United States Patent

Pauley

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[54] SIGNAL INHIBITOR FOR IMPACT WRENCH

[72] Inventor: **Reginald W. Pauley,** Belle Mead, N.J.

[73] Assignee: **Ingersoll-Rand Company,** New York, N.Y.

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[52] **U.S. Cl.**.....**173/12,** 173/80, 173/93.5, 81/52.3

[51] **Int. Cl.**.....**B25b 19/00**

[58] **Field of Search** 173/12, 80, 93.5, 94; 318/432, 318/433; 81/52.3, 52.4; 64/15; 91/59; 192/150

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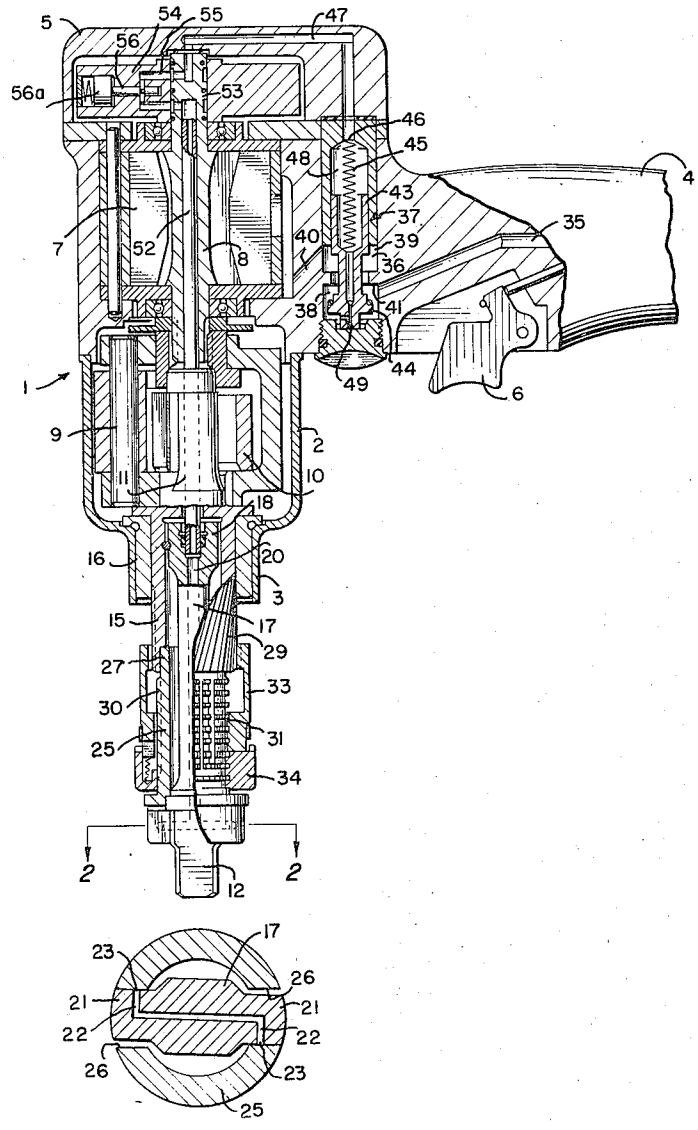
Primary Examiner—James A. Leppink

Attorney—David W. Tibbott and Frank S. Troidl

[57] **ABSTRACT**

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 between the motor 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 shutoff valve in the wrench is connected to a hollow signal 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. Means is provided for inhibiting the signal when the speed of the motor is abnormally high to avoid the motor from stopping prematurely. A second embodiment moves the signal passage out of the torsion bar.

8 Claims, 5 Drawing Figures



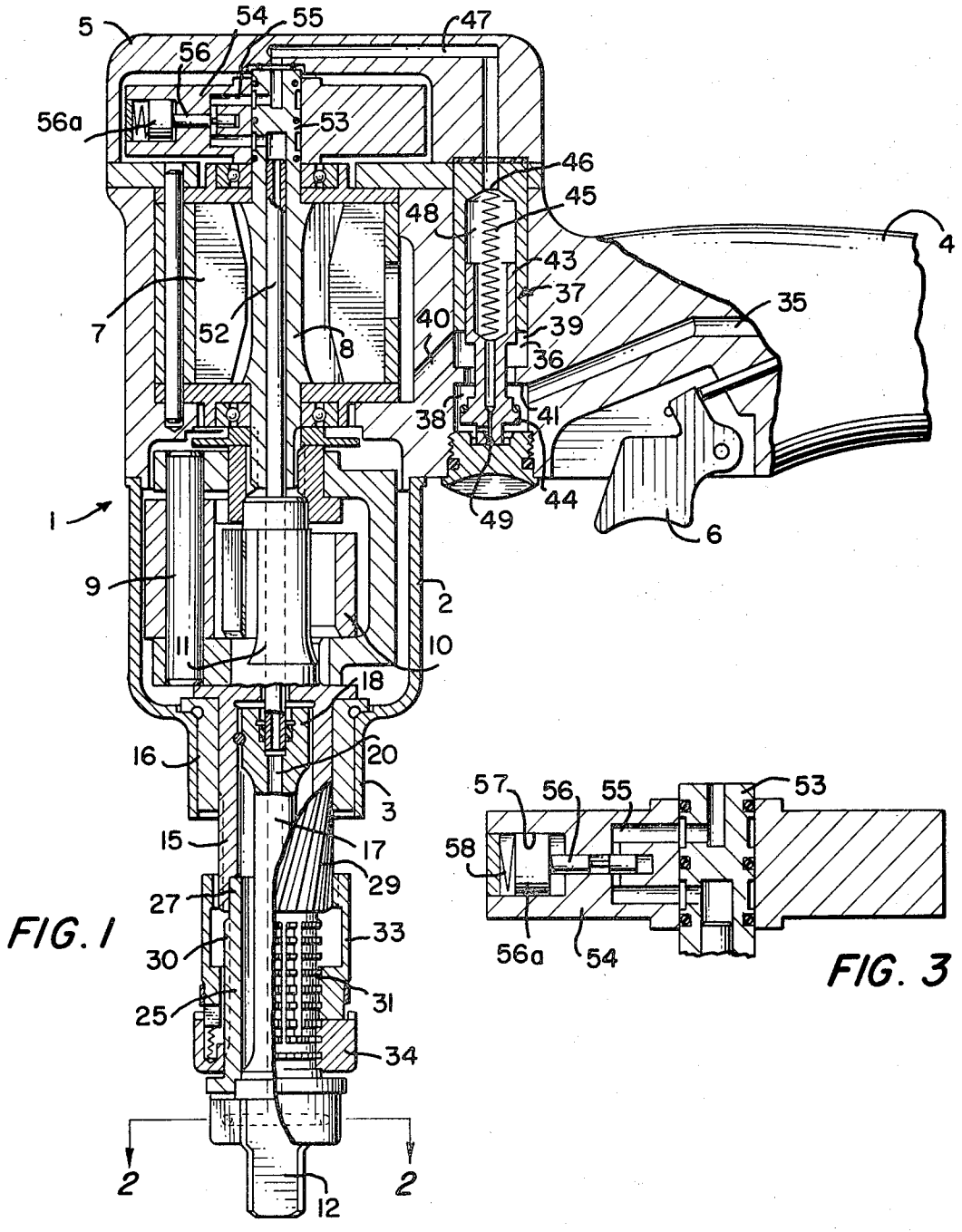


FIG. 1

FIG. 3

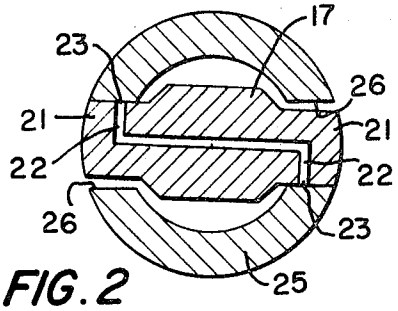


FIG. 2

INVENTOR
REGINALD W. PAULEY
BY
David W. Talbott
ATTORNEY

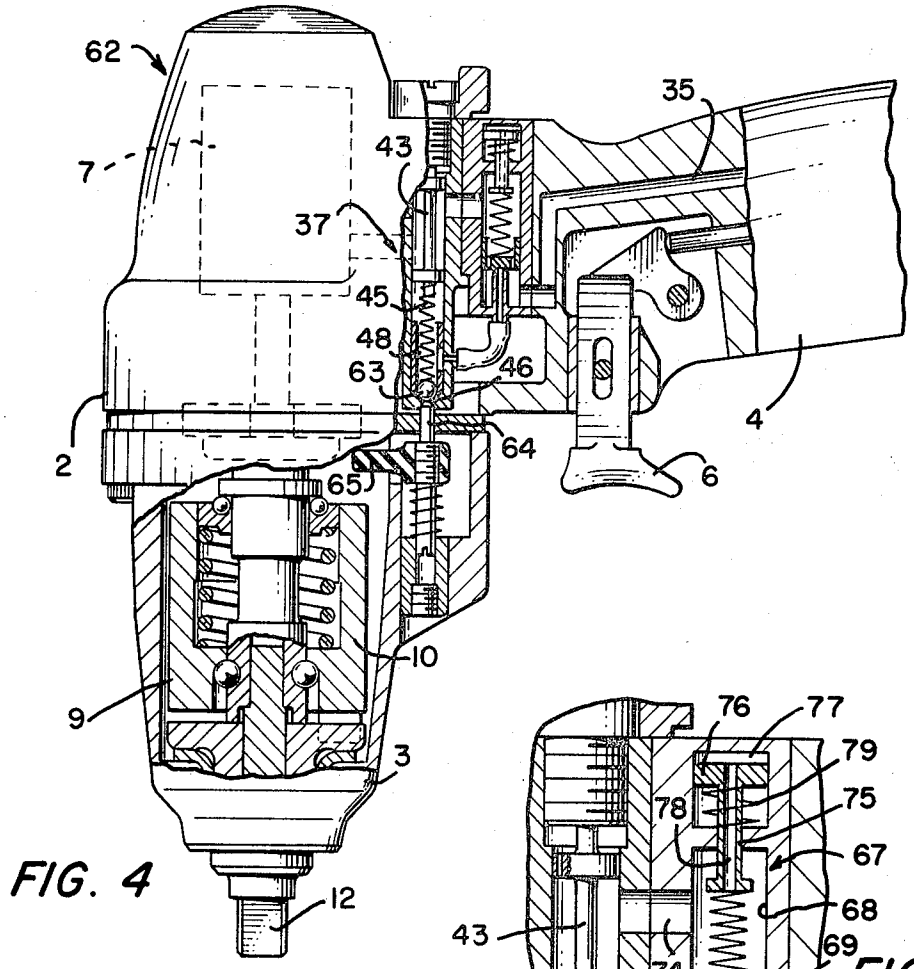


FIG. 4

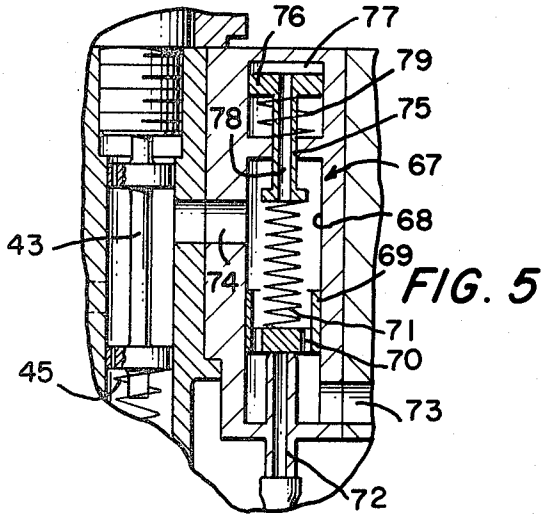


FIG. 5

INVENTOR
REGINALD W. PAULEY
BY

David W. Talbott
ATTORNEY

SIGNAL INHIBITOR FOR IMPACT WRENCH

BACKGROUND OF THE 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 and more particularly to a system or mechanism for avoiding stopping the wrench prematurely.

A conventional rotary impact wrench having a mechanism for stopping the wrench motor in response to a predetermined torque is disclosed in the U.S. Pat. No. 2,814,277, issued Nov. 26, 1957 to F. A. Jimerson. Under certain conditions this tool will stop prematurely. When a fastener can rotate freely for several turns before being seated, the wrench motor can develop a higher than normal speed during rundown and strikes an abnormally strong impact on its first blow which may create a false signal causing the motor to shut off. Of course, premature shutoff is undesirable.

SUMMARY OF THE INVENTION

A principal object of this invention is to provide means for eliminating or minimizing premature stopping of an impact wrench which automatically stops in response to a predetermined torque.

Other important objects are: to provide a system for inhibiting or rendering ineffective the signal of a torque measuring system of an impact wrench during its first blow; to provide a first blow signal inhibiting system which is useful on various types of torque measuring impact wrenches; and to provide s signal inhibiting means for a torque measuring impact wrench which is operative during abnormally high speeds of the wrench motor and is inoperative at other times.

In general, the foregoing objects are attained by mounting the signal blocking means on a part rotating with the motor and arranging it to block the signal when the centrifugal force caused by the motor speed is abnormally high. An alternate embodiment prevents the signal from being effective when the fluid flow to the wrench motor is abnormally high.

BRIEF DESCRIPTION OF THE 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;

FIG. 2 is a section taken on line 2—2 in FIG. 1;

FIG. 3 is an enlarged fragmentary view of FIG. 1 showing the signal blocking means in a closed position;

FIG. 4 is a view similar to FIG. 1 showing a second embodiment of the invention installed in another type of impact wrench; and

FIG. 5 is an enlarged fragmentary view of a portion of FIG. 4 showing details of the second embodiment of signal inhibiting means.

DESCRIPTION OF PREFERRED EMBODIMENTS

The first embodiment of the impact tool or wrench 1 shown in FIG. 1 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 elongated torsion spring or bar 17 having its rear end 18 formed as a square plug nonrotatably 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 workpiece. 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 workpiece. Thus the torsion bar 17 acts to limit the maximum torque applicable to a workpiece to a value of torque equaling substantially the prestressed torque of the bar 17.

This wrench 1 includes 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 passages 22 which extend radially outward and terminate in bleed ports 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 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 counterclockwise 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 shutoff 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 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 shutoff 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 airflow to the motor 7.

This invention involves the concept of inhibiting the signal in the tube 52 during the start of a wrenching operation to prevent the wrench from shutting off prematurely. Premature shut off of the the wrench is caused by overspeed of the wrench motor during rundown and this invention senses this overspeed and prevents or inhibits the signal system from stopping the wrench during the first blow of the impact mechanism 9 following rundown.

The motor shaft 8 includes a rearward extension 53 which carries a valve body 54 fixed thereon to rotate with it. The passage in the tube 52 is extended into the valve body 54 through a U-shaped passage 55 and a radially movable spool valve 56 intersects the U-shaped passage 55. The outer end of the spool valve 56 is fixed to a sliding weight 56*a* moving in a bore 57 and a spring 58 in the bore 57 urges the spool valve 56 inwardly where it is in a normally open position. The spring 58 is selected to hold the valve 56 in its open position during normal speeds of the wrench motor 7. During overspeed of the motor 7, centrifugal force overcomes the spring 58 and moves the valve 56 outwardly to close the signal passage 55 as shown in FIG. 3. As long as the signal passage 55 is blocked, the signal cannot operate the shutoff valve 37. After the motor stops because of an impact of the mechanism 9, the spring 58 returns the valve 37 to its open position wherein the signal system is effective during the remainder of the operation cycle of tightening a fastener.

SECOND EMBODIMENT

The second embodiment 62 shown in FIGS. 4 and 5 includes a conventional impact wrench including a casing 2, nose 3, handle 4, trigger 6, motor 7, impact mechanism 9 and spindle 12. The same reference numbers as used in the first embodiment are used to describe similar elements in this second embodiment. This wrench is disclosed in the U.S. Pat. No. 2,814,277, issued to F. A. Jimerson, mentioned previously, and includes a shutoff valve 37 which substantially corresponds to the shutoff valve of the first embodiment except that the pilot chamber 48 is closed by a valve ball 63 pressed against the edges of the pilot port 46 by the spring 45 to normally seal the pilot chamber 48 against leakage of air pressure from it.

A plunger 64 is slidably mounted forward of the ball 63 to lightly engage it and has an arm 65 extending into the wrench and located a short distance rearwardly of the impact mechanism. In the impact mechanism used in the second embodiment, the hammer 10 reciprocates and its rearward stroke increases as the impact blow intensity increases. The arm 65 is located where it is engaged and moved rearward by the hammer 10 when the impact torque delivered by the hammer reaches a predetermined magnitude or level. Rearward travel of the arm 65 forces the plunger 64 to open the ball 63 and exhaust the pilot chamber 48, causing the shutoff valve 37 to close.

This invention prevents the shutoff valve 37 from closing prematurely. During overspeed of the motor 7, air flowing to it is higher than normal. A flow measuring valve 67 is disposed between the inlet port 35 and the shutoff valve 37. This flow measuring valve 67 includes a bore 68 enclosing a slidable valve piston 69 containing several holes 70 spaced around its center. A spring 71 urges the valve piston 69 against the end of a tube 72, wherein it seals the tube. Air enters the bore through an inlet 73 on the tube side of the piston and exits through an outlet 74 located on the spring side of the piston 69.

The spring 71 is selected to maintain the tube 72 closed during normal flow of air through the valve 67 and to allow the valve piston 69 to open the tube when the motor 7 overspeeds and the air rate is above normal. When the airflow through the piston holes 70 is higher than normal due to overspeed of the motor during rundown, a sufficient pressure differential is created across the valve piston 69 to force it away from the end of the tube 72.

Opening the tube 72 allows air to flow through the tube into the pilot chamber 48 of the shutoff valve 37 which inhibits the valve 37 from closing even though the ball 63 may be unseated. In other words, even though the ball 63 is unseated, the pressure in the pilot chamber 48 will not drop sufficiently for the valve 37 to close when the tube 72 is open.

The spring 71 also engages the plunger 75 of a piston 76 sliding in a secondary chamber 77. The plunger 75 contains an axial passage 78 opening into the chamber 77 allowing the air pressure in the bore 68 to enter the chamber 77 and urge the plunger 75 against the spring 71. A second spring 79 urges the plunger 75 away from the first spring 71 and the pressure on the piston 76 overcomes the force applied by the second spring 79. The purpose of the plunger 75 is to apply the proper load to the spring 71 over a wide range of operating air pressures. 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.

I claim:

1. A rotary impact wrench containing a system 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;

signalling means for measuring the torque applied to the fastener by said spindle and for creating a fluid signal in response to the rise of the torque to a predetermined value;

shutoff means operative in response to said fluid signal to stop said motor;

a passage for conveying said signal from said signalling means to said shutoff means; and

inhibiting means located in said passage, controlled by said fluid signal and operative to prevent said signal from stopping said motor during the first impact delivered by said spindle to the fastener.

2. The wrench of claim 1 wherein:

said motor is fluid operated and said shutoff means for stopping said motor is a fluid operated valve operative to close in response to said signal.

3. The wrench of claim 2 wherein:

said signal flows through a passage in said driving train; and

said inhibiting means is mounted on said driving train and is operative to block said signal passage when the speed of said driving train exceeds a predetermined speed.

4. The wrench of claim 3 wherein:

said inhibiting means is a valve controlling said signal passage and having a normally open position.

5. The wrench of claim 4 wherein:

said valve is movable to a closed position by centrifugal force created by overspeed of the driving train.

6. The wrench of claim 4 wherein:

said valve is rotated in unison with said motor.

7. The wrench of claim 2 wherein:

said inhibiting means is operative to inhibit said signal when the flow of driving fluid to said motor exceeds a predetermined rate.

8. The wrench of claim 7 wherein:

said means for stopping said motor closes in response to the exhaust of pressure from a valve operating chamber; and

said inhibiting means allows an additional flow of fluid under pressure to enter said valve operating chamber when it is inhibiting said signal from operating said valve.

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