United States Patent [19]

Hess

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[54] **IMPACT WRENCH**

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[52] **U.S. Cl.** **173/12**; 173/93.5

[51] **Int. Cl.**[2] **B25B 19/00**

[58] **Field of Search** 173/12, 93.5

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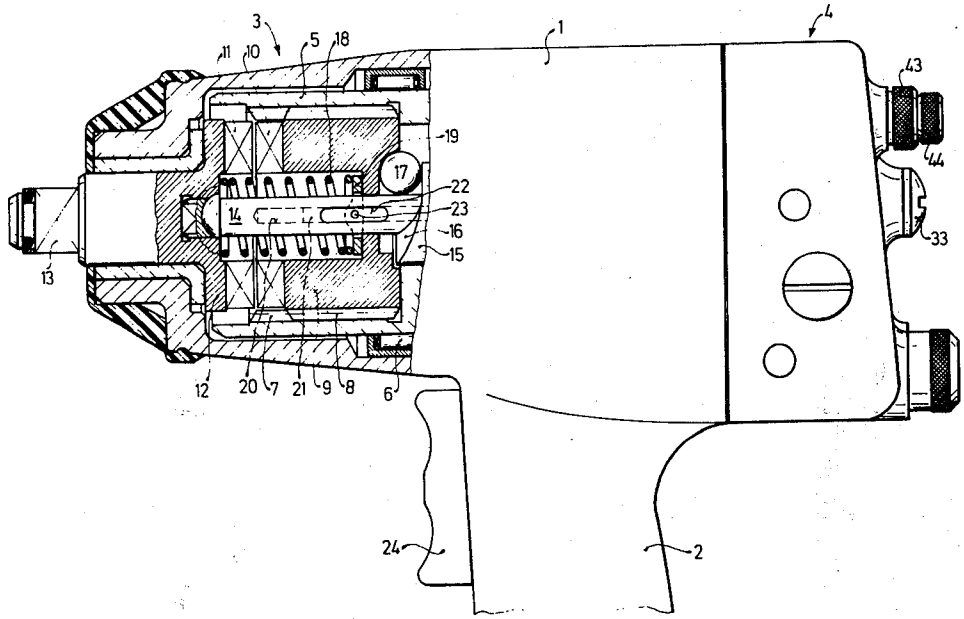
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[57] **ABSTRACT**

Fluid operated impact wrench or similar power tool apparatus wherein a tool actuator particularly a rotary impactor is moved by fluid power to move a tool by mechanical impacts of the actuator, against a force resistive to the moving of the tool. In response to the mechanical impacts of the tool actuator, a series of fluid control impulses is generated. An arrangement is provided which is controlled by the force resistive to the moving of the tool, for controlling the fluid power by said series of fluid control impulses.

13 Claims, 4 Drawing Figures



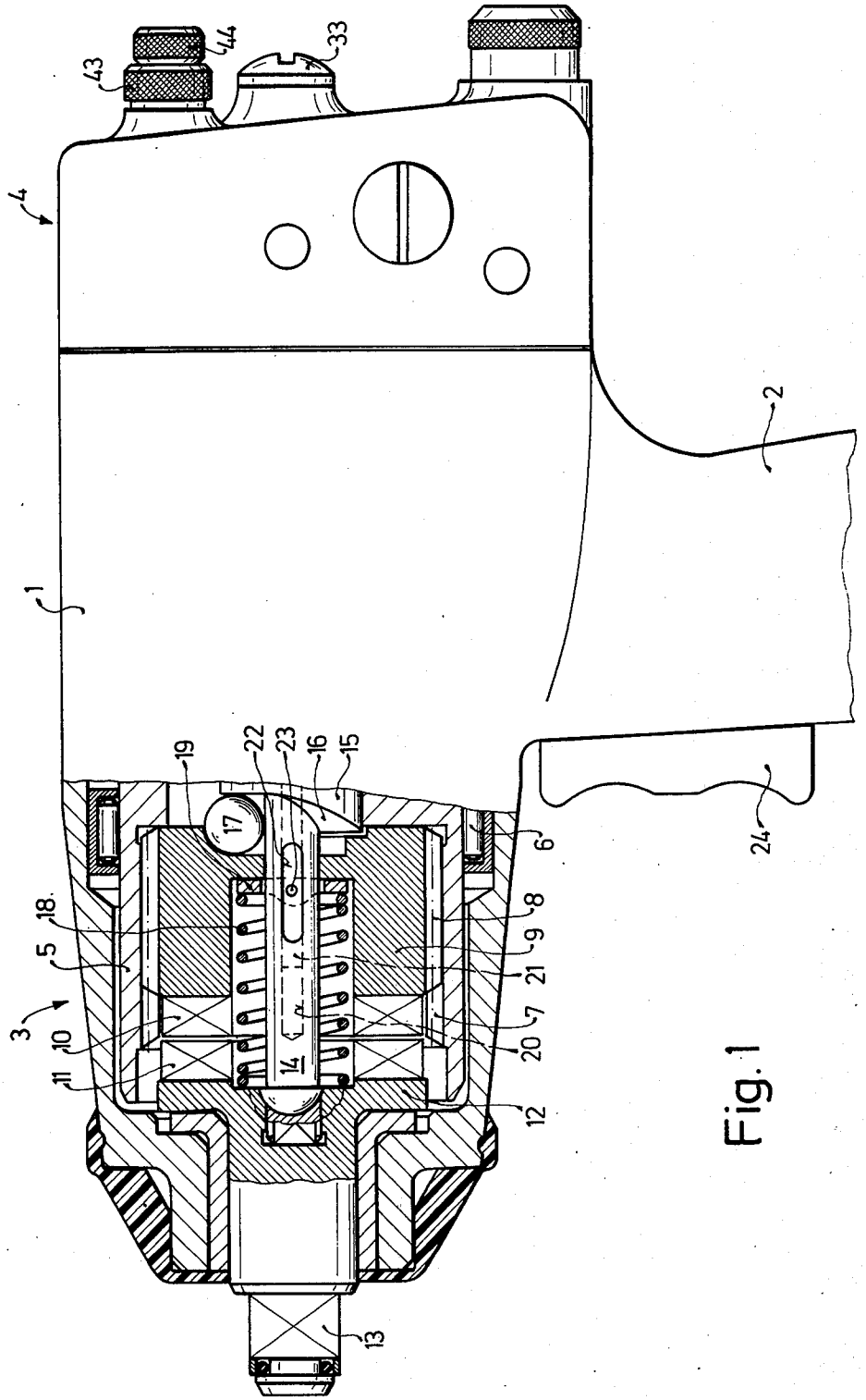


Fig. 1

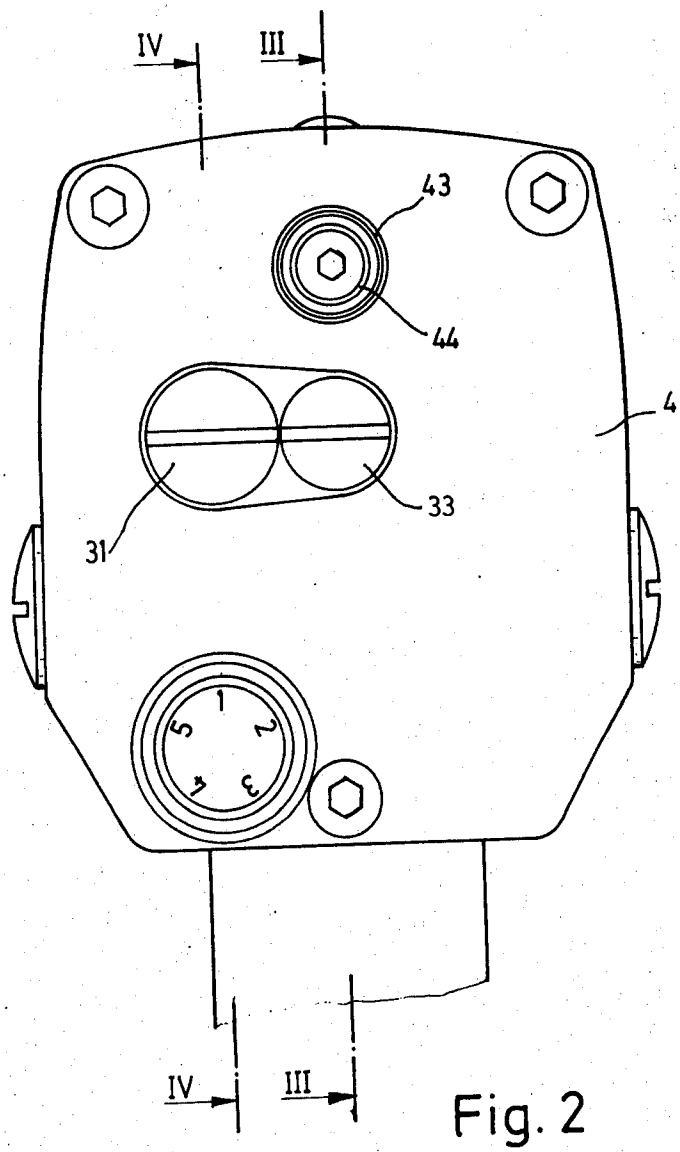


Fig. 2

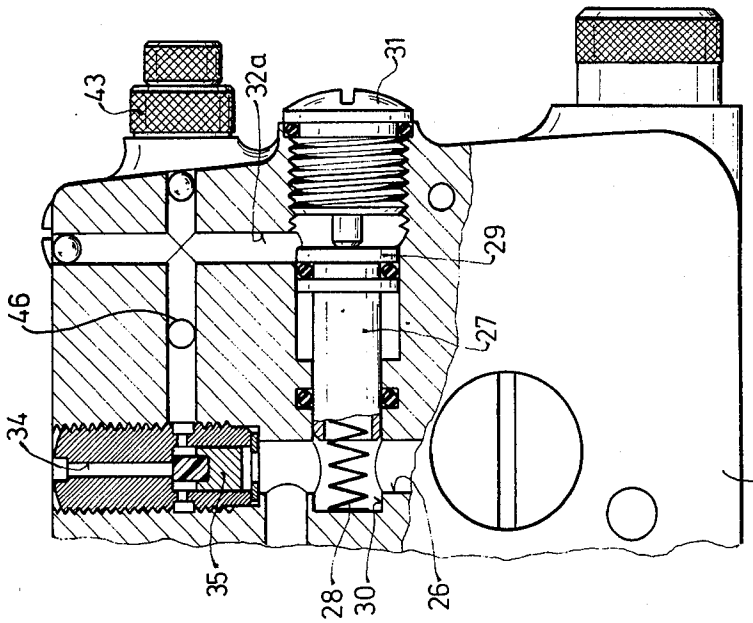

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Fig.4

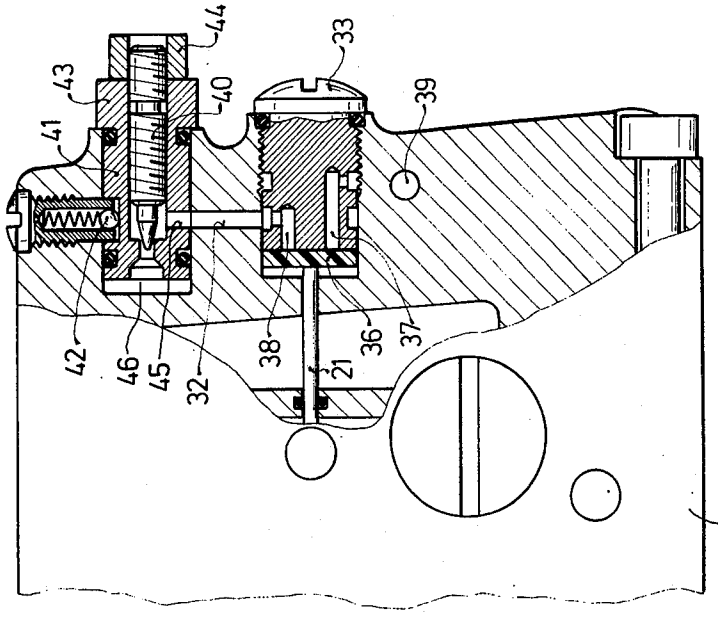

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Fig. 3

IMPACT WRENCH

BACKGROUND OF THE INVENTION

In known impact wrench arrangements of the indicated type, axial motions of the impactor are transferred to a shaft provided with free wheeling means. When this shaft has been rotated by a predetermined angular distance, it releases a mechanical device for deactivating the fluid power drive means. The known, mechanical control devices for this purpose are composed of a large number of parts, some of which are rather complicated. As a result, the known apparatus requires much service and repair, particularly when the impact wrench is subjected to rough use. In addition the known complex apparatus is rather expensive.

SUMMARY OF THE INVENTION

The invention overcomes the difficulties of the conventional impact wrenches by means of a fluid operated control unit for the fluid power motor, which allows relatively simple as well as reliable control in response to the forces resistive to the moving of the tool.

The new control unit comprises means for generating a series of fluid control impulses in response to the mechanical impacts of the tool actuator. It further comprises means controlled by the force resistive to the moving of the tool, for controlling the fluid power by said generated series of fluid control impulses.

In particular, the control unit comprises means for generating the series of fluid control impulses in response to axial reciprocation of the impactor, and means controlled by tool torque resistance, for controlling the fluid power by the generated series of fluid control impulses.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 of the drawing is a side view, partly in central vertical section, of a preferred embodiment of the invention;

FIG. 2 is an end view of the apparatus, the view being taken from the right end of FIG. 1;

FIG. 3 is a partial view of the apparatus, generally similar to the right-hand portion of FIG. 1 but showing part of the apparatus in section taken along line III—III in FIG. 2; and

FIG. 4 is a view generally similar to FIG. 3 but showing a section taken along line IV—IV in FIG. 2.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The impact wrench has a generally drum-shaped housing **1**, having a lower extension to provide the usual pistol grip **2**. The housing contains an impact mechanism **3**, shown at the left end of FIG. **1**; a control unit **4** shown at the right end of the same Figure; and any suitable rotary motor for fluid power operation such as a compressed air vane motor, between the mechanism and the unit **4**, the details of this motor not being illustrated as they are known to the art. The control unit **4** serves to inactivate the fluid power motor the impact mechanism **3** has built up a predetermined tightening torque of the driven tool. According to the invention this control unit **4** uses fluid pressure impulses for this purpose.

Impact mechanism **3** is of the type having an impactor guide housing **5** rigidly secured to the power output means of the vane motor, this housing **5** being rotatably supported in the drum **1** by roller bearings **6**. The impactor guide housing **5** has inner grooves **7** parallel to the axis of the apparatus, and keys **8** are in mesh with the grooves **7**, the keys **8** being provided on the outside of a hammer or impactor **9**. The front of the hammer **9** has cogs **10** thereon, for rotary impact against corresponding cogs **11** on an anvil **12**. This anvil **12** is shown as being held in the housing **1**, for rotation subject to friction. At its front end, shown at left, the anvil **12** has a tool head **13**, whereon a socket key of the tool can be secured.

Power fluid, such as compressed air, is brought to the vane motor through an inlet valve with actuating trigger **24**, and through a reversing valve for rotating the motor either clockwise or counterclockwise. The details of the inlet and reversing valves are not shown, being well known to persons skilled in the art.

In accordance with the invention the preferred embodiment as shown in FIG. **1** has a control shaft **14** rigidly coaxially secured to the anvil **12**, centrally of the hammer **9**. This control shaft **14**, as shown, has a collar **15** at an end of the shaft **14** between the hammer **9** and the vane motor, this collar **15** being rigid with the shaft **14** and having a helical surface **16**, facing the hammer **9**. A ball **17** is interposed between the surface **16** and the hammer **9** and is held in contact with the hammer **9** by a compression spring **18**, disposed in an axial recess of the hammer **9** around the control shaft **14** and reacting at its left end against the anvil **12** and at its right end against a clutch ring **19** in the recess of the hammer **9**. The collar **15** and the control shaft **14** rigid therewith are held against rightward axial motion, but are subject to rotation about the axis of the shaft **14**, by an axial bearing in one end of guide housing **5** (not shown).

The control shaft **14** has an axial bore which receives a push rod **21** extending into the control unit **4**. This rod **21** is secured to the clutch ring **19** by a pin **23** extending through longitudinal slots **22** in the control shaft **14**, so that axial movements of the hammer **9** are followed by the rod **21**.

The control end of this rod **21** is shown in FIG. **3**, and cooperates with the further control apparatus of FIG. **4**. As shown in the latter Figure, a duct **26** is formed in the control unit **4**, and it will be understood that compressed air passes upwardly through this duct and then forwardly to the motor, when the inlet valve controlled by the trigger **24** (FIG. **1**) is open; however, the duct **26** can be closed by a cylindrical control slider **27**, to interrupt the compressed air stream to the motor. Normally, the slider **27** is held in the position shown in FIG. **4** and the duct **26** is open, by the operation of a compression spring **28** which abuts against the wall of the housing at its left end and against the inside of the slider **27** at its right end. The right end of the slider also carries a piston **29** which slides in a suitably enlarged coaxial portion of a guide bore **30**. At its outer end the guide bore **30** is closed by a threaded plug **31**.

A control duct 32 (FIG. 3) for control of the fluid pressure for operating the tool has a terminal portion 32*a* (FIG. 4) which leads to the enlarged part of the guide bore 30, behind the piston 29. Ahead of this enlarged part, the control duct 32, 32*a* can be vented to the atmosphere through a vent 34, which is normally closed by a closure member 35. This member 35 is shown as a free piston, normally forced upwards by the pressure of the compressed air stream for operating the impact wrench motor. When such a pressure is present in the duct 26, the piston 35 closes the vent 34. When pressure in the duct 26 is reduced by closure of this duct by the slider 27, while there is pressure in the end part 32*a* of the control duct 32, the piston 35 is forced down by this latter pressure and the vent 34 is opened thereby.

The control valve 33 has a valve plug or plate 36 in form of a disc reciprocable by the push rod 21, which rod transmits the axial motion of the hammer 9 to this valve plate 36. When the hammer 9 is in non-impacting position, the push rod holds the plate 36 in rightwardly shifted position, as shown in FIGS. 1 and 3. This construction provides a particularly simple embodiment of the invention. In said rightwardly shifted and valve closing position of the valve plate 36, the plate separates a pressure inlet port 37, in the seat of the valve 33, from a pressure outlet port 38 in this valve seat. The pressure inlet port or bore 37 receives compressed air from the manually actuated on-off valve, which is connected with the trigger 24, through a channel 39, while the pressure outlet bore 38 is permanently connected with the control duct 32, which in turn is connected to the end part 32a across a throttle valve 40.

Operation of the Preferred Embodiment:

The drive motor (not shown) rotates the hammer guide housing 5 and thereby rotates the hammer 9, as usual. By means of friction at the rear end of the hammer, transmitted by the ball 17 and the surface 16, the collar 15 and the control shaft 14 transmit a rotary force to the anvil 12. At the same time a further portion of the rotary moment of the hammer 9 is transmitted to the anvil 12 by the clutch plate 19 and the compression spring 18. Thus the anvil 12 tends to rotate with the hammer 9. If this rotation of the anvil 12 is impeded by torque resistance, for example, if a nut, rotated by the tool end 13, meets with resistance due to threading it on a bolt, the hammer 9 and the anvil 12 will rotate relative to each other. The ball 17 then rolls along the helical path 16 and thereby axially shifts the hammer 9 into its impacting position, causing an impact between cogs 10 and 11. Since the helical path 16 then reaches its end, ball 17 is then released, allowing hammer 19 to be returned rightwardly by spring 18, thereby disconnecting cogs 10, 11 promptly after their mutual impact. The continuing rotation of the hammer causes repetition of this operation. Thus the impacting mechanism performs impact actions at 10, 11 until either the torque load applied to the anvil 12 has been overcome, or the impacting mechanism has been deactivated.

Such deactivation of the impact mechanism is effected when a certain predetermined torque has been reached by the tool. According to the invention the deactivating operation is effected as follows (FIG. 3):

On each impact operation of the hammer 9, the push rod 21 briefly opens the control valve 33, admitting a certain amount of compressed air—a control impulse—to the control duct 32 and, across the throttle valve 40, to the terminal portion 32*a* of this duct. After a certain number of such control impulses, pressure has been built up in the space behind the piston 29 of the blocking slide 27, thereby shifting this slide (FIG. 4) into a position thereof wherein it blocks the compressed air stream previously admitted to the impact wrench motor and thus arresting the motor. These operations cause reduction of pressure in the duct 26, so that the closure member 35 then opens the vent 34, allowing escape of the compressed air which still remains in the control duct. The spring 28 then shifts the blocking slide 27 back into its normal position, thereby readying the apparatus for new operation.

It is generally preferred to construct the apparatus so that the user can adjust the number of impacts of the impact mechanism, needed to deactivate the motor. Such adjustment can be provided by a number of devices, for example by means (not shown) for varying the force of the control spring 28. A particularly simple as well as fine adjustment is provided by controlling the increments of pressure in the space behind the piston 29. For this purpose the throttle 40 has a knurled end nut 44 which can be manually set, relative to a portion 43 of the throttle valve housing, locking the parts 43, 44 relative to one another and thereby adjusting the throttle. It will be understood that for this purpose the throttle 40 can have a needle shaped end disposed concentrically to a seat at the inner end of a throttle housing 41, and a threaded stem of said needle, as shown.

It is further preferred to arrange the device so that it either provides the automatic deactivating of its motor, as described, or omits the same, as when the impact wrench is used for unscrewing a bolt. For this purpose the throttle housing 41 (FIG. 3) can be inserted in the end piece of the impact wrench in a plurality of positions. In the illustrated position the control impulses generated by the control valve 33 are admitted to the throttle and thereby to the end part of the control duct 32, 32*a*, through a small bore 45 in the side wall of the throttle housing 41. It will be understood that this housing can be turned so as to disconnect this small bore from the control duct 32. In either position the throttle housing 41 can be held, for example by a ball catch 42. When the bore 45 is connected to the control duct 32, fluid admitted by the control valve 33 passes through the throttle 40, at a pressure reduced thereby, and to a throttle outlet 46. This outlet (FIG. 4) then leads the fluid, as a control impulse, to the slider unit 29, 27 for the control of the impact wrench.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be protected by Letters Patent is set forth in the appended:

1. In a power tool, a combination comprising a fluid-actuated motor; means for supplying pressurized fluid to said motor; actuator means driven by said motor and generating a series of impacts; means for sensing the occurrence of each impact and for generating a pressure pulse in response thereto; and means for interrupting the supply of said pressurized fluid to said motor

when a predetermined cumulative number of said pulses has been generated.

2. Apparatus as defined in claim 1 wherein said sensing means comprises a control duct and a valve and valve plug in said duct for controllably admitting fluid pressure to the duct; and a push rod interconnecting the valve plug with the actuator means.

3. Apparatus as defined in claim 2 wherein said valve has a seat surface, a port aperture in said surface for admitting fluid pressure thereto, a further port aperture in said surface for transmitting pressure therefrom to the control duct, and the valve plug is a disc-shaped plate movable onto and away from said seat by said push rod.

4. Apparatus as defined in claim 1, wherein said sensing means includes a control duct, a throttle therein, and vent means connectable with said motor and the control duct.

5. Apparatus as defined in claim 4 wherein the throttle is disposed between said vent means and said sensing means.

6. Apparatus as defined in claim 4 wherein said throttle has a throttle valve body and means are provided for selectively connecting the throttle valve to the control duct and disconnecting it therefrom.

7. Apparatus as defined in claim 4 wherein the throttle has means for adjusting the same to thereby modify the number of pulses needed for controlling said fluid power motor.

8. An impact wrench comprising a fluid power motor and an impactor driven thereby for effecting rotary motion of a tool; means for axially reciprocating said impactor during such rotary motion to rotate the tool by impacts in response to a torque resistance; means for generating a fluid control impulse in response to an axial reciprocation of said impactor and including a control duct and a valve and valve plug in said duct for controllably admitting fluid pressure to the duct, and a push rod interconnecting the valve plug with the impactor, said valve having a seat surface, a port aperture in said surface for admitting fluid pressure thereto, a further port aperture in said surface for transmitting pressure therefrom to the control duct, and the valve plug being discshaped plate movable onto and away from said seat by said push rod; and means controlled by said torque resistance for controlling said fluid power motor by such fluid control impulses.

9. An impact wrench comprising a fluid power motor and an impactor driven thereby for effecting rotary motion of a tool; means for axially reciprocating said impactor during such rotary motion to rotate the tool by impacts in response to a torque resistance; means for generating a fluid control impulse in response to an axial reciprocation of said impactor; and means controlled by said torque resistance for controlling said fluid power motor by such fluid control impulses, and including a duct for admitting fluid pressure to said motor, a slider movable between a first position outside said duct and a second position across said duct, means operable by fluid pressure impulses derived from said fluid pressure for moving said slider to said second position, and a spring for normally biassing said slider to said first position.

10. Apparatus as defined in claim 9 wherein said slider has a cylindrical portion movable longitudinally of the axis thereof and said spring is a compression spring coaxial with said cylinder.

11. An impact wrench comprising a fluid power motor and an impactor driven thereby for effecting rotary motion of a tool; means for axially reciprocating said impactor during such rotary motion to rotate the tool by impacts in response to a torque resistance; means for generating a fluid control impulse in response to an axial reciprocation of said impactor and including a control duct; vent means connectable with the fluid power motor and the control duct, and a throttle in said control duct between said vent means and said means for generating said fluid control impulses; and means controlled by said torque resistance for controlling said fluid power motor by such fluid control impulses.

12. An impact wrench comprising a fluid power motor and an impactor driven thereby for effecting rotary motion of a tool; means for axially reciprocating said impactor during such rotary motion to rotate the tool by impacts in response to a torque resistance; means for generating a fluid control impulse in response to an axial reciprocation of said impactor and including a control duct, a throttle therein having a throttle valve body, means for selectively connecting the throttle valve to the control duct and disconnecting it therefrom, and vent means connectable with the fluid power motor and the control duct; and means controlled by said torque resistance for controlling said fluid power motor by such fluid control impulses.

13. An impact wrench comprising a fluid power motor and an impactor driven thereby for effecting rotary motion of a tool; means for axially reciprocating said impactor during such rotary motion to rotate the tool by impacts in response to a torque resistance; means for generating a fluid control impulse in response to an axial reciprocation of said impactor and including a control duct; a throttle therein; means for adjusting said throttle to thereby modify the numer of control impulses needed for controlling said fluid power motor, and vent means connectable with the fluid power motor and the control duct; and means controlled by said torque resistance for controlling said fluid power motor by such fluid control impulses.

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