# United States Patent [19]

**Tibbott**

[11] **3,724,560**

[45] **Apr. 3, 1973**


[54] **AUTOMATIC THROTTLE SHUT-OFF POWER TOOL**


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



[22] Filed: **Sept. 8, 1971**

[21] Appl. No.: **178,553**

[52] **U.S. Cl.** .....**173/12**, 173/15

[51] **Int. Cl.** .....**B25b 23/14**

[58] **Field of Search** .....173/12; 91/59



[56] **References Cited**

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| | | | |
|---|---|---|---|
| 3,498,389 | 3/1970 | Tibbott | 173/12 |
| 3,512,590 | 5/1970 | Tibbott | 173/12 |
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*Primary Examiner*—Ernest R. Purser

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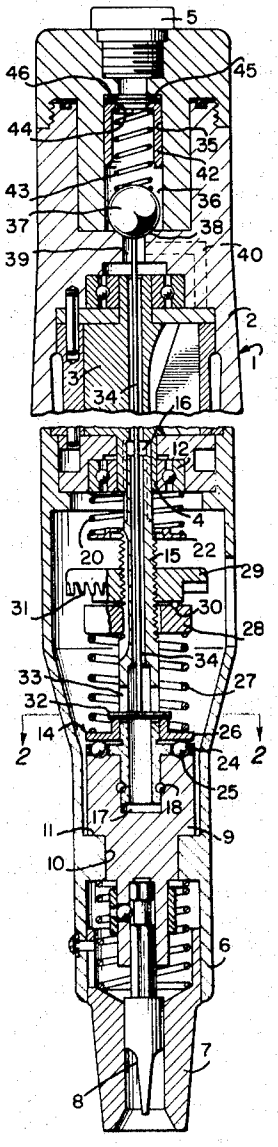
[57] **ABSTRACT**

A fluid-operated rotary power tool having a motor supply valve which is moved into engagement with a movable valve sleeve in response to a clutch reaching a predetermined torque load, thereby closing the valve and stopping the motor. The movable valve sleeve is normally urged away from the valve. When the movable valve sleeve is engaged by the valve, it is held there by a differential pressure to keep the valve closed until the valve returns to its normally closed position.


**10 Claims, 7 Drawing Figures**



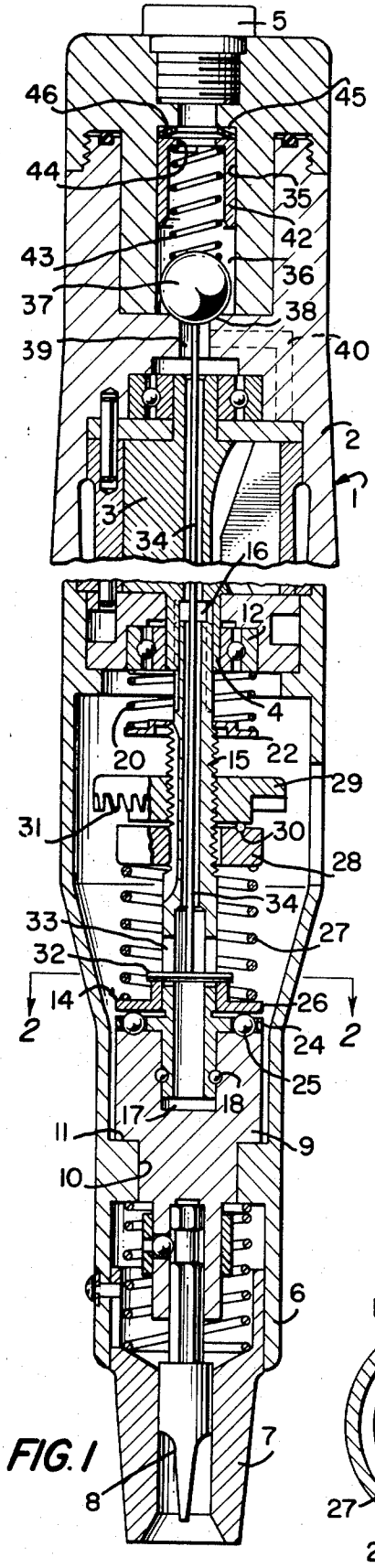



FIG. 1

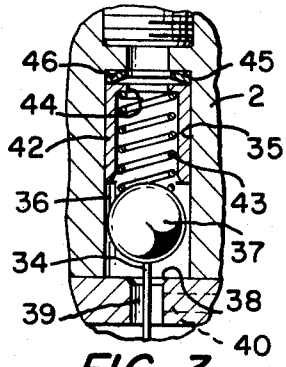



FIG. 3

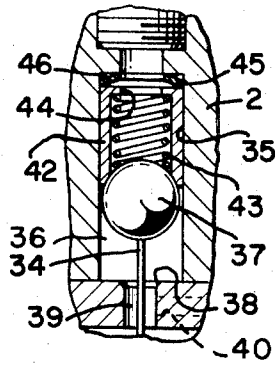



FIG. 4

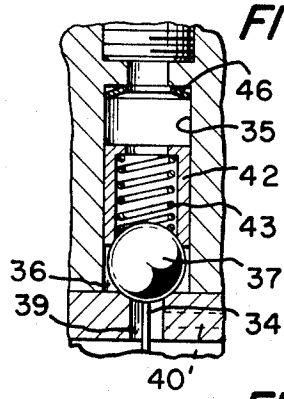



FIG. 5

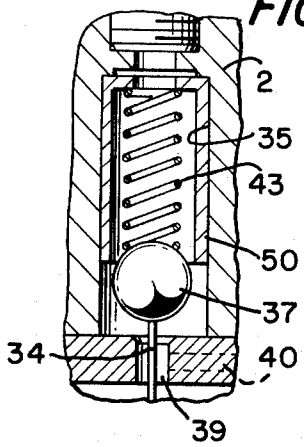



FIG. 6

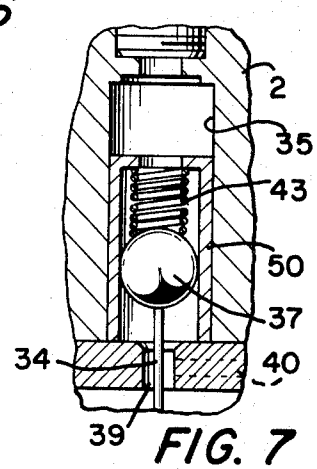



FIG. 7

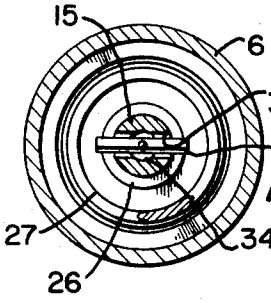



FIG. 2

# AUTOMATIC THROTTLE SHUT-OFF POWER TOOL

## BACKGROUND OF THE INVENTION

This invention relates to the art of power-operated tools such as power screwdrivers and wrenches and more particularly to a power tool that automatically stops in response to a selected torque load.

My U.S. Pat. No. 3,512,590, issued May 19, 1970, discloses a power screwdriver having a valve that opens to start the tool motor upon moving rearwardly over a first increment of travel and closes to stop the motor upon continuing to move rearwardly through an additional increment of travel, the additional valve travel being caused by the tool reaching a selected torque load on its spindle. The mechanism causing the valve to close when moving rearwardly includes a latch that releases a movable valve seat that is urged toward the valve.

## SUMMARY OF THE INVENTION

The principal object of this invention is to provide a valve mechanism that is an improvement over that in the above named U.S. patent and one that eliminates the valve latch mechanism disclosed in said patent.

Other important objects of this invention are: to provide an improved power tool valve mechanism for controlling fluid flow to the tool motor and for stopping the motor in response to a selected torque load; to provide an improved shut-off valve for a power tool that is simple and economical to manufacture and relatively free of maintenance problems; and to provide a power tool shut-off valve that includes a shut-off means that maintains the valve closed by differential pressure while the valve returns from its shut-off position to its normally closed position.

In general, the above objects are attained by providing a valve ball or plug that moves rearwardly off a fixed valve seat, to initially start the tool motor, by positioning a movable annular valve seat between the valve plug and the fluid pressure source, providing a spring means urging the movable valve seat away from the valve plug and arranging the movable valve seat so that when it engages the valve plug, a differential pressure is created acting to urge and hold it against the valve plug, thereby closing the fluid passage to the motor, while the valve plug returns to its normally closed position engaging its fixed seat.

## BRIEF DESCRIPTION OF THE DRAWING

This invention is described in connection with the accompanying drawing wherein:

FIG. 1 is a longitudinal section of an air-operated power screwdriver containing an embodiment of the valve of this invention;

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

FIGS. 3 to 5 are fragmentary view of the valve of FIG. 1 shown in various positions; and

FIGS. 6 and 7 are fragmentary sectional views similar to FIGS. 3 to 5 and showing a second embodiment of the valve.

## DESCRIPTION OF PREFERRED EMBODIMENTS

The power-operated screwdriver 1 shown in FIG. 1 includes a casing 2 housing an air motor 3 having a drive shaft 4. The screwdriver 1 has an air hose fitting 5 threaded into the rear end of the casing 2 adapted for coupling to an air hose (not shown) feeding air to the tool. The front nose 6 of the screwdriver 1 carries a screw finder 7 and a screwdriving blade 8 adapted to engage the slot of a screw. The blade 8 is detachably mounted in a spindle 9 which is rotatably and slidably mounted in a journal bearing 10 integrally formed in the interior of the casing. The bearing 10 carries a rearwardly facing shoulder 11 which engages a portion of the spindle 9 to limit its forward movement. The motor drive shaft 4 is mounted in the bearing 12. All of the foregoing structure is conventional in the screwdriver art.

The spindle 9 is interconnected to the motor drive shaft 4 by a torque responsive clutch mechanism 14 which releases under a predetermined torque load. The clutch mechanism 14 includes a hollow clutch shaft 15 having its rear end slidably splined in a socket 16 formed in the motor drive shaft 4, thus allowing the clutch shaft 15 to slide rearwardly into the socket 16 for a limited distance while maintaining a continuous driving connection therebetween.

The front end of the clutch shaft 15 is attached to the spindle 9 by a connection which allows the clutch shaft 15 to rotate relative thereto while being unable to slide axially relative to the spindle 9. This connection is formed by the front end of the clutch shaft 15 being seated in a rearwardly-opening bore 17 provided in the spindle 9 with several balls 18 being located in mating annular grooves formed in the clutch shaft 15 and the interior wall of the bore 17.

The clutch shaft 15 is urged forwardly by a light spring 20 engaged between the bearing 12 mounting the drive shaft 4 and a washer 22 resting on a rearwardly facing shoulder formed on the clutch shaft 15. As a result, the light spring 20 biases the spindle 9 against the shoulder 11 of the bearing 10. The clutch shaft 15 and spindle 9 are moved rearwardly in the tool by an operator forcing the tool blade 8 downwardly against a screw. The depth of the socket 16 in the drive shaft 14 limits the rearward movement of the clutch shaft 15.

The clutch shaft 15 carriers an integral clutch plate 24 which contains a series of holes spaced around its center. These holes house corresponding clutch balls 25 adapted to seat in mating ball seats or recesses provided in the rear face of the spindle 9. The balls 25 are pressed into their seats in the spindle 9 by a pressure ring 26 which is urged forward by a clutch spring 27. The rear end of the clutch spring 27 seats against a collar 28 keyed on the clutch shaft 15 and is held in place by a nut 29 threaded on the clutch shaft 15. A detent ball 30 is located in the rear face of the collar for seating in any of a series of cavities in the front face of the nut 29 to latch the nut 29 in its adjusted position. The nut 29 includes gear teeth 31 on its periphery for engaging with a "jacobs" chuck key (not shown) to enable turning the nut 29 for adjusting the load on the clutch spring 27. The load on the clutch spring 27 will determine the magnitude of torque load at which the torque clutch 14 releases.

The presser ring 26 engages a cross bar 32 which slides in a diametrical slot 33 formed in the clutch shaft 15 and abuts the forward end of a push-rod 34 extend-

ing rearwardly from the cross bar 32 through the hollow clutch shaft 15 and the drive shaft 4 of the motor 3. The disengagement of the clutch under torque moves the pressure ring 26 rearwardly on the clutch shaft resulting in moving the push-rod 34 rearward.

The air hose fitting 5 extending from the rear end of the casing 2 opens into an axial cylindrical bore 35 extending into a valve chamber 36 housing a valve ball 37 resting on a stationary valve seat 38. The valve ball 37 is engaged by the rear end of the push-rod 34 and closes the rear end of a valve passage 39. The valve passage 39 is connected to a motor supply passage 40 extending to the tool motor 3. The valve 37 controls the flow of air from the valve chamber 36 to the motor 3 via the passage 39 and the motor supply passage 40.

When the screwdriver is initially pressed against a screw, the spindle 9, the clutch shaft 15, push-rod 34 and valve 37 move rearwardly in the tool to raise the valve 37 an initial distance above the stationary valve seat 38, as shown in FIG. 3, and allow air to flow through the motor supply passage 40 to the motor 3. At this time, air flows freely through a sleeve 42 and around valve ball 37. This air drives the motor 3 and the screwdriver drives the screw engaged by the blade 8.

As the screw is driven home, it becomes tight and the torque load on the spindle 9 rises until it reaches the predetermined torque load that causes the clutch mechanism 14 to release and slip. The release of the clutch mechanism 14 is caused by the clutch balls 25 rolling out of their seats or pockets on the rear end of the spindle 9 and this unseating movement of the clutch balls 25 forces the push-rod 34 and valve 37 further rearwardly in the tool, over an additional distance, as shown in FIG. 4. This additional rearward movement moves the valve ball against the movable valve seat sleeve 42 which is slidably mounted in the axial bore 35. A spring 43 located between the valve ball 37 and sleeve 42 urges the sleeve 42 rearwardly in the valve bore 35 until it is engaged by the valve ball 37 which closes the front end of the valve sleeve 42 creating a differential of pressure that forces the valve sleeve 42 forwardly against the valve ball 37, thereby stopping the flow of air to the motor 3. The strength of the spring 43 is weak enough to be easily overcome by this pressure differential. In this first embodiment, the interior of the valve sleeve 42 is smaller than the valve ball 37 whereby it is plugged by the valve ball 37. The inner edge of the forward end of the sleeve 42 can be beveled as shown in FIG. 3 to form a better seal when engaged by the valve ball 37.

The valve sleeve 42 includes an inwardly directed flange 44 at its rear end to serve as an abutment for the spring 43. The rear end of the axial bore 35 is formed as a shoulder 45 and a resilient member such as the belleville spring 46 is located between the shoulder 45 and the sleeve 42 to allow the sleeve 42 freedom to move rearward for a slight distance during the initial engagement of the valve ball 37 with the sleeve 42. In other words, the belleville spring 46 serves as a bumper or buffer for the valve sleeve 42 and also enables it to move rearwardly in case the rearward movement of the valve ball 37 is greater than the movement required merely for it to engage the valve sleeve 42.

After the valve ball 37 engages the valve sleeve 42, the pressure differential causes them to remain engaged until the valve ball 37 is returned to its fixed seat 38, as shown in FIG. 5. After the motor stops, the operator lifts the screwdriver from the screw, allowing the spindle 9 to move forward to seat on the bearing shoulder 11. This movement allows the push-rod 34 and valve 37 to move forward until the valve 37 is again seated on the fixed or stationary valve seat 38. During this forward movement, the valve sleeve 42 remains engaged with the valve ball 37 to continue to close the flow of air to the tool motor. Once the valve ball 37 seats on the fixed valve seat 38, the pressure differential across the valve sleeve 42 is rapidly eliminated by a slight leakage across the sleeve 42 which is provided by the design of the tool. For example, this slight leakage can take place between the bore 35 and the sleeve 42 or it can be provided by the engaging surfaces between the valve ball 37 and the sleeve 42. Once the pressure differential across the valve sleeve 42 is dissipated, the spring 43 returns the valve sleeve 42 rearwardly to the position shown in FIG. 1 and the tool is ready for another cycle.

## SECOND EMBODIMENT

The second embodiment shown in FIGS. 6 and 7 replaces the valve sleeve 42 of the first embodiment with a valve sleeve 50 having an interior that snugly receives the valve ball 37 as shown in FIG. 7 to shut-off the flow of air to the motor. The interior of the sleeve 50 can be provided with a resilient coating to aid in sealing between the sleeve 50 and the valve ball 37.

As can be seen in FIG. 7, when the valve ball 37 moves rearwardly into the interior of the sleeve 50, a differential pressure is created across the sleeve 50 that moves it forwardly until it abuts the shoulder in the casing 2 that contains the fixed valve seat 38. As a result, the sleeve 50 does not move further during the forward return movement of the valve ball 37 to its fixed seat 38.

Although two embodiments of the invention are illustrated and described in detail, it will be understood that the invention is not limited simply to these embodiments, but contemplates other embodiments and variations which utilize the concepts and teachings of this invention.

I claim:

1. A fluid-operated rotary power tool comprising a casing;

a fluid motor driving a spindle;

a passage extending from a motive fluid pressure source to said motor;

a valve plug movable along said passage between a first position where it is closed to a second position, said plug being shaped whereby fluid flowing in said passage is free to flow past said valve plug to said motor when said plug is located intermediate said positions;

a movable annular valve seat located in said passage between said valve plug and the motive fluid pressure source and slidable along said passage between travel limits where it can be engaged with said valve plug in both said first and second positions and being normally located where it will be engaged by said valve plug in said second position,

said movable valve seat being operative to close said passage when engaged with said valve plug to prevent the flow of fluid therethrough;

spring means resiliently urging said movable valve seat away from said valve plug; and

said movable annular valve seat having a surface that is acted on by the fluid pressure of said motive fluid when engaged with said valve plug and is operative to hold the movable valve seat against said valve plug during the movement of said valve plug from said second position to said first position.

2. The power tool of claim 1, including:

a second annular valve seat located in said passage between said valve plug and motor and located to engage said valve plug in said first position to close said passage.

3. The power tool of claim 2, including:

torque sensing means connected to said motor to measure the torque on said motor and being operative, in response to a predetermined torque load on said motor, to effect the movement of said valve plug to its engagement position with said movable valve seat.

4. The power tool of claim 3, including:

a rod interconnecting said torque sensing means with said valve plug.

5. The power tool of claim 4, wherein

said torque sensing means is a torque-responsive clutch connected to a rod extending towards said valve plug and operative to move said plug toward said movable valve seat when said clutch reaches said predetermined torque.

6. A fluid-operated rotary power tool comprising:

a housing including a fluid-operated rotary motor;

a valve in a passage controlling the flow of motive fluid from a fluid pressure source to said motor and movable in a single direction in said housing over a distance including first and second successive increments of travel, said valve being movable over said first increment of travel from a normally closed position to an open position and movable over said second increment of travel from said open position;

means for moving said valve over said first increment of travel thereby to open said valve to operate said motor;

torque sensing means connected to said motor to measure the torque on said motor and being operative, in response to the rise of the torque load to a predetermined torque load, to move said valve over said second increment of its travel;

a movable valve seat located in said passage between said valve and the fluid pressure source where it can be engaged with said valve at the end of the second increment of its travel, said valve seat being operative to close said passage when engaged with said valve to prevent the flow of motive fluid therethrough;

spring means resiliently urging said valve seat away from said valve;

said movable valve seat being slidable in said passage and having a surface that is acted on by said high fluid pressure when engaged with said valve that is operative to hold the valve seat against said valve during the return movement of said valve to its normally closed position.

7. The power tool of claim 6, including:

a second valve seat located in said passage between said valve and motor and located to engage said valve in said normally closed position.

8. The power tool of claim 7, wherein:

said movable valve seat is an annular sleeve having a bore therethrough and slidable axially along said passage toward and away from said valve; and

said valve plugs the end of the bore of said sleeve when engaged thereto.

9. The power tool of claim 8, wherein:

said spring means is a spring located between and abutting both the valve and the movable valve seat.

10. The power tool of claim 9:

including additional resilient means urging said sleeve toward said valve for allowing said sleeve to move a limited distance along said passage toward said fluid pressure source when engaged with said valve.

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