Sept. 28, 1971 H. HORNSCHUCH ET AL 3,608,131

TORQUE CONTROL IMPACT WRENCH

Filed Oct. 2, 1969 2 Sheets-Sheet 1

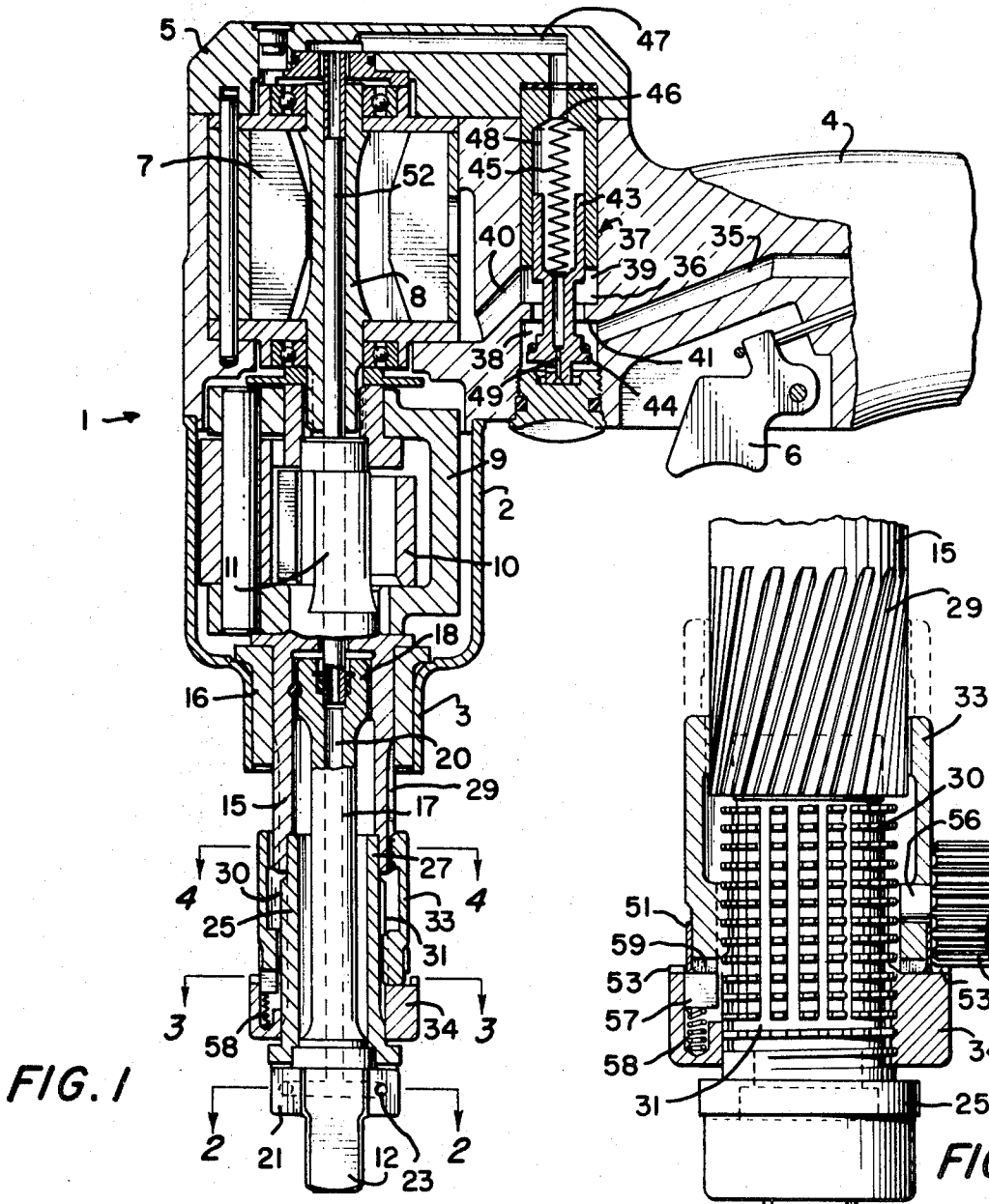


FIG. 1

FIG. 5

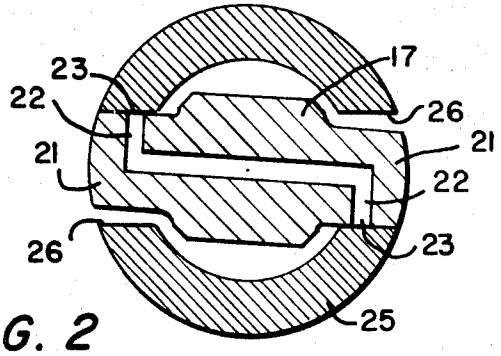


FIG. 2

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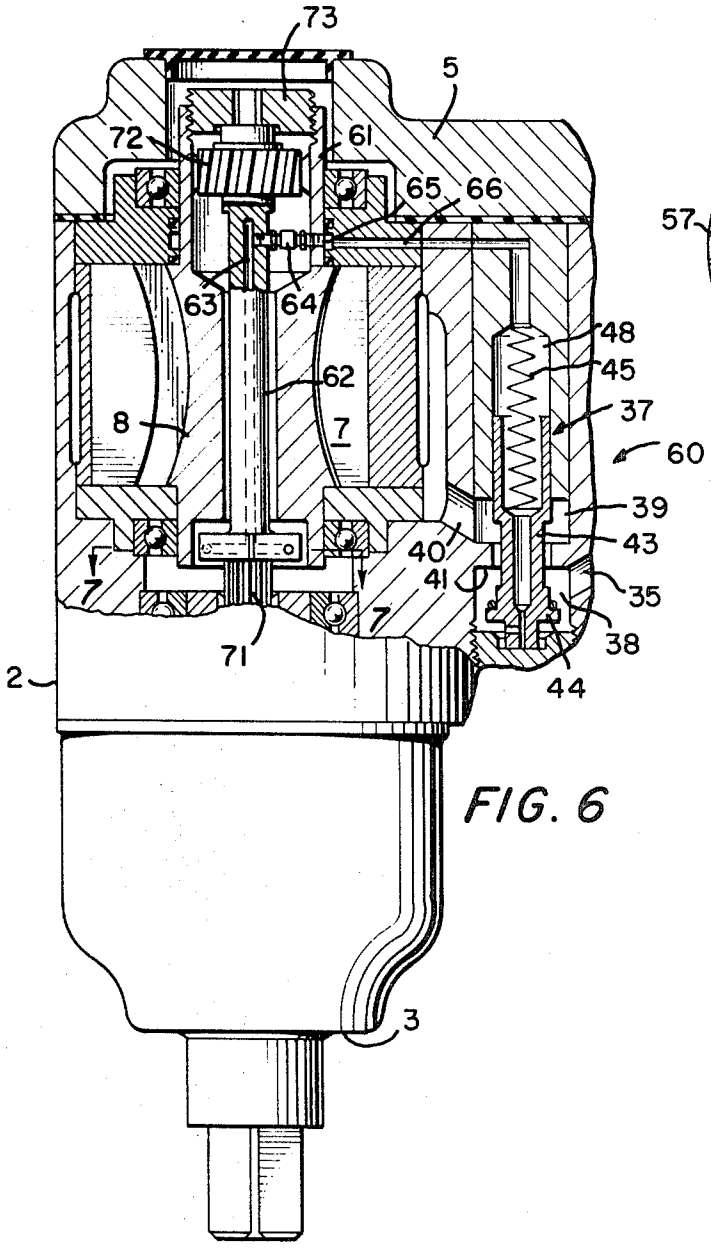


FIG. 6

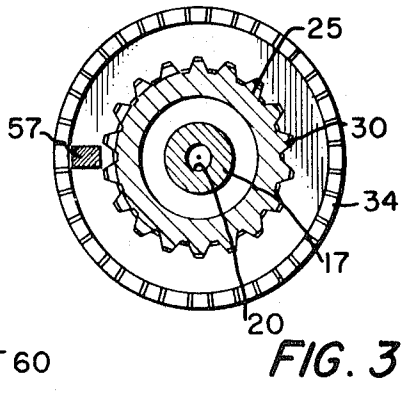


FIG. 3

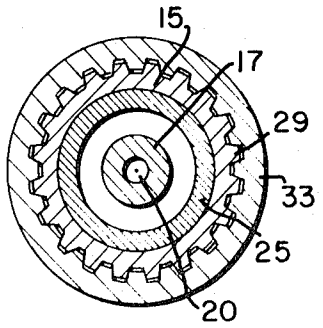


FIG. 4

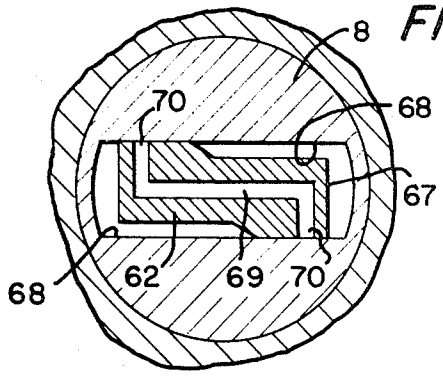


FIG. 7

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TORQUE CONTROL IMPACT WRENCH

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Int. Cl. B25b *19/00*
U.S. Cl. 173—12 11 Claims

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; and

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 **4** carries a trigger **6** 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 enlongated 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 prestressed 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 prestressed torque of the bar **17**.

This invention relates to a system for detecting when the torsion bar begins winding up further and, in response thereto, 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 clockwise 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** received 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 anvil **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 rearward 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 are machined to provide a tight seal 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 prewound 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 over the valve seat **41** to close off the inlet space **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 prewound 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** slidably 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** when 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 preloaded 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 shut-off valve means **37**.

The forward end of the torsion bar **62** carries a Z-shaped cross section **67** locked 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 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 driving 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 predetermined 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 mechanism 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.

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JAMES A. LEPPINK, Primary Examiner

U.S. Cl. X.R.

64—15; 81—52.4; 91—59; 173—93.5