A rotary impact tool, especially an impact wrench, having a hammer located in a rotatable guide housing and connected to the latter for rotation therewith and axially reciprocatable with respect thereto between an active and an inactive position. An anvil is located forwardly of the hammer to be rotated by the latter in the active position thereof. The guide housing and therewith the hammer are rotated by drive means which include a central stator and a hollow cylindrical rotor connected with the guide housing for rotation.
ROTARY IMPACT TOOL

BACKGROUND OF THE INVENTION

The present invention relates to a rotary impact tool, especially an impact wrench, with an impact mechanism comprising a coaxially arranged anvil and hammer, and drive means for driving the impact mechanism. The drive means preferably comprise a vane motor operated by compressed air which includes an inner cylindrical stator and a hollow cylindrical rotor surrounding the stator which defines between its inner surface and the outer surface of the stator a working space which is divided into individual working chambers by vanes which are closely guided in radially extending slots of the rotor.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a rotary impact tool of the aforementioned kind in which the active mass of the striking mechanism is increased by the mass of the rotor.

It is a further object of the present invention to provide a rotary impact tool of the aforementioned kind which is very compact in construction so that it may be handled conveniently by the operator and so that it may be manufactured at reasonable cost and will stand up properly under extended use.

With these and other objects in view, which will become apparent as the description proceeds, the rotary impact tool according to the present invention mainly comprises a tool housing, drive means in the tool housing and comprising a stator and a rotor surrounding the stator, a pot-shaped guide housing in the tool housing and connected to the stator for rotation therewith, with the bottom wall of the guide housing rotatably supported on the stator, a hammer arranged in the guide housing for reciprocating movement relative thereto, and cooperating means on the guide housing and the hammer for connecting the hammer with the guide housing for rotation therewith permitting axial movement of the hammer relative to the guide housing.

The aforementioned cooperating means preferably comprise an internal gearing on the guide housing and an external gearing on the hammer meshing with the internal gearing.

An especially advantageous arrangement is derived when the end of the rotor facing the impact mechanism is provided with a hollow cylindrical projection which extends over the outer surface of the guide housing and is supported on the latter.

The drive means are preferably constituted by a vane motor operated by compressed air and the hollow cylindrical rotor defines with the stator of the vane motor a working space which is divided into a plurality of individual working chambers by a plurality of vanes closely guided in radially extending slots in the stator.

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 drawings.

BRIEF DESCRIPTION OF THE DRAWING:

FIG. 1 is a side view of the impact tool partially sectioned along its axis; and

FIG. 2 is a cross-section taken along the lines 2—2 of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENTS:

Referring now to the drawing, it will be seen that the impact wrench according to the present invention has a substantially drummed-shaped tool housing 1 which is provided at its rear portion with a downwardly extending handle 2. The drive for the impact mechanism of the impact wrench is located in the rear portion of the housing 1 and the drive is preferably constituted by a vane motor operated by compressed air. The impact mechanism of the wrench is located in the front part of the housing.

The vane motor has an outer tubular rotor 3 which has an inner annular, preferably cylindrical, eccentric reaction surface 6 which surrounds a small stator 4 which is located coaxially with the rotor. Stator 4 has circumferentially spaced radially extending slots 4a in which vanes 5 are guided for radial reciprocating movement. Springs 4b in the bottom portions of the slots 4a urge the vanes 5 outwardly so that the ends of the vanes 5 are in contact with the eccentric reaction surface 6 during rotation of the rotor 3. The crescent-shaped cavity between the annular surface 6 and the outer surface 4c of the rotor is divided by the vanes 5 into working chambers 5a which expand on one side of a vertical dead-center plane, and contract on the other side thereof to receive and discharge fluid, respectively. The outer surface 4c of the stator is in contact with the inner reaction surface 6 of the rotor along an axial line located in the dead-center plane of the apparatus which also passes through the axis of the rotor 3.

The housing portion 1a which closes the tubular housing 1 has a threaded axial bore 31 into which the thread of an extension 3a of the stator 4 is threaded. In this manner, the central stator 4 is mounted at one end of the housing portion 1a.

The axial ends of the tubular rotor 3 are provided with radial rotor end walls 7 and 7a secured by screws, not shown, to the tubular rotor 3. The axial distance between the confronting faces of the rotor end walls 7 and 7a correspond to the effective axial length of the stator 4 and of the vane 6, a small amount of clearance being provided.

The rotor end wall 7a has a central opening through which the extension 3a of the stator 4 projects, forming with the rotor end wall 7a an annular space in which a ball-bearing 32 is located so that the rotor 3 is supported at the respective end for rotation on the extension 3a of the stator. The other end of the stator 4 has a cylindrical extension 8 projecting beyond the other rotor end wall 7, and carrying a ball bearing 9 on which the bottom wall 10 of a pot-shaped hammer guide housing 13 is mounted. The cylindrical outer surface of the bottom wall 10 is closely fitted at 11 into the inner surface of a hollow cylindrical extension 12 of the rotor 3 and thus supports the latter. A spline 17 formed within the free end of the hollow cylindrical extension 12 and on the outer surface of the bottom 10 of the guide housing 13 connects the latter for rotation with
the rotor 3. The guide housing 13 is turnably mounted by means of a needle bearing 13' in the housing 1.

The supply of compressed air to the vane motor takes place through the main valve in the grip portion 2 of the housing operated by a button 33. The two-way shifting valve 34, only schematically shown, supplies the pressure air either to conduit 35 or to conduit 36, depending on the desired direction of rotation of the rotor 3.

Assuming now that the pressure air is guided from the valve 34 into the inlet conduit 36, the pressure air flows into a circular channel 37 closed by circular end face of the rotor end wall 7a, but being swept by an axial conduit 38 in the rotor end wall 7a during rotation of the rotor 3. The air under pressure flows from the pressure conduit 38 into a recess 39 (FIG. 2) of the eccentric reaction surface 6 of the rotor. The recess 39 has a rounded end 39' adjacent the dead-center plane of the vanes 5, as best seen in FIG. 2, and is generally arcuate, widening toward the end of the rotor. The recess 39 is located at the high pressure side formed by expanding working chambers 5a and extends over about one-quarter of the circumference of the inner annular reaction surface 6 of the rotor. Particularly, the deepest part of the recess 39 has an axial length corresponding to about 30 percent of the axial length of the reaction surface 6, so that the outer edges of the vanes 5 still contact 70 percent of the maximum available surface of the reaction surface 6.

At the low pressure side of the vane motor, another recess 40 is provided at the other end of rotor 3, which is mirror-symmetrical to the dead-center plane, and from which the air is discharged. The rounded ends 39', 40' of the recesses 39, 40 are angularly displaced at an angle of about 40°, symmetrically to the dead-center plane of the vanes 5. Pressure air from the recess 40 enters a conduit portion 41a, communicating with the radial conduit 41 having an annular port 42 which is swept by a conduit portion 43a of a central axially extending conduit 43 which passes along the axis of the stator 4 into the discharge conduit 35 which is connected with the control valve 34.

During rotation of the rotor 3, the inner eccentric reaction surface 6 of the rotor 3 moves along the outer edges of the vanes 5. During this operation, the working chambers between adjacent vane 5 expand and transform the energy of the supplied compressed air into a torque acting on the rotor 3. During continuous rotation, the working chambers 5a are contracted so that the low pressure air is discharged, as explained. The arrangement of the conduit for the pressure air and discharged air has the advantage result of reducing and damping the noise produced by the apparatus.

The hammer guide housing 13 is pot-shaped and is provided at its inner surface therefor with an axially extending internal gearing 14. The internal gearing 14 meshes with an external gearing 15 provided on the outer surface of a hammer 16 located in the interior of the hammer guide housing 13 so that the hammer 16 is constrained to rotate with the guide housing 13 during rotation of the latter, while being axially movable with respect thereto. The hammer 16 carries at a front face thereof circumferentially spaced impact cocks 18 which are adapted to cooperate with corresponding impact cocks 19 on an anvil 20 located forwardly of the hammer 16. The anvil 20 is turnably mounted in a bearing in a front end portion of the housing 1 and projects with a tool head 21 of square or polygonal cross-section beyond the housing on which a tool, for instance a socket wrench may be mounted.

A control shaft 22 is coaxially arranged with the impact mechanism formed by the hammer 16 and the anvil 20 and the control shaft 22 is fixed to the anvil 20 for rotation therewith. The control shaft has at its end distant from the anvil 20 a collar 23 with a circumferentially extending axially rising and falling cam face 24 engaged by a ball 25 which is guided in an annular cut-out and an end face of the hammer 16 which faces the can face 24 of the collar 23. On the face thereof opposite the cam face 24, the collar 23 abuts against an axial roller bearing 26 on the bottom wall 10 of the guide housing 13. An extension 27 of the control shaft 22 is mounted in a slide bearing 28 provided in the bottom wall 10 of the guide housing 13. A compression spring 29 located in a space about the control shaft 22 abuts with one end against the anvil 20 and with the other end against the hammer 16. The compression spring 29 biases the hammer 16 to a position in which the cocks 18 on the hammer 16 are out of engagement with the cocks 19 on the anvil 20. At the same time, the spring 29 presses the hammer 16 over the ball 25 against the cam face 24 on the collar 23 of the control shaft 22.

The above-described impact tool will operate as follows: During rotation of the rotor 3, in the manner as described above, the hammer guide housing 13 and therewith the hammer 16 are rotated. Thereby, the control shaft 22 connected to the anvil 20 for rotation is taken along through the friction between the hammer 16 and the ball 25, on the one hand and the ball and the cam surface 24 on the other hand. At the same time, part of the turning moment imparted to the hammer 16 by the vane motor is also transmitted through the compression spring 29 to the anvil 20. In this way the anvil 20 it rotated together with the hammer 16. If the anvil 20 is now arrested by outside forces, for instance if the nut turned thereby encounters resistance, then the friction connection between hammer and anvil will be overcome so that the hammer 16 will rotate relative to the anvil 20 and the control shaft 22 connected to the latter. Thereby, the ball 20 will move on the rising portion of the cam face 24 and move thereby the hammer 16 axially towards the left to an active position, as viewed in FIG. 1, so that the cocks 18 and 19 will engage with each other with an impact to thereby tighten the nut. Since the cam face 24 drops again, the cocks 18 and 19 will be brought again out of engagement, whereafter the cycle will be repeated until the turning resistance imparted from outside onto the anvil and the tool connected thereto is overcome.

The described construction of the rotor 3 which is connected to the guide housing 13 for rotation is characterized by a very large inertia moment due to the relative large radial distance of the rotating masses from the axis of the tool.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of rotary impact tools differing from the types described above.

While the invention has been illustrated and described as embodied in a rotary impact tool, especially an impact wrench, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.
Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can be 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 claims:

1. In a rotary impact tool, especially an impact wrench, a combination comprising a tool housing, drive means in said housing and comprising a central stator and a tubular rotor surrounding said stator; a pot-shaped guide housing in said tool housing and connected to the rotor for rotation therewith, said pot-shaped guide housing having a bottom wall facing said drive means and being rotatably supported on said central stator; a hammer arranged in said guide housing for reciprocating movement relative thereto; and cooperating means on said guide housing and said hammer for connecting the hammer with the guide housing for rotation therewith while permitting axial movement of said hammer relative to said guide housing.

2. A combination as defined in claim 1, wherein said cooperating means comprise an internal gear on said guide housing and an external gear on said hammer meshing with said internal gear.

3. A combination as defined in claim 1, wherein said drive means is constituted by a vane motor operated by compressed air, said hollow cylindrical rotor defining with said stator a working space, said stator being provided with a plurality of radially extending slots, and including a plurality of vanes closer to a said slot and dividing said working space in a plurality of working chambers.

4. A combination as defined in claim 1, wherein said hammer is reciprocatable in said guide housing between an active and an inactive position, and including an anvil turnable mounted in said adjacent stator that end of said hammer which is distant from said drive means and cooperating with said hammer to be turned by the latter in the active position of the latter.

5. A combination as defined in claim 4, and including control means for reciprocating said hammer during rotation thereof with said guide housing, said control means comprising a control shaft coaxially fixed to said anvil for rotation therewith, a collar fixed to said shaft and provided with an axially rising and falling cam face facing the other end of said hammer, a ball riding on said cam face, and spring means for pressing said other end of said hammer against said ball.

6. In a rotary tool, especially an impact wrench, a combination comprising a tool housing, drive means in said housing and comprising a stator and a tubular rotor surrounding said stator; a pot-shaped guide housing in said tool housing, said pot-shaped guide housing having a bottom wall facing said drive means and being rotatably supported on said stator; a hollow cylindrical projection on said rotor extending over said guide housing to support said rotor on said guide housing; a hammer arranged in said guide housing for reciprocating movement relative thereto; and cooperating means on said guide housing and said hammer for connecting the hammer with the guide housing for rotation therewith while permitting axial movement of said hammer relative to said guide housing.

7. A combination as defined in claim 6, wherein said bottom wall of said guide housing has a cylindrical outer surface closely fitted in the inner surface of said hollow cylindrical projection.

8. A combination as defined in claim 6, and including a spline in the region of the free end of said projection for connecting said rotor with said guide housing.

9. In a rotary impact tool, especially an impact wrench, a combination comprising a tool housing, drive means in said housing and comprising a stator and a tubular rotor surrounding said stator; a pot-shaped guide housing in said tool housing and connected to said rotor for rotation therewith, said pot-shaped guide housing having a bottom wall facing said drive means and being rotatably supported on said stator; a hammer arranged in said guide housing for reciprocating movement relative thereto between an active and an inactive position; an anvil turnably mounted on said tool housing adjacent that end of said hammer which is distant from said drive means and cooperating with said hammer to be turned by the latter in the active position; cooperating means on said guide housing and said hammer for connecting said hammer with said guide housing for rotation therewith while permitting axial movement of said hammer relative to said guide housing; control means for reciprocating said hammer during rotation thereof with said guide housing; said control means comprising a control shaft coaxially fixed to said anvil for rotation therewith, a collar fixed to said shaft and provided with an axially rising and falling cam face facing the other end of said hammer, a ball riding on said cam face, and spring means for pressing said other end of said hammer against said ball, an axial thrusts bearing between the side of said collar facing away from said cam face and the bottom wall of said guide housing; and a sleeve bearing in said bottom wall of said guide housing, said control shaft having an extension guided in said sleeve bearing.

10. A combination as defined in claim 9, wherein said axial thrust bearing is a roller bearing.