United States Patent

[11] 3,616,864

[72] Inventors Clarence A. Sorensen
Fruitport;
Edwin J. Deremo, Spring Lake, both of Mich.

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[73] Assignee Gardner-Denver Company
Quincy, Ill.

[54] **TORQUE-CONTROLLED MOTOR SHUTOFF FOR POWER TOOL**
5 Claims, 4 Drawing Figs.

[52] U.S. Cl. 173/12, 91/59, 192/150
[51] Int. Cl. B23q 5/00
[50] Field of Search 173/12; 91/59; 192/150; 81/52.4

[56] **References Cited**

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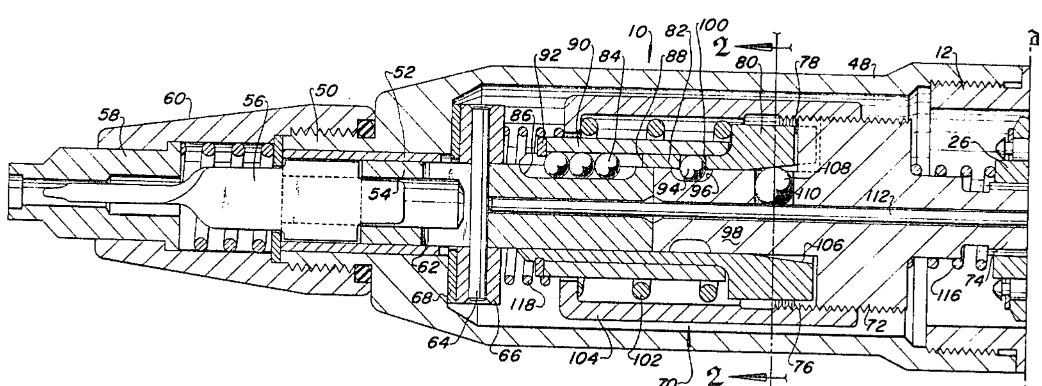
Primary Examiner—James A. Leppink
Attorney—Michael E. Martin

ABSTRACT: A torque-responsive shutoff mechanism for a torque-producing power tool having a valve operable to shut off the flow of motive pressure air to the tool motor. The shutoff valve includes an elongated actuating rod which is releasably held by a plurality of radially spaced balls which are operable to frictionally grip the rod diameter. The gripping ball members are forced into engagement with the rod by a driven member of a torque-sensing device interposed in the drive train of the tool. The driving and driven members of the torque-sensing device include interengaging sloped surfaces which force the members to move axially relative to each other upon reaching a predetermined resistance to rotation. The radially spaced balls contained within a conical recess in the driven member are relieved of their engaging force on the valve-actuating rod upon axial movement of the driven member whereby the shutoff valve is biased to the closed position. The driving and driven members of the torque-sensing device are biased into engagement by a variably compressible coil spring.



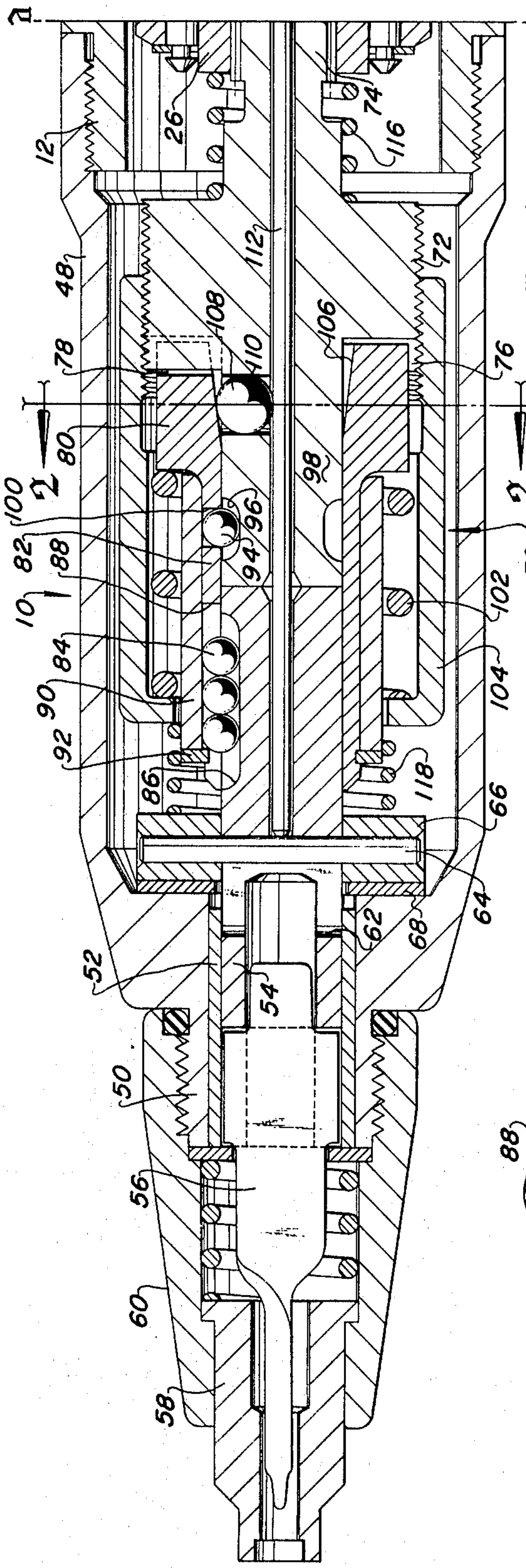


Fig 1

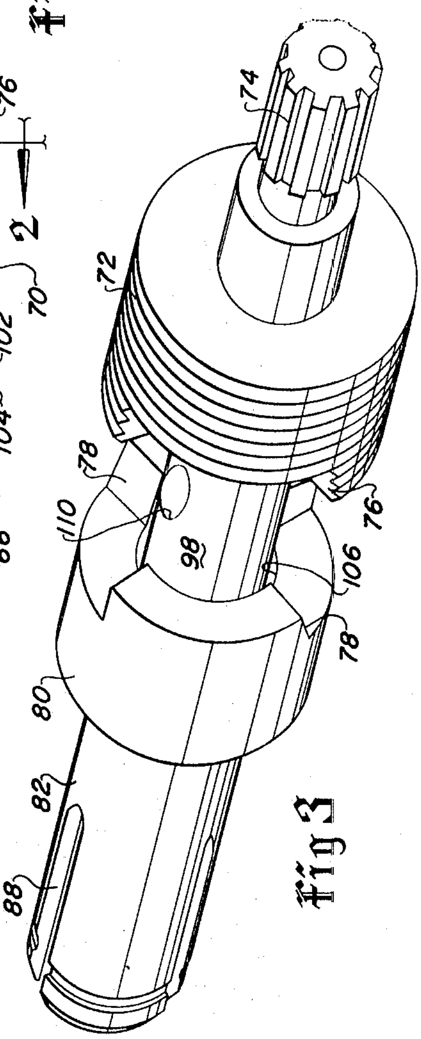
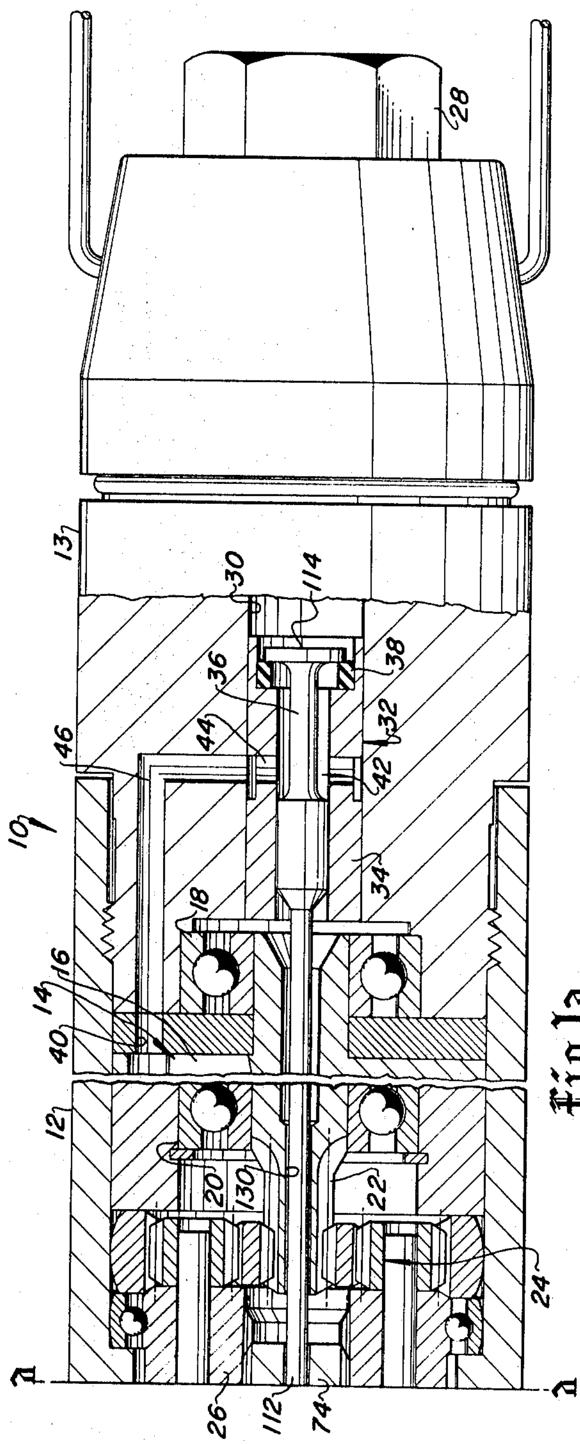


Fig 3

inventors
Clarence A. Sorensen
Edwin J. Deremo
by Michael E. Martin
agent


28
13
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114
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36
32
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130
22
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112
74
a
a

Fig 1a

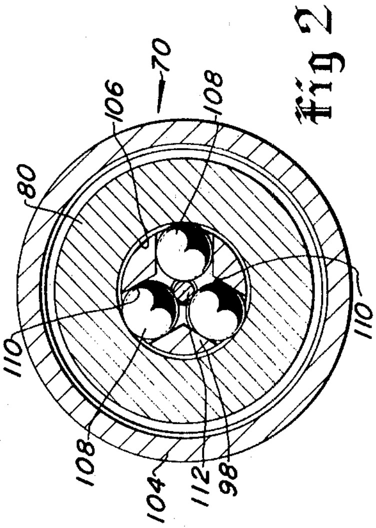
70
106
108
80
110
110
108
104
112
98

Fig 2

TORQUE-CONTROLLED MOTOR SHUTOFF FOR POWER TOOL

BACKGROUND OF THE INVENTION

In torque-producing power tools such as nutrunners, screwdrivers and the like, various devices are known for sensing the torque output of the tool and operating, upon sensing a predetermined torque, to disengage the tool motor from the output spindle or to shut off the power supply to the tool. A number of tool designs include means operable to both shut off the tool motor and disengage a clutch comprising part of the drive train of the tool.

Prior art fluid-operated power tools which include releasable clutch means operable to disengage the tool motor from the drive spindle and simultaneously actuate a motive fluid shutoff valve are disclosed in U.S. Pat No. 3,262,536 to R. C. Frisbie et al. and U.S. Pat. No. 3,275,116 to P. W. Martin. Generally, known devices are unduly complicated in design and comprise an excessive number of mechanically interacting components which are subject to wear and breakage thereby impairing the accuracy of torque control and resulting in frequent malfunction. Many disengaging-type clutches, which are widely used in prior art tools for controlling the torque output thereof, are also subject to breakage due to repeated impacting of the interengaging surfaces of the driving and driven elements. Although releasable or disengaging-type clutches are sometimes considered desirable in large portable torque tools, they are unnecessary in the relatively smaller tools having low drive train inertia and negligible operator reaction torque.

SUMMARY OF THE INVENTION

The present invention provides a torque control mechanism for a power torque tool which is operable to sense a predetermined torque transmitted to the drive spindle of the tool and actuate a shutoff device to interrupt the power supply to the tool motor. In the present invention there is provided a torque-sensing rotation transmitting means interposed in the drive train of a pressure fluid operated torque tool which is operable to sense a predetermined torque and, accordingly, produce mechanical movement sufficient to actuate a value to shut off pressure fluid to the tool motor without requiring total disengagement of the tool motor from the drive spindle.

The present invention also provides a torque-sensing device which is operable to actuate a shutoff valve of a fluid operated tool wherein mechanical movement is minimal and, accordingly, reliable operation and accurate control of output torque may be obtained. In the present invention a torque-sensing rotation transmitting device comprising relatively movable driving and driven members is operable to a cam a plurality of spherical members into frictionally gripping engagement with a shutoff valve actuator to hold the valve in the open position. In response to a predetermined torque transmitted from the driving to the driven member small axial movement therebetween operates to relieve the camming force on the spherical members whereby the gripping engagement of the actuator is relieved to allow the valve to close. The present invention may be advantageously utilized in various types of power torque tools including what are known as push-to-start tools and manual throttle valve controlled types.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a longitudinal section view of a pressure fluid operated torque tool according to the present invention;

FIG. 1*a* is a continuation of FIG. 1 from the line *a—a*;

FIG. 2 is a section view taken substantially along the line 2—2 of FIG. 1;

FIG. 3 is a perspective detail view of the driving and driven members of the torque-sensing device.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1 and 1*a* a power torque tool is illustrated in the from of a portable screwdriver, generally designated by the numeral 10. The tool 10 includes a housing 12 threadably engaged with a head portion 13 and containing a pressure fluid operated rotary vane motor 14 of a type well known in the art of industrial power tools. The motor 14 includes a rotor 16 suitable journaled in bearings 18 and 20. The rotor 16 includes an integral shaft portion 22 which is drivably engaged with a planetary gear speed reduction unit 24 having an output shaft formed by the planet gear carrier 26. The tool 10 is adapted to be connected to a power supply such as a source of pressure fluid, not shown, by means of a connector 28 mounted on the head portion 13. The connector 28 is in fluid flow communication with a passage 30 centrally positioned in the head. Located in the passage 30 is a pressure fluid shutoff valve assembly 32 including a valve guide 34, valve closure member 36, and a valve seat 38.

In the position shown in FIG. 1*a* the closure member 36 is in the seated or closed position preventing the flow of pressure fluid to the motor inlet port 40 from passage 30 by way of the passages 42 and 44 in the valve guide 34 and the passage 46 in the housing 13. Pressure fluid when supplied to the motor 14, is exhausted therefrom by suitable passage means, not shown.

The tool 10 includes a hollow detachable cover member 48 threadedly engaged with the housing 12. The cover 48 includes a nose portion 50 having a bore for receiving a cylindrical bushing 52. The bushing 52 rotatably journals a spindle 54 which in turn is drivably engaged with a screwdriver bit 56. The bit 56 is retained in engagement with the spindle 54 by a spring-biased screwfinder 58 and sleeve 60 threadably retained on the housing nose portion 50. The spindle 54 extends into the interior of the cover 48 and includes a slot 62 providing clearance for a transverse pin 64 suitably retained in a rotating thrust collar 66 which bears against a thrust washer 68. The spindle 54 is drivably engaged with a torque-sensing rotation transmitting means generally designated by the numeral 70. The torque-sensing means 70 includes a driving member 72 having a shaft portion 74 nonrotatably engaged with respect to the planet carrier 26 by suitable means such as complementary splines. The driving member 72 is provided with a pair of transverse sloping surfaces 76, one shown, see FIG. 3, engageable with coacting surfaces 78 on a driven member 80. The driven member 80 is provided with an integral sleeve portion 82 coaxially surrounding the spindle 54 and nonrotatably engaged therewith by means of ball keys 84 located in the keyway 86 and key slot 88 on the spindle 54 and sleeve portion 82, respectively. The ball keys 84 are radially retained by a tubular sleeve 90 which in turn is retained on the driven member 80 by a ring 92. The tubular sleeve 90 also retains a ball key 94 positioned partially in a groove 96 in the hub 98 of the driving member 72 and partially in a radial aperture 100 in the driven member 80. The groove 96 is dimensioned to permit limited axial movement between the driving member 72 and driven member 80 and cooperates with the ball key 94 to prevent total disengagement of the two members. The driving and driven members are axially biased into engagement by a coil spring 102. The axial biasing force produced by the spring 102 may be varied by adjustment of a tubular nut 104 threadably engaged with the driving member 72.

Referring to FIGS. 1 and 2, the driven member 80 includes a conical recess 106 opening to one end and forming an inclined surface circumsurrounding and forcibly engaging a plurality of radially spaced spherical members or balls 108. The balls 108 are located in radial holes 110 in the hub 98 of the driving member. The balls 108 are engaged by the surface 106 to be forced radially inwardly into fractional gripping relationship with an actuating member for the shutoff valve 32 comprising an elongated cylindrical cross section rod 112. The rod 112 extends longitudinally through the spindle 54, driving member 72 and rotor 16 to engage the valve closure member 36 for actuating the same to open in response to axial movement of the spindle 54 and torque-sensing means 70 toward the motor 14. In response to release of the actuating rod by the gripping balls 108, an unbalanced pressure force caused by pressure fluid acting on the surface 114 of the valve closure member 36 will operate to close the valve shutting off the motive fluid supply to the motor 14.

The torque-sensing means 70 is axially movably held in the shutoff valve closed position shown in FIG. 1 by a bias spring 116 located between the driving member 72 and the planer carrier 26 and by a spring 118 engaging the tubular nut 104 and the thrust collar 66.

To operate the tool 10, upon engagement of a fastener to be driven by the bit 56, application of an axial force by the tool operator against the bias of the spring 116 will move the bit 56, spindle 54, and torque-sensing means 70 axially toward the motor 14. The balls 108, forced into gripping relationship with the rod 112 by the driven member 80, will actuate the rod to open the valve closure member 36 thereby supplying motive pressure fluid to the motor 14. With pressure fluid supplied to the motor 14 the same will rotatively drive the spindle 54 through the gear reduction unit 24 and the torque-sensing means 70. The rod 112 nonrotatably gripped by the balls 108 will rotate with the torque-sensing means 70 and is suitably journaled by the bore 130 of the rotor 16 to permit relative rotation with respect thereto. The torque applied to the spindle by the motor 14 is sensed by the driving and driven members 72 and 80, respectively, and the force transmitted between the complementary sloped surfaces 76 and 78 produces a component tending to move the driven member 80 axially relative to the driving member 72. When said force component exceeds the biasing force produced by the spring 102 the driven member will move to release the engagement of the balls 108 with the inclined surface 106 whereby the gripping force of the balls against the rod 112 will be relieved and the valve closure member 36 will move to close in response to pressure fluid force on the surface 114, shutting off motive pressure fluid to the tool motor 14. Axial movement of the rod 112 on closing of the valve is limited by the transverse pin 64.

When the tool motor 14 shuts off indicating that maximum torque, as predetermined by the adjustable biasing force of the spring 102, has been applied to the fastener the operator will remove the tool from the work. The spring 116 will reposition the spindle 54 and torque-sensing means 70 to the position shown in FIG. 1. Since the relative movement of the balls 108 with respect to the rod 112 tends to move the balls away from the inclined surface 106, the gripping force between the balls and rod will be relieved sufficiently to allow the torque-sensing means 70 to be repositioned by the spring 116 for the next operating cycle.

As may be appreciated from the foregoing, the torque-sensing means 70 operates to control the torque output of the tool 10 with a minimum of mechanical movement but yet with accuracy and great reliability. Since the driving and driven members 72 and 80 do not disengage completely there is minimal wear and chance of failure from breakage commonly encountered with prior art torque control clutches and similar devices.

The present invention need not be limited to the tool embodiment illustrated. For example, some types of pressure fluid operated torque tools utilize a manually controlled throttle valve for starting the operating cycle of the tool. The throttle valve is interposed between the shutoff valve, such as the valve 32, and the pressure fluid supply. In such an arrangement the shutoff valve would be spring biased to be in the open position and in response to release of the actuating rod by the torque-sensing means the shutoff valve would be closed by a pressure fluid force acting on a surface such as the surface 114 in opposition to the spring bias. The aforementioned manually controlled valve when released by the operator would be operable to vent pressure fluid from the passage upstream of the shutoff valve relieving the pressure fluid force on the shutoff valve and allowing the aforementioned bias spring to reopen the shutoff valve for the next operating cycle. Moreover, the present invention may be used with tools having other sources of motive power, namely, electric motor-driven tools whereby the actuating rod 112 may, for example, operably engage a spring-biased switch to shut off motive energy to the tool motor.

What is claimed is:

1. In a torque tool:

a motor operable to rotatively drive a spindle;

a power supply;

shutoff means including an elongated actuating rod operable to provide for said power supply to be connected to said motor and for said power supply to said motor to be shut off, and the improvement comprising:

torque-sensing rotation transmitting means interposed between said motor and said spindle including driving and driven members having complementary sloped surfaces providing for engagement therebetween to transmit torque from said motor to said spindle, said driven member being operable to move axially with respect to said driving member upon sensing a predetermined torque produced by said motor, and said driven member including a conical recess forming an inclined surface substantially circumsurrounding and engaged with a plurality of gripping members and forcing said gripping members into engagement with said rod, said gripping members being responsive to the axial movement of said driven member to release said rod to provide for the shutoff of said power supply to said motor, and adjustable biasing means operable to yieldably bias said driving and driven members into engagement and to force said driven member to forcibly engage said gripping members to hold said gripping members in engagement with said rod.

2. The invention set forth in claim 1 wherein:

said gripping members comprise a plurality of balls radially spaced with respect to said actuating rod.

3. In a torque tool:

a motor operable to rotatively drive a spindle;

a power supply;

shutoff means including an elongated actuating member movable to provide for said power supply to be connected to said motor and for said power to said motor to be shut off, and the improvement comprising:

torque-sensing rotation transmitting means interposed between said motor and said spindle including driving and driven members operable to move axially relative to each other upon sensing a predetermined torque produced by said motor, a plurality of members spaced around and operable to be in frictional gripping engagement with said actuating member for moving said actuating member, surface means on one of said driving and driven members circumsurrounding and engageable with said plurality of members to hold said plurality of members in frictional gripping engagement with said actuating member and in response to the relative axial movement of said driving and driven members said plurality of members are operable to release said frictional gripping engagement with said actuating members to allow said actuating member to move to shut off said power to said motor.

4. The invention set forth in claim 3 wherein:

said driving and driven members of said torque-sensing means include complementary sloping surfaces operable to provide for engagement between said driving and driven members to transmit torque from said motor to said spindle, and said driven member includes a substantially conical recess forming said surface means engageable with said plurality of members and said driven member operable to move axially with respect to said driving member in response to a predetermined torque produced by said motor.

5. The invention set forth in claim 4 wherein:

said torque-sensing means includes adjustable biasing means operable to yieldably bias said driving and driven members into engagement.

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