TORQUE CONTROL IMPACT WRENCH


Filed Oct. 2, 1969, Ser. No. 863,152

Int. Cl. B25h 19/00

U.S. Cl. 173—12

3,608,131

Patented Sept. 28, 1971

3,608,131

ABSTRACT OF THE DISCLOSURE

A rotary impact wrench containing a motor, a rotary impact mechanism, and a spindle adapted to drive a fastener. A resilient torsion bar is mounted either between the motor and the impact mechanism or the impact mechanism and the spindle and includes a member for preloading or prewinding the torsion bar so that it does not wind up further until after the torque on the torsion bar exceeds a selected value. A shut-off valve in the wrench is connected to a hollow passage extending through the torsion bar and terminating in an exit port which is normally closed by the preloading means and is opened when the torsion bar winds up further in response to the rise of torque on the torsion bar above the selected value of torque, resulting in creating a fluid signal which causes the valve to shut off the power supply to the wrench motor.

BACKGROUND OF INVENTION

This invention relates to rotary impact wrenches having a torque-responsive means for stopping the wrench motor in response to a predetermined magnitude or value of torque applied by the wrench to a fastener, such as a nut or the like.

A conventional rotary impact wrench having an adjustable torque limiting means is disclosed in the U.S. Pat. No. 2,822,677 issued Feb. 11, 1958, to H. C. Reynolds. This tool includes an axially extending torsion bar spring which is utilized to transmit rotary impacts to a fastener. The torsion bar is wound or prestressed to a predetermined value of torque corresponding to the maximum torque load that is to be transmitted by the torsion bar to the fastener. By being prestressed, the torsion bar transmits torque loads as a rigid non-deflecting coupling so long as the transmitted torque is equal to or less than the prestressed torque on the torsion bar. When the impact torque load applied to the torsion bar by the rotary impact tool exceeds the prestressed torque of the torsion bar, the torsion bar begins acting as a spring, instead of a rigid coupling, and deflects an additional amount and then rebounds to absorb and dissipate the excessive impact torque load without transmitting it to the fastener. This torsion bar is commonly known as a "prestressed" or "preloaded" torsion bar.

SUMMARY OF INVENTION

A principal object of this invention is to provide a novel torque-responsive motor shut-off system for an impact wrench which is accurate and reliable. Other important objects are: to provide a novel control system for sensing a torque load in an impact wrench and shutting off the wrench motor in response to a selected torque load; to provide a novel control system for use with an impact wrench having a prestressed torsion bar for sensing a predetermined torque load and stopping the wrench in response to such predetermined torque load; and to provide a novel shut-off means for an impact wrench responsive to a predetermined torque load on the impact wrench.

In general, the foregoing objects are attained in an impact wrench containing a motor, a rotary impact mechanism, a spindle adapted to deliver a series of rotary impacts to a fastener, and a preloaded or prestressed torsion bar interconnecting either the motor to the impact mechanism or the impact mechanism to the spindle. The motor is connected to its power supply through a fluid operated shut-off valve which is connected to a passage extending through the torsion bar and terminating in an exit port which is normally closed by the prestressing member of the torsion bar. When the torsion bar winds up further in response to the rise of torque on the torsion bar above a selected value of torque, the exit port is opened to create a fluid signal which causes the shut-off valve to close thereby stopping the flow of power to the wrench motor.

BRIEF DESCRIPTION OF DRAWING

The invention is disclosed in the accompanying drawings wherein:

FIG. 1 is a fragmentary elevational view with parts cut away and shown in section of an impact wrench utilizing one embodiment of the invention;

FIGS. 2, 3, and 4 are respective sections taken on lines 2—2, 3—3, and 4—4 in FIG. 1;

FIG. 5 is an enlarged fragmentary view with parts shown in section of the front spindle portion of the wrench in FIG. 1;

FIG. 6 is a fragmentary axial section of a second embodiment of the invention;

FIG. 7 is a section taken on the line 7—7 in FIG. 6.

DESCRIPTION OF PREFERRED EMBODIMENTS

The first embodiment of the impact tool or wrench 1 shown in FIGS. 1 to 5 includes a casing 2 having a front nose 3, a pistol-shaped handle portion 4, and a rear cap 5. The handle 6 carries a trigger 7 which is connected to a throttle valve (not shown) and is operative to feed fluid pressure to the motor 7. The motor 7 includes a hollow motor shaft 8 which is connected to a conventional rotary impact mechanism 9 including a hammer 10 and an anvil 11. The impact mechanism 9 delivers rotary impacts to a spindle 12 in a manner which is well known in the impact wrench art. All the foregoing structure is conventional and, for that reason, is not described in detail.

The anvil 11 includes an integral forwardly extending tubular portion 15 journaled in a bearing 16 mounted in the nose 3 of the impact tool casing 2. The tubular portion 15 of the anvil surrounds an elongated torsion spring or bar 17 having its rear end 18 formed as a square plug non-rotatably anchored in a corresponding square hole in the anvil 11 so that the impacts received by the anvil 11 from the hammer 10 are rigidly coupled to the upper end of the torsion bar 17. The forward end of the torsion bar 17 is integrally connected to the spindle 12 which is adapted to engage a socket (not shown) having a square hole for detachably receiving the square forward drive end of the spindle 12.

The impact energy received by the anvil 11 is transmitted by the torsion bar 17 to a work piece. In order for the torsion bar 17 to accomplish this, it must be wound or prestressed under a torque which is equal to or greater than the torque of the impacts being transmitted. Once the torsion bar 17 is wound under a given torque load, it acts as a rigid coupling in transmitting torque loads which are equal to or less than the prestressing torque of the torsion bar. In other words, so long as the torque loads applied to the torsion bar 17 do not exceed its prestressing torque, no further deflection of the torsion bar occurs.

When the impact load applied to the torsion bar 17 exceeds its prestressing torque, the bar deflects or winds
up additionally under each impact and then rebounds, resulting in the impact being absorbed substantially by the torsion bar without transmitting it to the work piece. Thus the torsion bar 17 acts to limit the maximum torque applicable to a work piece to a value of torque equaling substantially the pretressed torque of the bar 17.

This invention relates to a system for detecting when the torsion bar begins winding up further and, in response, then shutting off the impact wrench motor. The torsion bar 17 contains a hollow axial passage 20 and a pair of radially extending wings 21 adjacent its front end 12. The axial passage 20 connects to a pair of branch ports 22 which extend radially outward and terminate in bleed ports 23 provided in the faces of the wings 21. Looking at FIG. 2, the branch passages 22 are arranged in the form of a Z with the exit or bleed ports 23 being located in the faces on the wings 21 facing in a clock-wise direction, looking at FIG. 2. A tube 25 containing a pair of diametrically located slots 26 in its forward end is located on the torsion bar 17 with the slots 26 over and keyed on the wings 21. The main portion of the tube 25 extends rearwardly from the wings 21 and has a rear end 27 journaled in the forward end of the tubular portion 15 of the annul 11.

The exterior of the tubular portion 15 contains a series of helically arranged splines 29 and the exterior of the tube 25 contains a series of longitudinally extending splines 30 which are also provided with a thread 31. A sleeve 33 is mounted over both the tube 25 and the tubular portion 15 and includes cooperating axial flutes on its forward end and helical flutes on its rear end to interconnect the tubular portion 15 with the tube 25. A nut 34 is threaded on the thread 31 of the tube 25 and engages the forward end of the sleeve 33 whereby it can be adjusted to wind up the torsion bar 17, thereby applying a preload torque to the bar 17. The sleeve 33 winds up the torsion bar 17 as it moves rearwardly on the helical splines 29, due to the helix of the splines 29.

Due to the location of the bleed ports 23 on the faces of the wings 21 facing in a clockwise direction, the sides of the slots 26 are urged against the bleed ports 23 thereby sealing them, as the torsion bar is resiliently wound, by means of the nut 34 being turned on the tube 25 to move the sleeve 33 rearwardly on the helical splines 29. The side surfaces of the slot 26 covering the bleed ports 23 are urged against the seal 33 when engaged over the bleed ports 23, as shown in FIG. 2. Looking at FIG. 2, it can be seen that when the torque load on the torsion bar 17 exceeds the preload torque, the torsion bar will be wound up further in a counter-clockwise direction resulting in the bleed ports 23 being opened by moving away from the side surfaces of the slot 26 which normally seal the bleed ports 23. At this moment the venting of the ports 23 and the connecting fluid passage 20 creates a signal which is utilized to shut off or stop the wrench motor 7.

The trigger 6 controls the feeding of fluid pressure to an inlet port 35 opening into a chamber 36 containing a shut-off valve means 37 which is normally open and is operative, when closed, to shut off the flow of pressure fluid to the tool motor 7. The chamber 36 is divided into an inlet space 38, a cylinder 39 and an outlet port 40 extending to the motor 7. The valve means 37 includes a valve seat 41 located between the inlet space 38 and the cylinder 39. As a result of this arrangement, pressure flows through the inlet port 35, the inlet 38, the valve seat 41, the cylinder 39, and the outlet port 40 to the motor 7.

A spool valve 43 is slidably mounted in the cylinder 39. The valve 43 includes a valve head portion 44 adapted to seat 41 to close off the inlet port 38 from the cylinder 39. A spring 45 is mounted in the cylinder 39 to bias the valve 43 to a normally open position, as shown in FIG. 1. The rear end of the cylinder 39 contains a pilot port 46 connected to a passage 47 located in the rear cap 5. The portion of the cylinder 39 containing the spring 45 and pilot port 46 is termed a pilot chamber 48.

The valve 43 contains a small leak passage 49 extending between the inlet space 38 and the pilot chamber 48. As a result of the leak passage 49, fluid pressure applied to the inlet space 38 will slowly flow into the pilot chamber 48 formed in the cylinder 39 at the lower end of the valve 43. After fluid pressure is applied to the inlet space 38, the sudden exhausting of the pilot chamber 48 will result in the creation of a differential fluid pressure acting across the valve 43 causing the valve 43 to be quickly closed against the spring 45.

The passage 47 in the rear cap 5 connects to a tube 52 which extends axially from the rear cap 5 through the hollow motor shaft 8 and into the rear end of the passage 20 in the torsion bar 17. Appropriate seals are mounted at both ends of the tube 52 to prevent leaks from developing at these points.

As a result of the passage 20 in the torsion bar 17 being connected to the pilot chamber 48 in the shut-off valve 37, the opening of the bleed ports 23, in response to the rise of torque above the preload torque on the torsion bar, will exhaust the pilot chamber 48 and cause the spool valve 43 to shut off the air flow to the motor 7.

The nut 34 is provided at its rear face with a series of beveled gear teeth 53 adapted to engage the teeth 54 of a conventional Jacob's chuck key 55 in the same manner that it is used on the conventional Jacob's drill chuck. During the use of the chuck key 55 the axle pin 56 seats in a radially-opening hole provided in the sleeve 33 as shown in FIG. 5.

Means is provided for automatically locking the nut 34 in an adjusted position on the sleeve 33 when the chuck key 55 is withdrawn from the operative position shown in FIG. 5. The nut 34 carries a tang 57 slidable mounted therein in a corresponding longitudinally extending slot and urged rearwardly by a spring 58. The forward edge of the sleeve 33 is provided with a series of forwardly opening notches 59 adapted to receive the tang 57 to lock the nut 34 against turning relative to the sleeve 33. A ring 51 surrounds the sleeve 33 and seats against the front portion of the tang 57 where it can be moved forwardly to force the tang 57 forward out of a notch 59. The ring 51 is wide enough to partially cover the hole in the sleeve 33 and the chuck key 55 is removed so that it must be moved forward to insert the axle pin 56 into its hole. In moving forward, the ring 51 forces the tang 57 out of the notch 59, thereby automatically unlocking the nut 34 so that it can be turned by the chuck key 55.

SECOND EMBODIMENT, FIGS. 6 and 7

The second embodiment 60 of impact wrench in FIGS. 6 and 7 differs from that of FIG. 1 by having the pre-loaded torsion bar located between the motor 7 and the impact mechanism 9.

The hollow motor shaft 8 is provided with a rearward extension 61 and the torsion bar 62 contains a central passage 63 connected by a short hose 64 to a port 65 provided in the extension 61. The port 65 is connected by a rotary joint to a passage 66 that runs to the pilot chamber 48 of the motor shaft 8.

The forward end of the torsion bar 62 carries a Z-shaped cross section 67 located between a slot provided in the front end of the motor shaft 8 forming a pair of parallel surfaces 68. The Z-shaped cross section 67 contains a cross passage 69 that is connected to the central passage 63 and terminates in bleed ports 70 located at the end of each leg of the Z-shaped cross section, similar to the bleed ports 23 in the first embodiment. The torsion bar 62 also includes an integral spline extension 71 located forward of the Z-shaped cross section 67 which is connected in the usual manner to drive the impact mechanism 9.
Normally the bleed ports 70 are sealed by being pressed against the surfaces 68 of the motor shaft, due to the twist or prestress applied to the torsion bar 62 in the same manner as in the first embodiment. This condition will remain until the torque on the torsion bar 62 exceeds the prestressing torque load applied to the torsion bar. As soon as the bleed ports 70 are opened, they vent the air from the pilot chamber 48, causing the spool valve 43 to close and shut off the supply air to the motor 7.

The rear end portion of the torsion bar 62 carries 10 helical gear teeth 72 engaging corresponding gear teeth on the shaft extension 61. The rear end face of the torsion bar 62 engages a screw 73 threaded into the extension 61, so that the forward movement of the screw 73 forces the torsion bar 62 forward and twists it to increase the preload on the torsion bar 62.

While several embodiments of the invention are shown and described in detail, this invention is not limited simply to the specifically described embodiments, but contemplates other embodiments and variations which utilize the concepts and teachings of this invention.

We claim:

1. A rotary impact wrench containing a system for measuring the torque output of the wrench and for stopping the wrench motor in response to a selected value of torque, said wrench comprising:
   a driving train including a motor, a rotary impact mechanism, and a spindle adapted to deliver a series of rotary impacts to a fastener;
   a resilient torsion member interconnected in said driv- ing train to transmit a torque load in said train and adapted to yield in response to said torque load;
   rigid means for winding and holding said resilient torsion member a selected amount to apply a predetermined preloaded value of torque to it preventing it from yielding further until the torque load on the member rises above said preloaded value of torque;
   means for creating a signal in response to further yielding of said resilient torsion member; and
   means operative, in response to said signal, to stop said motor.

2. The wrench of claim 1 wherein:
   said signal is a fluid signal.

3. The wrench of claim 2 wherein:
   said resilient torsion member is an axially extending torsion bar containing an axially extending fluid passage having an exit port near one end of said torsion bar; and
   said rigid means seals said exit port until said prede- termined value of torque is reached whereupon said rigid means opens said exit port.

4. The wrench of claim 3 wherein:
   said rigid means non-rotatably engages said one end of said torsion bar and includes an engaging surface normally covering said exit port.

5. The wrench of claim 4 wherein:
   said fluid passage in said torsion bar is connected to a valve operative to shut off said motor in response to the opening of said exit port.

6. The wrench of claim 5 wherein:
   said torsion bar interconnects said rotary impact mecha- nism to said spindle.

7. The wrench of claim 5 wherein:
   said torsion bar interconnects said motor to said rotary impact mechanism.

8. The wrench of claim 5 wherein:
   said rigid means includes a tubular portion surrounding said torsion bar which is non-rotatably locked to the other end of said torsion bar and is connected to said one end of said torsion bar by a means adapted to hold said torsion bar in its preloaded wound condition.

9. A system for measuring the torque output of an impact wrench including a motor, a rotary impact mechanism and a spindle adapted to deliver a series of rotary impacts to a fastener, the invention comprising:
   a yieldable member interconnected between the motor and the impact mechanism and adapted to yield in response to the torque load on the spindle;
   resilient means opposing the yielding of said yieldable member under a torque load;
   means applying a preload to said resilient means preventing said yieldable member from yielding further until the torque load on said spindle rises above a predetermined value; and
   means creating a signal in response to further yielding of said yieldable member thereby indicating that the torque load has risen above said predetermined torque load.

10. The system of claim 9 including:
    means operative to stop the motor in response to said signal.

11. The system of claim 10 wherein:
    said signal is a fluid signal.

References Cited

UNITED STATES PATENTS
2,808,916 10/1957 Johnson 173—12
2,822,677 2/1959 Reynolds 64—15
2,973,067 2/1961 Eddy 173—12
3,174,606 3/1965 Hornschuch et al. 173—12
3,174,559 3/1965 Vaughan 173—12

JAMES A. LEPPINK, Primary Examiner
U.S. Cl. X.R.
64—15; 81—52.4; 91—59; 173—93.5