Oct. 8, 1957 R. H. JOHNSON 2,808,916

IMPACT WRENCH

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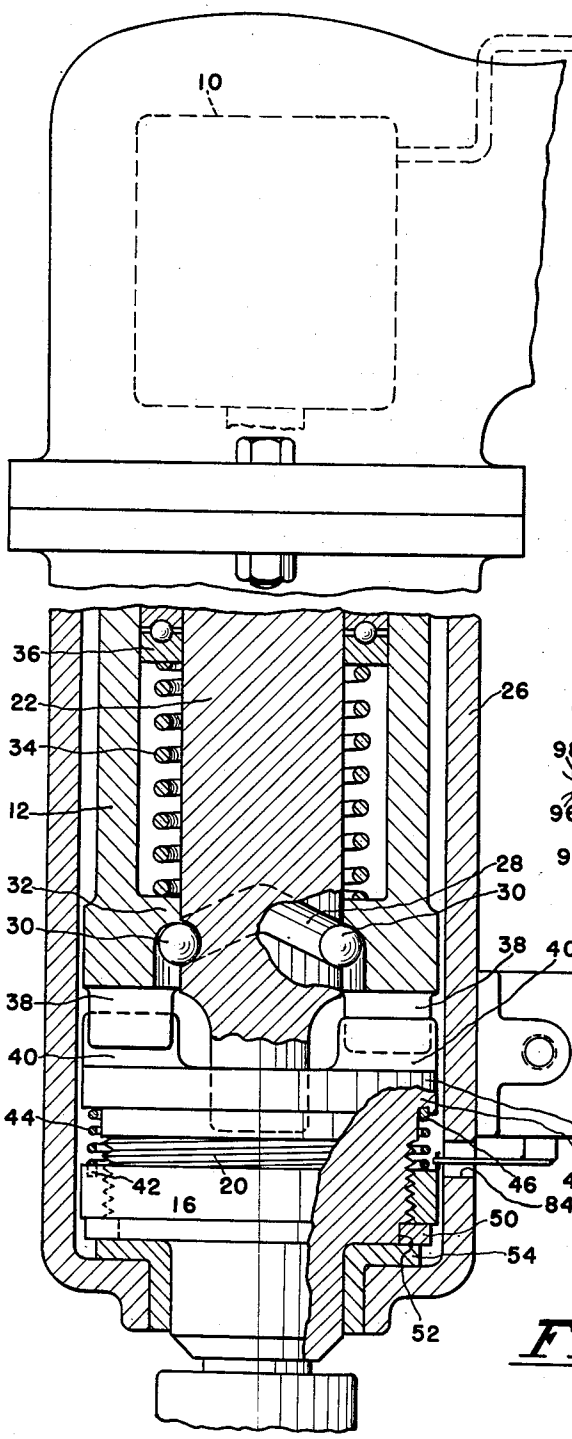


FIG-1

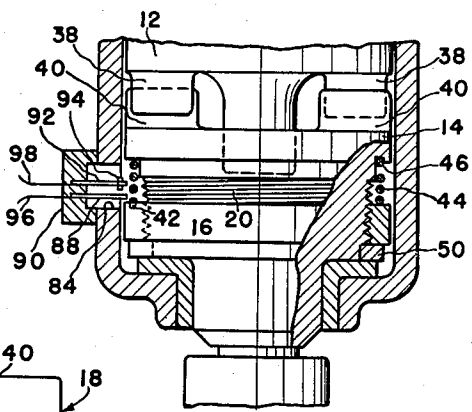


FIG-2

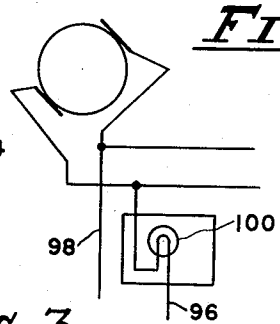


FIG-3

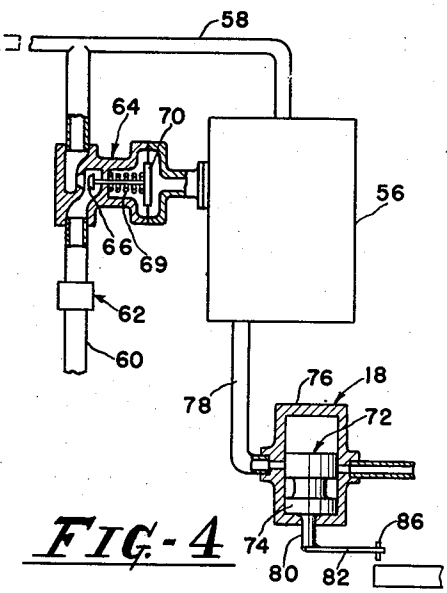


FIG-4

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IMPACT WRENCH

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7 Claims. (Cl. 192—30.5)

This invention relates to torque indicators for impact tools and more particularly to a torque indicator which is operative in proportion to the rate of change of speed and amount of movement of the anvil of a rotary impact tool during the impacting period of a work cycle for indicating the torque delivered by the tool to a work piece.

In the field of impact tools of the type adapted to deliver a series of rotational blows in rapid succession for rotating screws, nuts or other work pieces, there has long been the demand for a simple means for indicating the degree of tightness, or torque, of the work. This demand is based on the fact that in the absence of such an indicator the degree of tightness of the work attained—short of maximum torque of the tool—is dependent entirely on the guess of the operator. In most instances it is desirable to avoid such guess work, even of an experienced operator, and in some instances it is essential that the amount of torque applied to the work be maintained within relatively narrow limits.

In an effort to solve this problem various types of torque limiting mechanisms have been devised. These systems for the most part have proved unsatisfactory in performance or impractical in construction.

It is, accordingly, one object of this invention to provide a relatively simple device for indicating the amount of torque, or tightness, of the work-piece in accordance with the speed and amount of movement of the anvil of the impact wrench during the impacting portion of the tightening operation.

It is a further object of this invention to indicate the amount of torque applied to the work by an impact tool during the impacting period in accordance with the amount of relative rotational movement between the anvil and an inertia member slideably mounted on the anvil.

Other objects of this invention will become obvious from the following specification and drawings in which

Figure 1 is a vertical elevation of a conventional rotary impact tool provided with a preferred form of the present invention arranged to operate an air shutdown system,

Fig. 2 is a vertical elevation showing the torque indicator arranged to operate an electrical indicator,

Fig. 3 is a diagrammatic view of a signal system for connection with the tool disclosed in Fig. 2, and

Fig. 4 is a view, partly in section, of an air shut-down system for connection with the tool shown in Fig. 1.

Referring to the drawings, and more particularly to Figure 1, a preferred form of the torque indicator is shown adapted to a conventional rotary impact tool comprising, in general, a motor **10** arranged to drive a hammer **12** adapted to impart a series of blows in rapid succession to an anvil **14**. The force of the hammer blows are transmitted by the anvil through a suitable connection to the work (not shown). Slideably mounted on the anvil **14** is means, such as the inertia member **16** operative in proportion to the amount and speed of movement of the anvil in one direction for actuating an indicator

96—100 or shutdown device **18**. More particularly, the inertia member **16** is mounted on a cam **20** on the anvil **14** so that any relative rotational movement between the inertia member **16** and the anvil **14**—arising from the acceleration of the anvil **14** and the resistance to such acceleration by the member **16** due to its inertia—is translated in part into longitudinal movement of the member **16**.

Impact tool construction

Referring in greater detail to the construction of the impact tool, shown by way of illustration only, the tool includes the motor **10** connected through suitable gearing (not shown) to a spindle **22** arranged to drive a hammer **12** rotatably mounted thereon within the tool casing **26**. The driving connection between the spindle **22** and hammer **12** comprises a ball-race arrangement in which inverted races **28** are formed on the opposite sides and in the periphery of the spindle **22** for the reception of the balls **30** which project from the races **28** into the path and abutting an internal flange **32** of the hammer **12**. A compression spring **34** biased between the upper surface of the flange **32** and a hammer bearing **36** serves to constantly urge the hammer into its lower-most, or forward, position with the balls **30** located at the low points of the race **28**.

Depending from the lower end of the hammer **12** is a pair of lugs, or jaws, **38** disposed 180 degrees from each other and arranged to engage a similar pair of jaws **40** on the anvil **14**. The inclination of the races **28** is such that the hammer **12** can be moved a sufficient distance longitudinally to permit the hammer jaws **38** to move over and past the anvil jaws **40**.

Impact tool operation

In operation of the tool and during the period that there is little resistance to rotation of the anvil **14**—a period commonly designated as the "rundown" period—the spring **34** will hold the hammer in engagement with the anvil and the anvil and the hammer rotate at the speed of the spindle **22**. When the resistance to rotation of the anvil **14** is increased, as by increased tightness of the work, the spindle **22** will rotate relative to the hammer **12** thereby camming the hammer **12** longitudinally rearward against the force of the spring **34** until the jaws **38** move longitudinally out of engagement with the jaws **40**. The hammer will then be accelerated rotationally in the direction of rotation of the spindle at a speed determined by the combined speed of the spindle and the rotational speed imparted to the hammer **12** relative to the spindle by the spring **34** in forcing the hammer forwardly along the path of the race **28**. Thus, the hammer moves into engagement with the anvil striking a high velocity blow which tends to rotate the anvil **14** against the resistance of the work.

Torque indicator construction

The torque indicating device shown comprising an inertia member in the form of an internally threaded ring **16** threaded on external threads **20** on the anvil **14**. A torsion spring **44** has one of its ends **42** locked in the ring **16** and the opposite end **46** is secured to a shoulder **48** on the anvil. In the form of the invention disclosed it is assumed that during the tightening operation the anvil **14** moves in right-hand rotation (as viewed in Figure 1) such that rotation of the anvil **14** relative to the ring **16** tends to wind up the spring **44**. Thus, when such movement between these two members ceases, for reasons explained in detail hereinafter, the spring **44** acts to return the ring **16** to its lower limiting position abutting a ring **50** fitted in an undercut **52** in the anvil **14** and resting against a bushing **54**.

Torque indicator operation

Considering the operation of the inertia ring **16**, first in general and then in greater detail, a cycle of operation is as follows: During the rundown period of the impact tool the ring **16** is held against the stop ring **50** and there is no relative movement between the ring **16** and the anvil **14**. During each blow of the hammering portion of the tightening cycle the anvil is rotated relative to the inertia ring **16** causing the ring to thread longitudinally rearward along the anvil. When the anvil speed falls below a certain value the spring **44** acts to thread the ring **16** longitudinally forward on the anvil. Thus the ring **16** is actuated longitudinally rearward and returned to its original position during each period between successive hammer blows. As the torque required to turn the work increases the anvil is turned through a proportionally smaller number of degrees by each hammer blow and the longitudinal movement of the ring **16** is also proportionally reduced. Thus the amount of longitudinal movement of the ring **16** is an indication of the amount of torque required to rotate the work.

Considered now in greater detail the operation of the inertia ring **16** is as follows. Throughout the so-called rundown period the hammer **12** remains engaged to the anvil **14** and there is no relative movement between the ring **16** and the anvil **14**. It is noted that during the first portion of the rundown period the hammer is accelerated from standstill to its operating speed, and that such acceleration has a tendency to rotate the anvil relative to the ring **16**. However, by the proper choice of strength of the spring **44** the ring **16** is held against such relative rotation during this period.

During the impacting period of the tightening cycle the anvil is periodically accelerated by the hammer blows at a rate greatly in excess of that occuring during the rundown period. Such high rate of acceleration results in movement of the anvil relative to the ring **16** causing the ring to thread rearwardly along the anvil **14** and wind up the spring **44**.

More particularly, the anvil is rotated rapidly through a certain number of degrees by each blow of the hammer. The ring **16**, on the other hand, due to its inertia resists such rapid rotation and, neglecting the relatively small frictional force between the anvil and the ring **16**, the only force tending to overcome such inertia force and accelerate the ring **16** is the force of the spring **44**. Due to the elasticity of the spring **44** the ring **16** is accelerated at a relatively much slower rate than the anvil **14** and accordingly the anvil rotates relative to the ring during each hammer blow.

Moreover, inasmuch as the anvil completes its turning movement, resulting from a single hammer blow, in such a short time the spring is capable of rotating the ring **16** only a relatively small amount as compared to movement of the anvil. Accordingly, the amount of relative movement between the anvil and ring **16** is determined for the most part by the degree of rotation of the anvil. It is noted, however, that such relation is not necessary to the operation of the indicator.

When the anvil speed, during rotation resulting from a single hammer blow, falls to the speed of the ring **16**, the spring **44** will unwind threading the ring **16** forwardly along the anvil to position the inertia ring **16** against the stop ring **50** for the next hammer blow of the anvil.

During the portion of the impacting period when the work is relatively loose and accordingly is rotated by a relatively small amount of applied torque the anvil **14** is rotated rapidly through a relatively large number of degrees by each blow struck by the hammer **12**. As the work is progressively tightened the resistance to rotation of the anvil is progressively increased and the number of degrees that the anvil **14** is turned by each hammer blow is reduced proportionally. This means that the relative rotation between the inertia ring **16** and the anvil is proportionally reduced as the work is tightened, and, accordingly, the longitudinal movement of the rnig **16** is also proportionally decreased. The amount of longitudinal movement, or lack thereof, of the ring **16** is used as an indication of the degrees of tightness, or torque, of the work.

It is to be noted at this point that the amount of longitudinal movement of the ring **16** for any degree of tightness of the work may be varied by changing the strength of the spring **44**, weight of the ring **16**, or angle of inclination of the cam **20**, or any combination thereof. It is also to be noted that although a torsion spring **44** is shown for returning the ring **16** to its lower limiting position between hammer blows, by the proper choice of the angle of inclination of the cam **20** and strength of the spring **44**, a compression spring could be used with equal effectiveness.

Air operated shut-down system

For the purpose of illustration the tool in Fig. 1 is assumed to be driven by an air-motor, and, also for purposes of illustration, a control system is shown whereby the longitudinal movement of the ring **16** may be utilized to operate a shut-down system for stopping the operation of the motor at some predetermined torque applied to the work. The system shown comprises, in general, an air reservoir **56** supplied with compressed air by a branch pipe **58** connected in the air supply line **60** for the motor. The air pressure in the reservoir **56** is utilized to actuate a valve **64** connected in the air supply line **60** at a point downstream the motor control valve **62**. The valve **64** may be any conventional type and it is illustrated here as including a valve **66** normally biassed into its open position by a spring **69**, and moved into its closed position by a diaphragm **70** exposed on one side to the pressure existing in the reservoir **56**.

Longitudinal movement of the ring **16** is used to actuate a valve **72** for controlling the rate of discharge of air from the reservoir **56** and hence the pressure in such reservoir. More particularly, the valve **72** comprises a relatively light spool valve **74** reciprocally mounted in a valve casing **76** connected in the discharge line **78** of the reservoir. Secured to the end of the valve stem **80** is an arm **82** which projects through an opening **84** in the housing **26** into the path of longitudinal movement of the ring **16**. A screw **86** threaded in the free end of the arm **82** provides a simple means for varying the amount of longitudinal movement required to actuate the arm **82**. In other words the maximum tightness of the work at which the arm **82** is actuated by the inertia ring **16** may be varied by merely adjusting this screw.

The operation of the control system takes advantage of the fact that the position of the control ring **16** during the run-down period and at the time the work has reached the required tightness is substantially the same—i. e., during these two periods there is little or no longitudinal movement of the ring. This system takes advantage also of the fact that the pressure of the air supply to the motor at a point downstream of the motor control valve **62** is lower during the run-down period than during the impacting period of the tool. This pressure relationship exists because during the run-down period there is very little load on the motor **10** and hence very little restriction to the flow of air through the motor to its exhaust port. During the impacting period the load on the motor is increased thereby increasing the resistance to flow of air through the motor so that the pressure upstream of the motor and downstream of the motor control valve is increased.

Operation of the shut-down system

The operation of the control system is as follows: Assuming a supply pressure of around 100 pounds per square inch (p. s. i.) during the run-down period, the pressure down-stream of the motor control valve will be

around, for example, 85 p. s. i. or less. During this period the valve **72** remains in its lower limiting position thereby closing off the discharge pipe **78** and a pressure of approximately 85 p. s. i. will exist in the reservoir **56**.

When the work resistance to rotation increases to a point where the hammer **12** starts to impact, the pressure downstream of the valve **62** will rise to a value of, say for example, 95 p. s. i. This will tend to increase the pressure in the reservoir **56** but inasmuch as during this portion of the tightening period the ring **16** is being actuated to vibrate the valve **74**, air is intermittently bled from the reservoir **56** to maintain the reservoir pressure below 95 p. s. i. When the work has reached the desired degree of tightness, or torque, the ring **16** will cease to move a sufficient distance longitudinally to actuate the arm **82** and the valve **74** will cut off flow of air from the reservoir **56**. The pressure in the reservoir will then rise to 95 p. s. i. and actuate the valve **66** against the force exerted by the spring **69** to shut off the supply of air to the motor.

If desired, the valve **74** may be formed such that there is leakage therearound to lower the pressure within the reservoir **56** and permit opening of the valve **66** and thereby automatically ready the tool for another tightening operation.

Electrical indicator

Referring now to Fig. 2 the torque indicator and tool shown in Fig. 1 is provided with an electrical system for operating either a shut-down device or an indicator system. In this instance, a suitably insulated contact carrying spring **88** is mounted in an insulated block **90** and projects through the opening **84** into the longitudinal path of the ring **16**. A similar spring **92** is mounted in line with and rearwardly of the spring **88** and carries an adjustable contact point **94**. A pair of electrical leads **96** and **98** are connected to the springs **88** and **92**, respectively, so that when the spring **88** is actuated into contact with the point **94** an electrical connection is established between these two leads. The leads **96** and **98** may be connected in a circuit such as disclosed in Fig. 3 with a light **100** or other signal connected in one of the lines.

With this arrangement during run-down period the electrical circuit will remain open. During the hammering cycle below a predetermined tightness of the work the circuit **96**, **98** will be completed intermittently by operation of the ring **16** resulting in flashing of the light **100**—if desired a conventional electrical delay device may be connected in this circuit so that the light **100** remains lit during this period. When the desired degree of tightness, or torque, of the work is attained the ring **16** will cease to actuate spring **88** so that the light will go out thereby warning the operator that the desired torque has been reached.

It is to be understood that the signal system and control system shown are shown by way of illustration only and that other systems may be used without departing from the spirit of invention. For example, a signal system (not shown) may be readily devised whereby the light is on during the rundown period, off during the hammering period, and comes on again when the work has reached the desired degree of tightness.

While I have shown and described a specific form of my invention, it is to be understood that various changes and modifications may be made without departing from the spirit of the invention as set forth in the appended claims.

I claim:

1. A torque indicator for impact tools having a motor driven hammer adapted to deliver a series of hammer blows and an anvil arranged to receive such blows and transmit the force thereof to a work piece, comprising an inertia member mounted on the anvil and operated in response to the amount and speed of movement of the anvil resulting from a hammer blow, and means adapted to the tool and operatively associated with said member for indicating the amount of turning force applied by the anvil to the work piece.

2. A torque indicator for impact tools having a motor driven hammer adapted to deliver a series of hammer blows and an anvil arranged to receive such blows and transmit the force thereof to a work piece, comprising an inertia member slidably mounted on the anvil and operative in proportion to the rate of change of speed and amount of movement of the anvil resulting from a hammer blow, and means adapted to the tool and actuated by said member for indicating the amount of turning force applied by the anvil to the work piece.

3. A torque indicator for impact tools having a motor driven hammer adapted to deliver a series of hammer blows and an anvil arranged to receive such blows and transmit the force thereof to a work piece, comprising an inertia member mounted on said anvil and moveable relative thereto in a direction transverse to the axis of rotation of the anvil whenever the rate of change of speed of rotation of said anvil exceeds a predetermined value, a stop on the anvil for limiting movement in one direction of said member relative to the anvil, and means adapted to the tool and actuated by said member for indicating the amount of turning force applied by the anvil to the work piece.

4. A torque indicator for impact tools having a motor driven hammer adapted to deliver a series of hammer blows and an anvil arranged to receive such blows and transmit the force thereof to a work piece, comprising an inertia member mounted on said anvil and moveable relative thereto whenever the rate of change of speed of rotation of said anvil exceeds a predetermined value, a stop on the anvil for limiting such relative movement of the member in one direction transverse to the axis of rotation of the anvil, a cam on the anvil and engaging said member for camming said member longitudinally whenever there is movement of the member in a transverse direction and relative to the anvil, and indicating means mounted on the tool and actuated by such longitudinal movement of said member and operative when such movement is below a predetermined amount for indicating the amount of turning force applied by the anvil to the work piece.

5. A torque indicator for impact tools having a motor driven hammer adapted to deliver a series of hammer blows and an anvil arranged to receive such blows and transmit the force thereof to a work piece, comprising an inertia member mounted on said anvil and moveable relative thereto whenever the rate of change of speed of rotation of said anvil exceeds a predetermined value, a stop on the anvil for limiting rotational movement in one direction of said member relative to the anvil, yieldable means between said member and the anvil for urging said member against the stop, and means adapted to the tool and actuated by said member for indicating the amount of turning force applied by the anvil to the work piece.

6. A torque indicator for impact tools having a motor driven hammer adapted to deliver a series of hammer blows and an anvil arranged to receive such blows and transmit the force thereof to a work piece, comprising an inertia member mounted on said anvil and moveable relative thereto whenever the rate of change of speed of rotation of said anvil exceeds a predetermined value, a stop on the anvil for limiting rotational movement in one direction of said member relative to the anvil, a cam on the anvil and engaging said member for actuating said member longitudinally whenever there is relative rotational movement between the anvil and said member, yieldable means between said member and the anvil urging said member against the stop, and means mounted on the tool and actuated by such longitudinal movement of said member for indicating the amount of turning force applied by the anvil to the work piece.

7. A torque indicator for impact tools having a motor

driven hammer adapted to deliver a series of hammer blows and an anvil arranged to receive such blows and transmit the force thereof to a work piece, comprising threads on said anvil, a threaded ring rotatably mounted on the anvil and arranged to thread longitudinally along said anvil threads whenever the rate of change of speed of the anvil resulting from a hammer blow exceeds a predetermined value, a stop on the anvil for limiting rotational movement of said ring in one direction relative to the anvil, yieldable means between said ring and the anvil for urging said ring against the stop, and means

mounted on the tool and actuated by such longitudinal movement of said ring for indicating the amount of turning force applied by the anvil to the work piece.

References Cited in the file of this patent

UNITED STATES PATENTS

2,068,745	Hall	Jan. 26, 1937
2,543,979	Maurer	Mar. 6, 1951
2,768,546	Amtsberg	Oct. 30, 1956