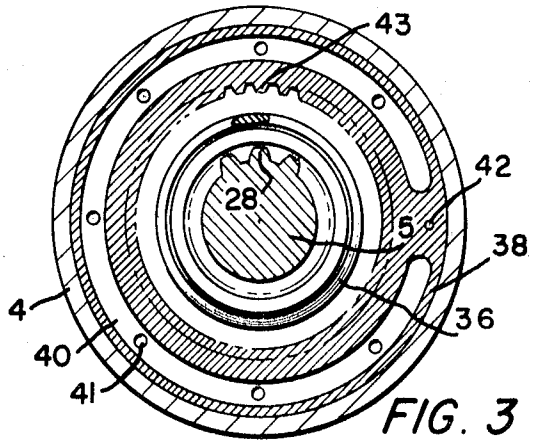



FIG. 3

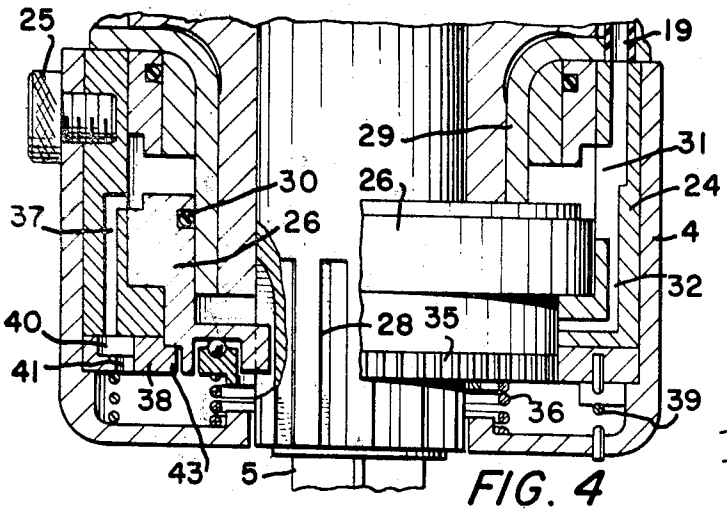



FIG. 4

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# TURN-OF-THE-NUT WRENCH SHUTOFF SYSTEM

## BACKGROUND OF THE INVENTION

This invention relates to power wrenches for driving threaded fasteners and more particularly to wrenches that drive or turn fasteners through a selected or predetermined angle.

In general, power wrenches that turn fasteners through selected angles and thereafter automatically stop are known in the art as "turn-of-the-nut" wrenches. An example of such a wrench is disclosed in U.S. Pat. No. 3,011,479. In order for a wrench of this type to tighten fasteners effectively, so that they are tightened properly, without being overtightened, the "turn-of-the-nut" cycle should begin when the fastener is in a selected condition of tightness.

## SUMMARY OF THE INVENTION

The principal object of this invention is to provide a "turn-of-the-nut" wrench which drives a fastener to a selected condition and thereafter drives it through a predetermined angle and automatically stops.

Other important objects are to provide a combination "turn-of-the-nut" wrench and a fastener speed measuring tool which starts the "turn-of-the-nut" cycle in response to the reduction of the speed of a fastener to a selected magnitude; to provide a "turn-of-the-nut" wrench which is an improvement on prior wrenches of this type; to provide a wrench which drives a fastener to a condition in which it is rotating at a selected slow speed and thereafter drives it further through a selected angle and automatically stops; and to provide a wrench having a simplified mechanism which carries out the foregoing objects.

In general, the foregoing objects are attained in a wrench including a motor, a spindle, a mechanism for interconnecting the motor to the spindle, a valve responsive to a high pressure signal to close the power supply to the motor, means for measuring the speed of the spindle and operative, in response to a selected slow speed, to create an intermediate pressure signal, and means operative in response to said intermediate pressure signal to begin measuring the angle of rotation of the spindle and to create a high pressure signal after a predetermined angle of rotation of said spindle. The high pressure signal is applied to the valve causing it to close and stop the motor. Thereafter, the wrench is removed from the fastener and is automatically restored to a starting condition wherein it is ready to being tightening another fastener.

## BRIEF DESCRIPTION OF DRAWING

The invention is described in connection with the accompanying drawings wherein:

FIG. 1 is an elevational view with portions being cutaway of an impact wrench embodying this invention;

FIGS. 2 and 3 are enlarged sections taken respectively along lines 2—2 and 3—3 of FIG. 1 and

FIG. 4 is an enlarged section of the front portion of FIG. 1 showing the wrench mechanism in position at the end of a fastener driving cycle.

## DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1 of the drawing shows generally an impact wrench 1 including a casing 2, a handle 3, a front nose 4 and a spindle 5. The casing 2 contains an air motor 6, shown in dotted lines, driving a conventional rotary impact mechanism 7, which in turn drives the spindle 5. The handle contains an air supply inlet passage 8 controlled by a throttle valve (not shown) actuated by a trigger 9. A motor-reversing mechanism is controlled by a lever 10. All of the foregoing mechanism is conventional in the impact wrench art.

Air from the inlet passage 8 passes through a normally open shutoff valve 14 which includes a valve spool also designated as 14, sliding in a cylindrical bore 15 provided in the casing 2 adjacent the upper end of the handle 3. The valve spool 14 is



urged rearwardly in the wrench by a spring 16 toward its shutoff position. In the position shown in FIG. 1, the valve 14 is shown in an open position which is its normal position. The spool valve 14 contains a bleed port 17 extending from the main air passage 8 to the chamber 18 located on the opposite side of the spool valve and this chamber is termed a valve control chamber.

During the operation of the wrench 1, the control chamber 18 is normally exhausted through an exhaust hose 19. The exhausting of the control chamber 18 maintains a differential pressure across the spool valve 14 sufficient to hold the spool valve in its open position wherein air pressure is free to flow from the inlet 8 to the motor 6. If the chamber 18 is exhausted at a higher rate than air can flow from the inlet 8 through the bleed port 17 into the chamber 18, a differential pressure is maintained across the valve 14.

The novel mechanism embodying this invention is located within the nose 4 of the wrench 1. This mechanism includes a stationary cylinder 24 which is coaxial with and surrounds the spindle 5. A screw 25 is shown in FIG. 1 for locking the cylinder 24 in position within the nose 4. A piston 26 is slidably mounted in the cylinder 24 and includes a forward flange 27 which slidably engages splines 28 located on the spindle 5. The interior wall of the piston 26 slides on an annular extension 29 of the casing 2 which surrounds and supports the spindle 5. The piston 26 contains an O-ring 30 engaging the extension 29 to serve as a sealing means. The rear face of the piston 26 cooperates with the stationary cylinder 24 and the casing extension 29 to form an enclosed space or chamber 31 which is connected by the hose 19 to the chamber 18.

In the retracted position of the piston 26 as shown in FIG. 1, the chamber 31 is connected to a bleed passage 32 formed in the stationary cylinder 24 and extending forwardly in the wrench to an outlet 33 located adjacent a series of radially extending choppers or teeth 35 formed on the exterior of the forward portion of the piston 26 as shown in FIG. 1. When the piston 26 is in its retracted position, and the spindle 5 is rotating, the piston teeth 35 rotate across the outlet 33 and alternately open and close it. Due to this alternate opening and closing of the outlet 33 of the passage 32, the exhaust of pressure from the chamber 31 will be responsive to the rotary speed of the piston 26. When the rotary speed of the piston 26 is high, the exhaust of the chamber 31 is relatively unimpeded and as the rotary speed of the piston slows the teeth 35 progressively restrict the exhaust of pressure from the chamber 31.

Depending on the dimensions of the teeth 35 and the area of the outlet 33, the pressure in the chamber 31 will rise in response to the slowdown of the spindle 5 and this rise in pressure can be controlled by controlling the above dimensions. As the pressure in the chamber 31 rises, it will reach an intermediate pressure sufficient to force the piston 26 to its forward position, as shown in FIG. 4. The amount of pressure required to do this will depend on the strength of the spring 36 mounted in front of the piston 26 and urging it rearwardly.

The movement of the piston 26 to its forward position uncovers a second exhaust passage 37 located in the cylinder 24 and exhausting from the front face of the cylinder 24. The outlet of the passage 37 is covered by a ring 38 rotatably mounted on the front face of the cylinder 24 and resiliently urged to a predetermined rotary position by a torsion spring 39. The ring contains an arcuate groove 40 on its rear face seating over the outlet of the passage 37 and several exhaust openings 41 connecting the groove 40 with the atmosphere. The groove 40 is of less length than a full circle and thus contains a nongrooved area 42 shown in FIG. 3. The ring 38 also contains internal teeth 43 adapted to engage with the teeth on the piston 26 in the forward position of the piston. Hence, the ring 38 turns with the piston 26 when the piston moves forwardly.

The length of the groove 40 and the location of the nongrooved area 42 will determine the amount of rotation of a fastener after the piston 26 moves to its forward position, shown in FIG. 4. So long as the groove 40 connects the

passage 37 to the atmosphere, the wrench will continue to operate. When the nongrooved area 42 covers the outlet of the passage 37, the pressure in the chamber 31 will rise further to a high pressure sufficient for the shutoff valve 14 to close and stop the wrench motor from operating further.

## OPERATION

FIG. 1 shows the position of the various parts of the wrench 1 when it is at rest. Initially, it is assumed that a suitable wrench socket (not shown) mounted on the spindle 5 and the wrench 1 is positioned with the socket seating over a fastener which is ready to be tightened. After seating the wrench on the fastener, the operator depresses the trigger 9 opening the throttle (not shown) which feeds air to the inlet passage 8. Air in the inlet passage 8 applies a pressure on the shutoff valve 14, forcing it forwardly in the wrench against the spring 16 to its open position wherein the air pressure flows to the motor 6. The rotation of the motor 6 drives the mechanism 7 thereby rotating the spindle 5 to drive the fastener. Initially, the driving speed of the spindle 5 is assumed to be relatively fast during the rundown of the fastener. As the fastener becomes tight, the spindle speed is progressively reduced.

The inlet pressure acting on the shutoff valve 14 is fed through the bleed port 17 located in the valve 14 into the control chamber 18. This pressure in chamber 18 is exhausted through the hose 19 to the second chamber 31 and the chamber 31 is exhausted through the passage 32 and its outlet 33. During the relatively high speed of the spindle 5, the chopper teeth 35 rotating across the outlet 33 provide relatively little restriction to the exhaust of the pressure from the outlet 33. However, as the spindle speed slows, the chopper teeth 35 progressively restrict the exhaust of pressure from the outlet 33 causing the pressure in the chambers 31 and 18 to rise.

Ultimately, the pressure in the chamber 31 rises to a first selected pressure which is effective to force the piston 26 forwardly to the position shown in FIG. 4. This forward movement of the piston is determined by the strength of the spring 36 which urges the piston rearwardly. The movement of the piston 26 to its forward position closes the outlet 33 of the passage 32 and opens the second exhaust passage 37. In addition, in its forward position, the chopper teeth 35 of the piston engage with the teeth 43 on ring 38 thereby causing the ring 38 to begin rotating in unison with the piston 26 and the spindle 5. Initially, in the forward position of the piston 26, the bleed passage 37 opens into a groove 40 in the ring 38 which allows the passage 37 to be exhausted.

However, after the ring rotates through a predetermined angle, the nongrooved portion of the ring 38 covers the outlet of the passage 37 causing the pressure in the chamber 31 to rise to a second higher selected or predetermined pressure sufficient to cause the shutoff valve to move to its closed position as shown in FIG. 1. The closing of the shutoff valve 14 stops the motor 6. Thereafter, the operator releases the trigger 9 to close the throttle and lifts the socket from the fastener. At this time, the torsion spring 39 returns the angle measurement ring 38 to its original starting position, the spring 36 returns the piston 26 rearwardly to its original retracted position and the wrench 1 is ready for another operating cycle.

As a result of the following structure, I have provided a power wrench which will drive a fastener until the driving speed of the fastener is reduced to a predetermined slow speed wherein the wrench will create a first pressure signal sufficient to cause the wrench to begin measuring the rotation angle of the fastener. After the fastener is driven through a predetermined angle, the wrench will create a second pressure signal which will cause its shutoff valve to close and stop the wrench motor. When the wrench is removed from the fastener, the mechanism will return to its starting condition wherein the wrench is ready for another cycle.

Although only one embodiment of the invention is illustrated and described in detail, it should be understood that the invention is not limited simply to this embodiment, but contemplates other embodiments or versions which follow the teachings and concepts of this invention.

I claim:

1. A power wrench comprising:
- a casing containing a motor, a spindle adapted to drive a fastener and drive means interconnecting the motor to the spindle;
- a power supply system for supplying power to the motor and containing means adapted to be actuated to stop the flow of power to the motor;
- means for measuring the speed of said spindle during wrench operation and operative to provide a signal when the speed of the spindle is reduced to a predetermined speed; and
- means for measuring the amount or angle of rotation of said spindle and operative to begin measuring the spindle rotation in response to said signal and to actuate said means for stopping the motor power after said spindle is rotated through a predetermined angle following said signal.

2. A power wrench comprising:
- a casing containing a motor, a spindle and a drive mechanism for interconnecting the motor to the spindle;
- a valve operative in response to a high pressure signal to close and stop the supply of power to the motor;
- means for measuring the speed of the spindle and operative, in response to a selected slow speed, to create an intermediate pressure signal; and
- means operative in response to said intermediate pressure signal to begin measuring the angle of rotation of the spindle and to create a high pressure signal after a predetermined amount of rotation of said spindle for operating said valve and causing it to close.

3. The wrench of claim 2 wherein:
- said valve is a pressure-operated shutoff valve and includes a chamber adapted to contain pressure acting on said valve urging it to close.

4. The wrench of claim 3 including:
- means for continually pressurizing said chamber;
- primary exhaust means for said chamber and including chopper means rotated by said spindle and alternately opening and closing said primary exhaust means as said spindle rotates whereby the pressure in said chamber rises as the spindle speed is reduced;
- a moveable member subject to the pressure in said chamber and resiliently urged to one position when the wrench is at rest, said movable member being operative, in response to the rise of pressure in said chamber to a first predetermined pressure in response to the reduction in speed of said spindle, to move to a second position;
- a second member cooperating with said movable member when in said second position to provide secondary exhaust means for said chamber, and operative to measure the angle of rotation of said spindle and to close said secondary exhaust means in response to the rotation of said spindle through a predetermined angle thereby causing the pressure in said chamber to rise to a magnitude sufficient to cause said shutoff valve to close.

5. The wrench of claim 4 wherein:
- said movable member is a piston slidably and nonrotatably engaged to said spindle and cooperating with said casing to form a second chamber connected to said first chamber, said piston being movable to said second position by pressure in said second chamber.

6. The wrench of claim 5 wherein:
- said chopper means includes teeth mounted on said piston and rotating across the outlet of a primary exhaust passage connected to said second chamber when said piston is in its first position; and
- said outlet of said primary exhaust passage being closed when said piston is in its second position.

7. The wrench of claim 6 wherein:

said secondary exhaust means includes a secondary exhaust passage which is opened by said piston in its second position; and

said second member is rotatably mounted in said casing and arranged to be engaged with said piston in its second position to rotate with said piston.

8. The wrench of claim 7 wherein:



said second member is a ring located to rotate across the outlet of said secondary exhaust passage and interconnected to the casing by a spring which returns the second member to a starting position when disengaged from said piston.

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