



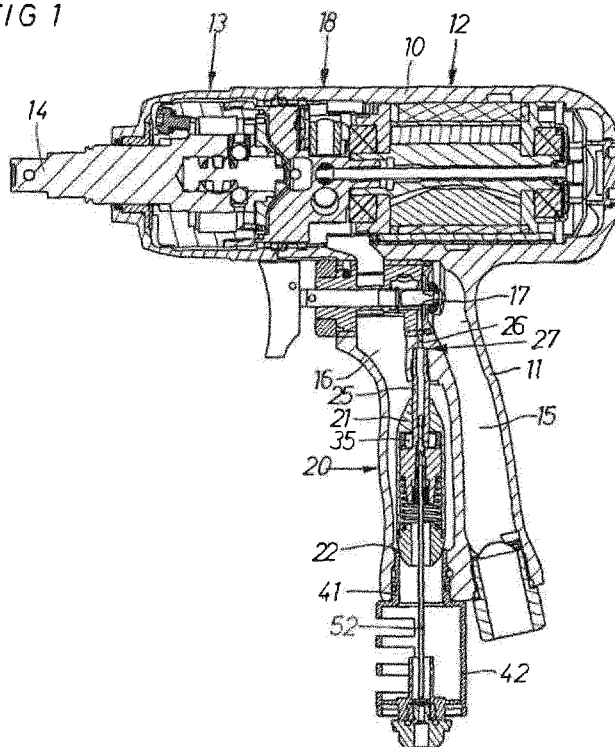
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- (71) Applicant: **ATLAS COPCO INDUSTRIAL TECHNIQUE AB** [SE/SE]; S-105 23 Stockholm (SE).
- (72) Inventor: **SÖDERLUND, Per THOMAS**; Tåppvägen 16, S-139 35 Värmdö (SE).
- (74) Agent: **EKEBERG, Lars**; C/o Atlas Copco Industrial Technique AB, Patent Department, S-105 23 Stockholm (SE).

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[Continued on next page]

- (54) Title: PNEUMATIC IMPULSE WRENCH WITH AN AUTOMATIC MOTOR POWER CONTROL VALVE

FIG 1



(57) Abstract: A pneumatic impulse wrench comprises a housing (10) with a motor (12), a pressure air inlet passage (15) with a throttle valve (17), an exhaust air outlet passage (16) connected to the motor (12), an impulse generator (13) coupling the motor (12) to an output shaft (14), and a power control valve (20) located inside the outlet passage (16) and controlled by the back pressure from the motor (12) via a pressure line (27). The power control valve (20) comprises a tubular valve element (21) movably supported on a tube element (25) which is rigidly secured to the housing (10) and forms a part of the pressure line (27) which extends between the inlet passage downstream of the throttle valve (17) and an activation chamber (35) associated with the valve element 21. The valve element (21) is arranged to cooperate with an annular shoulder (22) in the outlet passage (16) to restrict the exhaust air outlet flow as well as the motor speed during low torque running down phase of a screw joint tightening process to thereby avoid a too strong first impulse being delivered after settling of the screw joint. At continued tightening after delivery of the very first impulse the motor load and hence the back pressure from the motor (12) increases whereby the air pressure in the activation chamber (35) forces the valve element (21) away from the shoulder (22) to open up the outlet passage (16) and enable full motor power.

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Pneumatic impulse wrench with an automatic motor power control valve.

The invention relates to a pneumatic impulse wrench which comprises a housing with a motor, an impulse generator and a motor power control valve. In particular, the invention relates to a pneumatic impulse wrench which comprises a housing with a pressure air inlet passage and an exhaust air outlet passage, and an automatic motor power control valve in the form of an exhaust flow controlling outlet valve, wherein the latter is controlled by the back pressure from the motor during operation of the wrench and shiftable between a flow restricting position and an open position.

An impulse wrench of the above type is previously described in for instance US Patent 6,135,213.

One problem inherent in prior art impulse wrenches of the above type is that the power control valve has been in the form of a separate unit attached externally to the tool housing, which means that it has been too easily exposed to mechanical damage.

Another problem is that such a separate valve unit also influences in a negative way the overall dimensions of the wrench, because it is important for a comfortable handling and use of power tools of this type that the physical size is kept as small as possible.

Still another problem related to prior art impulse wrenches of the above type is addressed to the mechanical complexity

of the power control valve itself which has rendered the valve rather expensive with high production costs.

The impulse wrench according to the invention intends to solve the above problems by relocating the power control valve to avoid external damage and to enable a less complex valve design.

Further objects and advantages of the invention will appear from the following specification and claims.

A preferred embodiment of the invention is described below in detail with reference to the accompanying drawing.

In the drawing

Fig. 1 shows in section an impulse wrench according to the invention.

Fig. 2 shows on a larger scale a longitudinal section through the power control valve.

Fig. 3 shows on a still larger scale a detailed section through the power control valve.

The impulse wrench illustrated in the drawing is of the type having a pneumatic rotation motor connected to an output shaft via a hydraulic impulse generator. When applied on a screw joint for tightening the same the initial stage of operation consists of a relatively high speed running down phase wherein the torque resistance from the screw joint is low. During that phase the impulse generator will transfer torque of a high enough level to rotate the screw joint but without performing any torque impulses. However, when the screw joint is settled and the

tightening sequence and the torque resistance increases the impulse generator starts delivering impulses. Now, if initially the running down resistance is very low and the rotation speed therefore is high the kinetic energy build-up in the motor and the impulse generator is likewise high, the very first impulse delivered to the screw joint would contain a very high energy. This could cause not only complete the tightening of the screw joint during that very first impulse, but might also cause an overtightening of and even a damage to the joint. This is especially the problem at stiff screw joints where the torque build-up is very abrupt and steep.

In order to limit the speed and the energy build-up in the rotating parts of the motor and impulse generator during the running down phase there is employed an exhaust valve which is operated as a function of the back pressure from the motor. This means that during the running down phase there is a low torque resistance and a likewise low back pressure from the motor. At this low back pressure the exhaust valve occupies a closed position, which means that the motor instead is retarded to a low speed by a high back pressure in the exhaust passage and is able to deliver only a limited power output. This low speed means a limited kinetic energy build-up in the motor and the impulse generator and a substantially reduced risk for overtightening and/or damaging the screw joint. Of course, the closed position of the exhaust valve is not a fully closed position but means a restricted flow area for the exhaust air. If fully closed the motor would not start and operate at all.

When, however, the very first impulse has been delivered to the screw joint the motor and the impulse generator has come to a full stop, and to build up kinetic energy before the nextcomming impulse the motor has to start accelerating from zero over a short angular interval, which means that when a succeeding impulse is to be delivered the speed is much lower than it would have been after a unlimited high speed running down phase. During the succeeding accelerating and impulse generating phases the load on the motor is substantially higher, which means that the back pressure from the motor is high and the exhaust valve is shifted from the flow restricting position to a fully open position. This means that the motor now is able to deliver full power, and the continued step-by-step torque build-up in the screw joint may now proceed in a controlled way until the desired target tightening level is obtained.

The very impulse wrench illustrated in the drawing comprises a housing 10 formed with a pistol type handle 11, and enclosing a pneumatic vane type motor 12 and a hydraulic impulse generator 13. An output shaft 14 is supported at the front end of the housing 10 and is coupled to the motor 11 via the impulse generator 13. A pressure air inlet passage 15 and an exhaust air outlet passage 16 extend through the handle 11, and a throttle valve 17 is supported on the handle 11 for selective supply of pressure air to the motor 12 via the inlet passage 15.

Both the pneumatic vane motor 12 and the hydraulic impulse generator 13 are of a well known design and are not described in further detail. The impulse generator 13 is also provided with an automatic motor shut-off mechanism 18

of a previously known type, but since this device has no connection with the invention it is not described in further detail.

In the outlet passage 16 there is located a power control valve 20 which is arranged to control the output power of the motor 12 by controlling the exhaust air outlet flow from the motor 12. The control valve 20 is arranged to operate in response to the actual back pressure from the motor 12 in the inlet passage 15, which corresponds to the actual torque load on the motor 12. The control valve 20 comprises a tubular valve element 21, and an annular shoulder 22 rigidly mounted in the outlet passage 16, wherein the valve element 21 is longitudinally shiftable between a flow restricting position close to the shoulder 22 and an open position at a distance from the shoulder 22.

In the outlet passage 16 and rigidly secured to the housing 10 there is a tube element 25 which extends in the longitudinal direction of the outlet passage 16. The tube element 25 has an internal passage 28 which communicates via a bore 26 with the inlet passage 15 just downstream of the throttle valve 17. The bore 26 and the passage 28 of the tube element 25 form together a pressure line 27 for communicating the back pressure from the motor 12 to the control valve 20.

The valve element 21 of the control valve 20 is tubular in shape and comprises an internal cylindrical cavity 30 partly defined by a rear end wall 31. The latter has a central opening 32 for receiving the tube element 25 which extends into the cavity 30 and forms a supporting guide for the valve element 21. The tube element 25 is formed with a

cylindrical head 33 which is located inside the cavity 30 and cooperates sealingly with the wall of the cavity 30. The head 33 forms together with the wall of the cavity 30 and the rear end wall 31 an activation chamber 35 which communicates with inlet passage 16 via the pressure line 27. The internal passage 28 of the tube element 25 communicates with the activation chamber 35 via lateral opening 36 in the tube element 25.

The valve element 21 has a cylindrical stepless outer cylindrical surface 38 which together with the walls of the outlet passage 16 forms a smooth annular flow passage for the exhaust air. This enables a free and unrestricted exhaust air outlet flow in the fully open position of the valve 20. The downstream end of the valve element 21 comprises a conical end piece 39 which is arranged to cooperate with the annular shoulder 22 in the outlet passage 16 to control the exhaust air flow passing through the outlet passage 16. The shoulder 22 is formed by a sleeve shaped element 40 mounted in the outer end portion of the outlet passage 16. This sleeve element 40 is formed by a neck portion 41 of an outlet flow deflector 42 attached as a separate unit to the wrench handle 11.

Inside the cavity 30 of the valve element 21 there is located a spring 45 which acts between the head 33 of the tube element 25 and a forward end wall 46 of the cavity 30 to apply a bias force on the valve element 21 towards the flow restricting position of the latter, i.e. wherein the conical end portion 39 of the valve element 21 cooperates in a flow restricting way with the shoulder 22. The forward

end wall 46 is formed by the rear end surface of the conical end piece 39.

An annular distance piece 48 is arranged in the cavity 30 between the head 33 and the rear end wall 31 to limit the movement of the valve element 21 towards the shoulder 22 and to thereby define a suitable size of the flow restricting opening between the valve element 21 and the shoulder 22 in the flow restricting position of the valve 20, i.e. during a low load condition of the motor. This distance piece 48 may be made in any desired axial size to adapt the outlet flow restricting opening to suit the actual operating conditions of the wrench.

Inside the tube element 25 there is a flow restriction in the form of an inner collar 50, and an adjustable conical needle 51 threaded into the head 33 and arranged to cooperate with the collar 50 to enable adjustment of the air flow through the pressure line 27 for obtaining a desired valve operation. The flow restriction passed this needle-collar valve device serves to dampen and slow down the shifting movement of the valve 20 to thereby get a more stable outlet flow restriction action. The needle 51 may be reached from outside for adjustment by a suitable tool via a central opening 55 in the end piece 39.

A small size tube 52 is secured in a central bore 53 in the needle 51 and extends out of the valve 20 and the flow deflector 42 and may be used for indicating the operation of the valve 20, the motor shut-off mechanism 18, and the operator's activation of the throttle valve 17. This feature is well known and used in prior art wrenches of the type described in the document referred to above, and in order

not to make this specification unnecessary extensive a detailed description of this feature is left out.

In operation of the impulse wrench a non-illustrated nut sleeve attached to the output shaft 14 is applied on a screw joint to be tightened and the throttle valve 17 is opened to let in pressure air via the inlet passage 15 to energize the motor 12. The motor 12 starts delivering a torque to the screw joint and a running down phase is commenced. Initially, the torque resistance from the screw joint is low and the impulse generator 13 is able to transfer torque without producing any impulses. During this operating phase the power control valve 20 occupies its flow restricting position under the bias force of the spring 45, and the back pressure from the motor 12 is very low. This means that the pressure downstream of the throttle valve 17, in the pressure line 27 and in the activation chamber 35 is not strong enough to dominate the spring 45 and make the valve element 21 move from its flow restricting position. The result is a restricted outlet flow from the motor 12 and a limited motor speed, whereby only a limited kinetic energy being built up in the rotating parts of the wrench. This means that when the screw joint settling point is reached and the torque resistance starts increasing the risk for getting a very vigorous first impulse is avoided.

As the screw joint has settled and the torque resistance commences the load on the motor 12 increases and the back pressure from it increases the pressure in the pressure line 27. This means that the pressure in the activation chamber 35 will start dominating the spring 45 and move the

valve element 21 rearwardly to thereby open up the gap between the valve element 21 and the shoulder 22 and permit a full exhaust flow to pass through the outlet passage 16. This means that the motor 12 is now able to operate at full power. By adjusting the position of the needle 51 it is possible to set a suitable response of the valve 20 to the increasing back pressure from the motor 12.

As the desired target tightening level is reached in the screw joint the non-illustrated automatic motor shutoff mechanism 18, which is situated downstream of the throttle valve 17, will be closed and the motor 12 is stopped. Before the throttle valve 17 has been closed the air pressure between the same and the shutoff mechanism 18 as well as in the pressure line 27 will increase to the full pressure of the pressure air source which results in that the power control valve 20 remains open. When the throttle valve 17 is eventually closed the pressure in the pressure line 27 will be discontinued and the valve 20 will be returned to its initial flow restricting position by the action of the spring 45. Now a screw joint tightening process is completed.

It is to be understood that the embodiments of invention are not limited to the above described example but may be freely varied within scope of the claims.

Claims.

1. A pneumatic impulse wrench comprising a housing (10), a rotation motor (12), an output shaft (14), an impulse generator (13) coupling the motor (12) to the output shaft (14), a pressure air inlet passage (15), an exhaust air outlet passage (16), a throttle valve (17) for selective pressure air supply to the motor (12), and an automatic motor power control valve (20) arranged to control the exhaust air flow through the outlet passage (16) as a function of the actual back pressure from the motor (12) during wrench operation, wherein the power control valve (20) comprises an annular shoulder (22) in the outlet passage (16), a valve element (21) partly shiftable between a flow restricting position and an open position in relation to the annular shoulder (22), and an activation chamber (35) associated with the valve element (21), and a pressure line (27) connecting the activation chamber (35) with the air inlet passage (15) downstream of the throttle valve (17) to supply pressure air to the activation chamber (35) for accomplishing shifting of the valve element (21) from the flow restricting position towards the open position at a certain back pressure from the motor (12),

c h a r a c t e r i z e d in that

- the annular shoulder (22) is located inside the outlet passage (16),
- the valve element (21) is of a tubular shape and located inside the outlet passage (16),
- a tube element (25) located in the outlet passage (16) and rigidly secured to the housing (10) and forming a part of the pressure line (27), wherein

- the valve element (21) is movably supported on said tube element (25).

2. Impulse wrench according to claim 1, wherein the valve element (21) comprises a internal cylindrical cavity (30) with a transverse end wall (31), and said tube element (25) extends into said cavity (30) through said end wall (31) and is provided with a cylindrical head (33), wherein the activation chamber (35) is located inside the valve element (21) between said head (33) and said end wall (31) and communicates with the inlet passage (15) via said tube element (25).

3. Impulse wrench according to claim 1 or 2, wherein the valve element (21) has a conical end piece (39) for cooperation with the annular shoulder (22) in the flow restricting position.

4 Impulse wrench according to anyone of claims 1-3, wherein the valve element (21) has a stepless cylindrical outer shape so as to form a smooth annular flow path relative to the outlet passage (16).

5. Impulse wrench according to anyone of claims 1-4, wherein the annular shoulder (22) is formed by a sleeve shaped element (40) mounted in the outer end portion of the outlet passage (16).

6. Impulse wrench according to claim 5, wherein said sleeve shaped element (40) comprises a neck portion (41) of an outlet flow deflector (42) attached to the housing (10,11).

7. Impulse wrench according to anyone of claims 1-6, wherein the housing (10) is formed with a pistol type handle (11), and the outlet passage (16) is located in the handle (11).

FIG 1

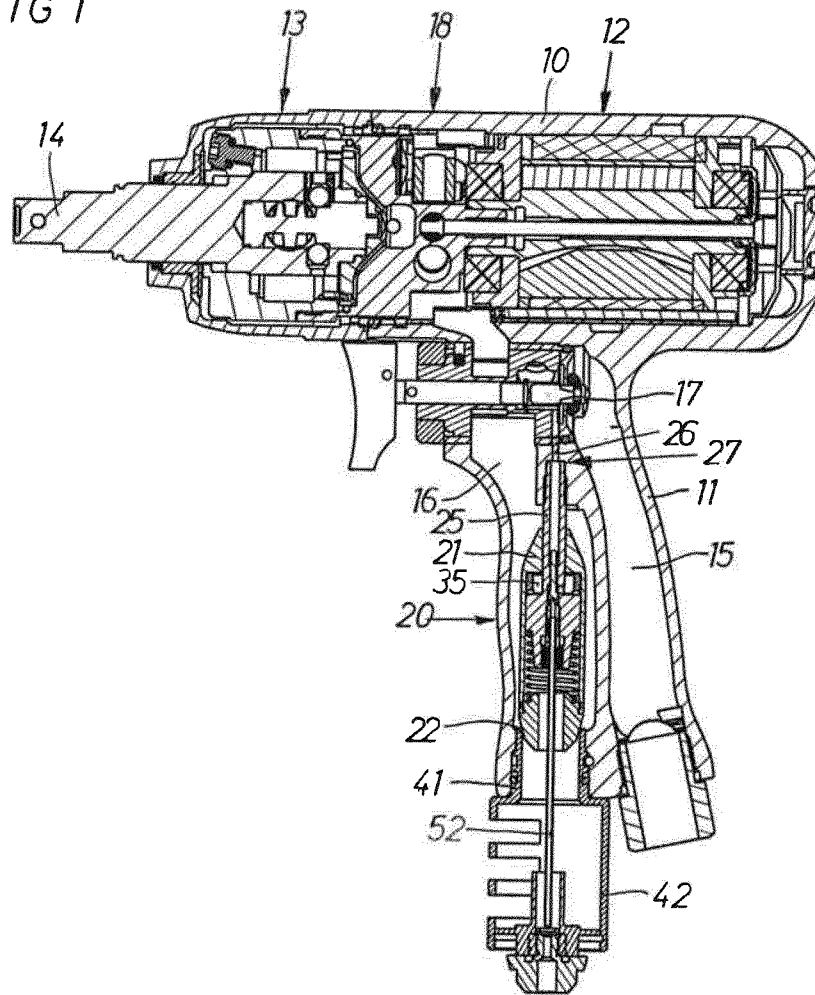


FIG 2

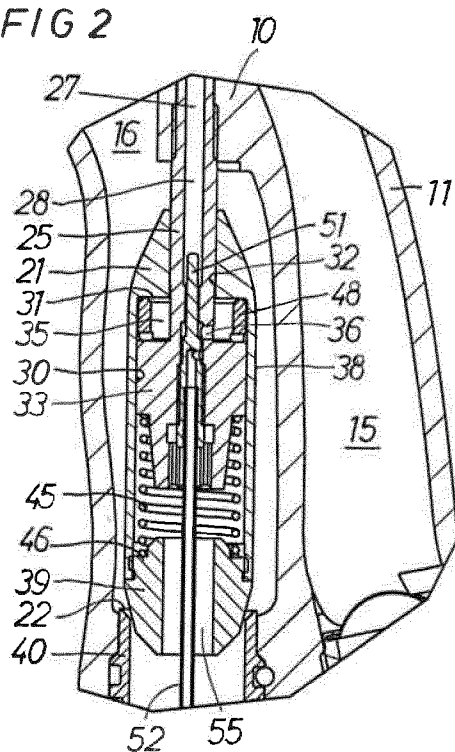
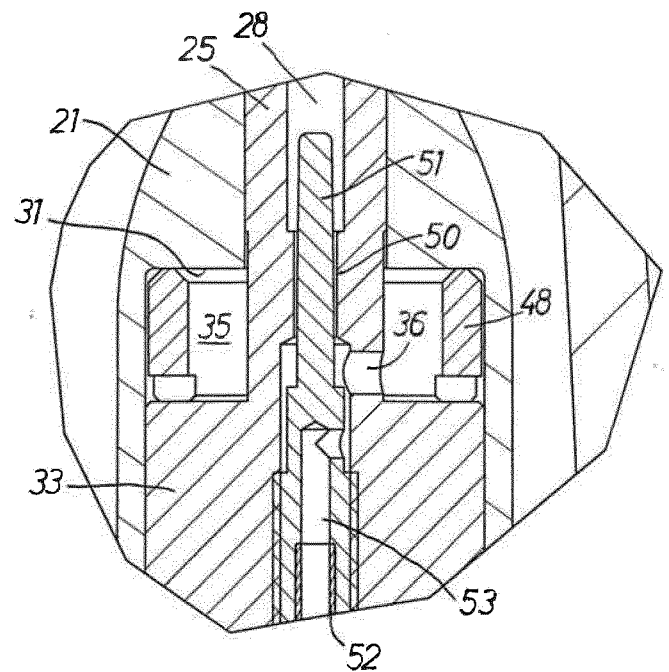


FIG 3



INTERNATIONAL SEARCH REPORT

International application No
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A. CLASSIFICATION OF SUBJECT MATTER

INV. B25B21/02 B25B23/145 B25F5/00
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B25B B25F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EP0-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 900 632 A2 (ATLAS COPCO TOOLS AB [SE]) 10 March 1999 (1999-03-10) paragraphs [0013] - [0025]; figure 2 -----	1-7
A	EP 0 802 023 A1 (ATLAS COPCO TOOLS AB [SE]) 22 October 1997 (1997-10-22) column 1, line 40 - column 2, line 1 column 2, line 53 - column 4, line 25; figures 2,3 -----	1



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

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Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

Authorized officer

Kühn, Thomas

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2013/072116

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