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Snider

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[54] **AIR OPERATED TOOL**

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[52] **U.S. Cl.** **173/163**, 92/144

[51] **Int. Cl.** **B23b 47/08**

[58] **Field of Search** 92/144; 60/64; 173/163

[56] **References Cited**

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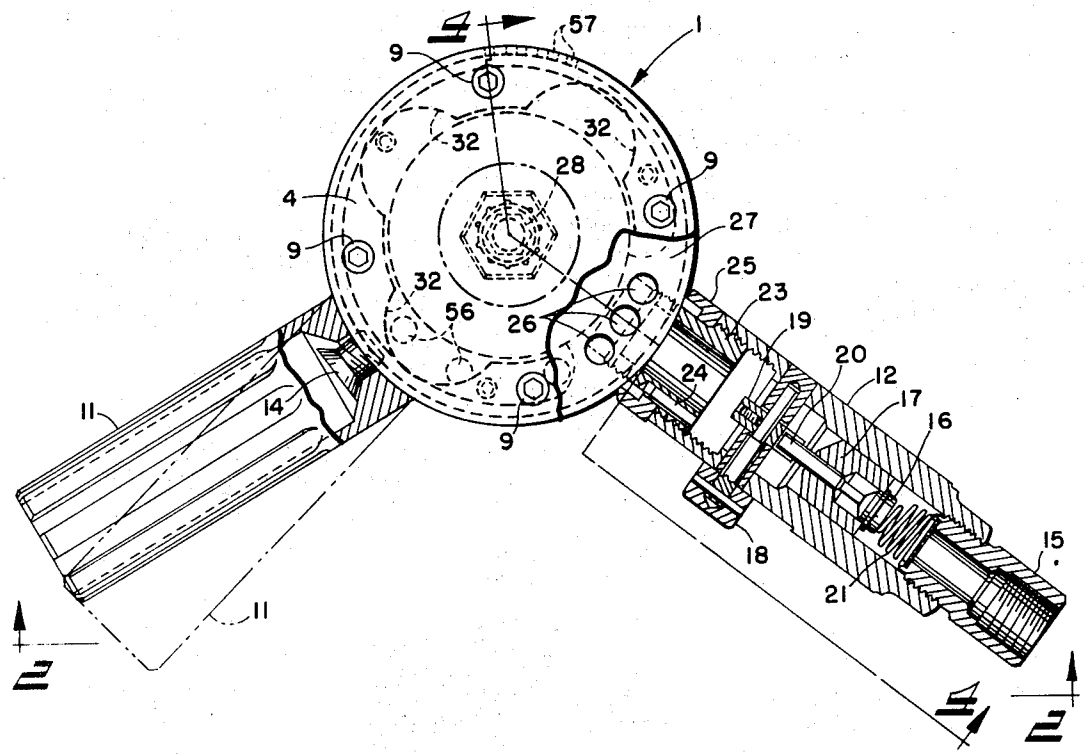
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[57] **ABSTRACT**

An air operated tool characterized in that it is of lightweight strong construction and in that the air motor and surrounding tool housing define therebetween a large size annular exhaust chamber through which air exhausted from the motor passes at low velocity to lateral exhaust passages in the housing thus to provide a tool which operates at low noise level. The tool herein is further characterized in that it has a simplified starting slot arrangement wherein an angularly disposed passage through one stator end plate communicates an inlet chamber of the motor with the starting slot. The tool herein is still further characterized in that the tool housing has two generally radially extending hollow handles by which it is held and manipulated, one handle being secured to the tool housing in either of two angular positions and the other handle containing a manually operated throttle valve and being rotatably adjustable on said housing to position the valve control member to suit the operator's convenience.

11 Claims, 5 Drawing Figures



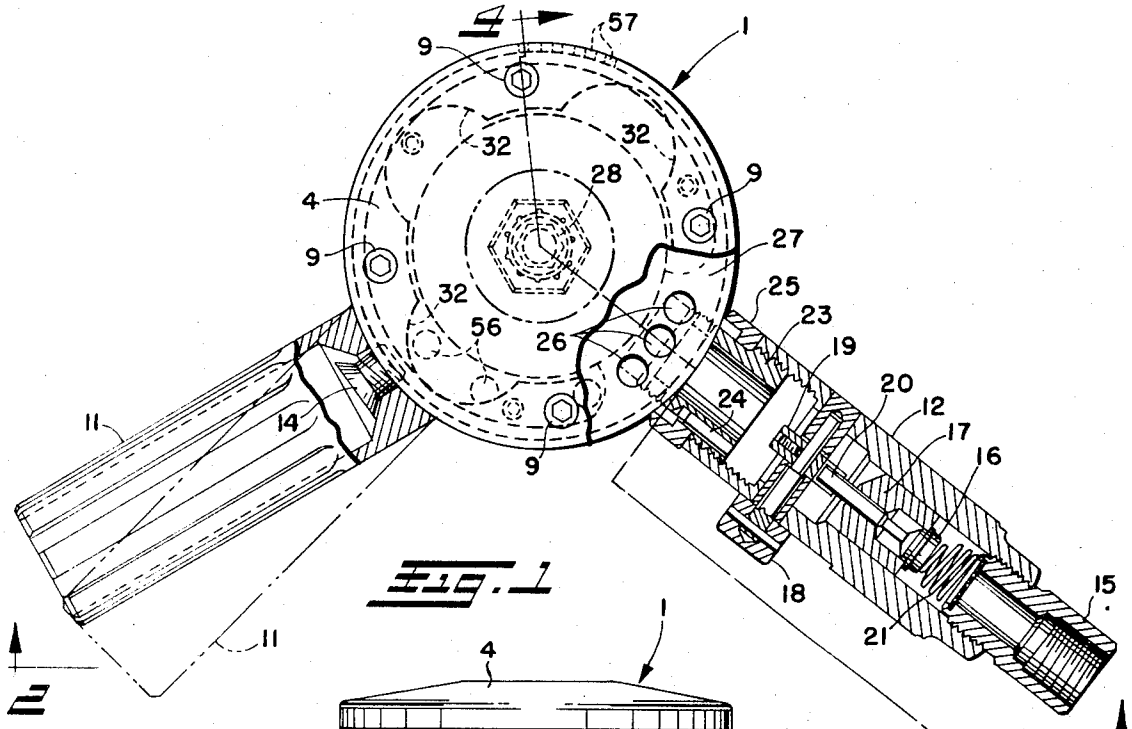


Fig. 1

Fig. 2

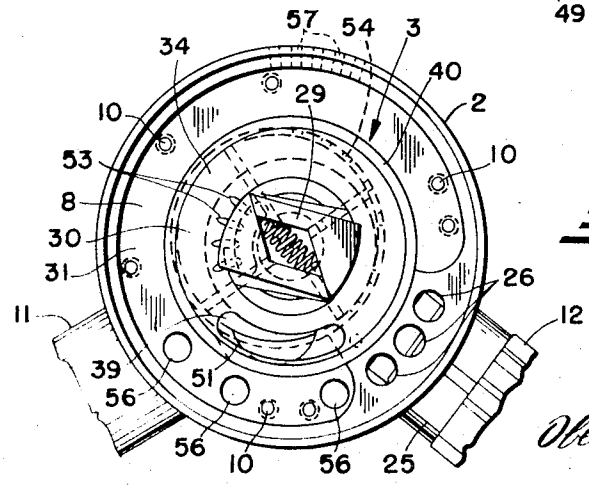


Fig. 3

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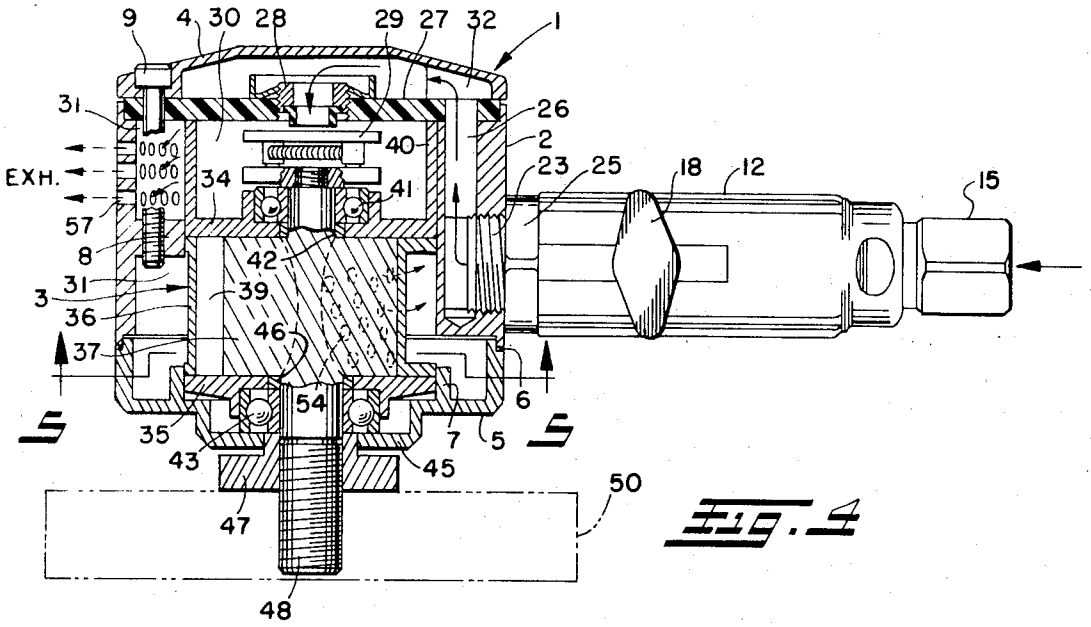


Fig. 4

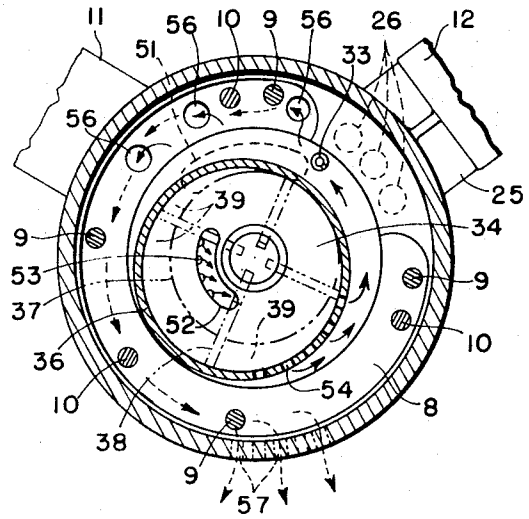


Fig. 5

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AIR OPERATED TOOL

BACKGROUND OF THE INVENTION

Known air operated tools for heavy duty high speed work such as grinding operations are generally quite heavy and thus fatiguing to the operator during prolonged periods of use. Moreover, known air operated tools are noisy in operation due to high velocity pulsating air exhaust from the tool housing.

Aside from the foregoing disadvantages, known air operated tools are of complex structure, and although the provision of starting slots in the air motors are known, communication of the starting slot with the air inlet is generally achieved by drilling radially extending holes in the stator end plate which extend through the main inlet slot of said plate, whereby the radially outer portions of the drilled holes must be filled with plugs as of lead, for example. This is an expensive manufacturing operation and furthermore, such plugs may become dislodged from the radially outer portions of the holes with consequent damage to the motor.

SUMMARY OF THE INVENTION

In contradistinction to the foregoing, the air operated tool herein is of lightweight, strong and simple construction thereby rendering the use of the tool less fatiguing to the operator, enhancing the useful working life of the tool as a whole, and effecting substantial economies in manufacture and assembly.

It is another object of this invention to provide an air operated tool of the character indicated which is rendered quiet in operation by provision of a novel annular, large volume exhaust chamber arrangement between the tool housing and the motor assembly secured therewithin in radially spaced relation to the interior wall of the tool housing, the exhaust from the tool housing being in a direction away from the operator.

Other objects and advantages of the present invention will appear hereinafter.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a top plan view of an air operated tool embodying the present invention, a portion of the top cover plate being broken away to show a portion of the motor hold-down and sealing plate therebeneath and the handles by which the tool is held and manipulated being shown in cross-section;

FIG. 2 is an elevation view as viewed along the line 2—2, FIG. 1;

FIG. 3 is a top plan view with both the top cover plate and the motor hold-down and sealing plate removed;

FIG. 4 is a cross-section view taken substantially along the line 4—4, FIG. 1; and

FIG. 5 is a cross-section view taken substantially along the line 5—5, FIG. 4, the rotor and vanes being shown in phantom lines to illustrate the starting slot and holes in the upper stator end plate.

DETAILED DESCRIPTION OF THE DRAWING

As shown in the drawings, the air operated tool 1 herein comprises a hollow cylindrical housing 2 in which an air motor 3 is clamped between upper and lower end caps 4 and 5 in radially spaced relation to the inner wall of the housing 2, the motor 3 being coaxially clamped in said housing 2 by means of the coaxial pilots 6 and 7 of the lower end cap 5 which have close fits in the lower end of the housing 2 and around the lower end of the motor 3 and by means of the close fit of the upper end of the motor 3 in the bore of the radially inwardly extending web 8 of the housing 2. The caps 4 and 5 are secured to housing 2 by sets of four screws 9 and three screws 10 which are threaded into the web 8 as shown.

The housing 2 has secured thereto the handles 11 and 12 by which the tool 1 is held and manipulated, the handle 11 having an inner cylindrical surface which has its axis offset from the longitudinal axis of the handle 11 and from the center axis of the housing 2 so that the angular position of the handle 11 may be adjusted as shown in full lines or in phantom lines in FIG. 1 by loosening the screw 14 and turning the handle 180° about its longitudinal axis.

The other handle 12 has screwed into the outer end thereof a hose fitting adapter 15 for connection of an air pressure supply hose thereto and has therein a valve member 16 which is adjustably moved toward or away from a seat in bushing 17 by turning the thumb lever 18 of a cam 19 which engages the valve stem 20 to effect movement of the valve member 16 away from its seat or for movement of the valve member 16 toward the seat under the influence of the spring 21. To facilitate mounting of the handle 12 to the housing 2 in different rotary positions about its longitudinal axis thus to position the valve operating lever 18 as desired by the operator, the housing 2 is formed with a left-hand thread which is engaged by the left-hand thread of the bushing 23, and non-rotatably but axially movably keyed to the bushing 23 by pin 24 is a clamp ring 25; the bushing 23 being provided with right-hand threads engaged with the handle 12. To adjust the handle 12 as aforesaid, a wrench is applied on the ring 25 and turned in a clockwise direction as viewed in FIG. 2, thus to loosen the bushing 23 with respect to the housing. While holding the ring member against turning following the loosening operation the handle 12 may be turned clockwise to position the thumb lever wherever desired and then, while holding the handle 12 in its adjusted position, the ring 25 may be turned counterclockwise to advance the bushing 23 and handle 12 radially inward to cause the ring 25 to be tightly frictionally engaged between the flat on the outside of the housing 2 and the inner end of the handle 12.

As best shown in FIGS. 4 and 5, the annular web 8 in the housing 2 is for a portion of its circumference extended upwardly and downwardly to accommodate the three air inlet passages 26 which register with three corresponding passages in the motor hold-down and seal plate 27. The plate 27 fits in a counterbore in the upper end of the housing 2 and has a central opening in which is disposed an adjustable ring 28 which cooperates with the governor 29 as set forth, for example, in the Snider U.S. Pat. No. 3,535,982. The plate 27 is preferably made of fabric reinforced phenolic material which has great strength in compression and which is capable of slight yielding when clamped to the housing 2 by the end cap 4 to form an air-tight seal around the inlet openings 26 and to prevent communication between the inlet and exhaust chambers 30 and

31. The end cap 4 is provided with four scalloped areas 32 to decrease the weight, the scallops 32 being equally spaced as are the screws 9 so that it is immaterial how the cap 4 is mounted on the housing 2 since one of the four scallops 32 will register with the inlet passages 26.

The motor 3 comprises a stator assembly including upper and lower end plates 34 and 35 with a stator 36 clamped therebetween, said stator 36 having an eccentric bore which forms with the rotor 37 and vanes 38 radially slidably carried thereby motor chambers 39 which alternately increase and decrease in volume as the rotor 37 rotates in the stator 36. The end plate 34 and stator 36 are held in predetermined relative rotary positions by the pin 33. The upper end plate 34 has an upwardly extending skirt portion 40 which is adapted to be sealingly clamped against the bottom surface of the motor hold-down and seal plate 27. The upper end plate 34 has a bore in which the outer ring of the upper bearing 41 is closely fitted and the inner ring of said bearing 41 and a spacer ring 42 are clamped between the governor 29 and the rotor 37 together with an intervening spacer ring, the governor 29 being screwed onto the upper shaft portion of the rotor 37.

The lower end plate 35 has a bore in which the outer ring of the lower bearing 43 is closely fitted and is engaged with the inturned flange 45 of the bottom cap 5 when the latter is tightened to exert clamping pressure on the stator assembly between said flange 45 and said plate 27. The inner ring of bearing 43 and a spacer ring 46 is clamped between the rotor 37 and a nut 47, the inner ring of the bearing 43 being a close fit on the lower shaft portion 48 of the rotor 37 which extends axially through the nut 47 and which is adapted to have secured thereto as by means of a nut 49, a grinding wheel 50 or other suitable tool.

As best shown in FIGS. 3 and 5, the end plate 34 has therethrough an arcuate inlet slot 51 whereby air pressure from the inlet chamber 30 admitted into a motor chamber 39 through the inlet slot 51 will cause rotation of the rotor 37 in a clockwise direction as viewed in FIG. 3, or in a counterclockwise direction as viewed in FIG. 5.

To provide for increased torque at low speeds, and to facilitate starting of the motor 3, the underside of the end plate 34 is formed with an arcuate starting slot 52 which is circumferentially offset with respect to the inlet slot 51 and which is disposed nearer to the center of the rotor 37, the end plate 34 having a plurality of small holes 53 drilled angularly therethrough to clear the upstanding boss in which the upper bearing 41 is fitted and to communicate the starting slot 52 with the inlet chamber 30. As seen, air entering the starting slot 52 through the passages 53 will enter the radial slots of the rotor 37 inwardly of the inner edges of the vanes 38 whereby the vanes 38 will be actuated by air pressure into contact with the eccentric bore of the stator 36, whereby high torque may be obtained at low speeds. Moreover, such air pressure behind the inner edges of the vanes 38 enables starting of the motor 3 as soon as the valve 16 is opened.

Where the volume of the motor chambers 39 decreases, the stator 36 is formed with a series of exhaust openings 54 which open into the surrounding large volume exhaust chamber 31 beneath the annular web 8, the web 8 being provided with a plurality of holes 56 therethrough for flow of exhaust air through said passages into the upper portion of the exhaust chamber 31 which is defined between the outer wall of the skirt portion 40 of the upper end plate 34 and the inside wall of the housing 2, whereby exhaust air entering the upper chamber 31 through the holes 56 flows circumferentially toward the multiplicity of exhaust passages 57 through the wall of the housing 2, the latter being located so that the exhaust air is directed away from the operator as best shown in FIG. 1. The continuity of the upper exhaust chamber 31 is interrupted by the portion which contains the three inlet passages 26 and hence circumferentially beyond the exhaust passages 57 in the housing 2 there will be a trapped body of exhaust air which constitutes a cushion to assist in the muffling action of the upper and lower portions of the large volume exhaust chamber 31.

By reason of the dual exhaust chamber 31 construction of great length and relatively great cross-section area exhaust noise is greatly reduced thus to result in a quiet operating air tool 1. The housing 2, end caps 4 and 5, and handles 11 and 12 are preferably made of aluminum alloy or like lightweight metal, and furthermore these parts are of hollow, thin wall, but strong, construction to minimize weight without sacrifice in strength and rigidity. The rotor 37 will usually be fabricated of steel or like strong metal and if it be desired to decrease the weight of the same, axially extending holes may be drilled therein between the vanes 38 and filled with a lightweight plastic or like material.

As known, air motors do not convert all of the energy released by controlled expansion of the compressed air into mechanical motion and therefore the compressed air is exhausted under pressure considerably above atmospheric with the result that the sudden rush of air out of the motor creates sharp objectionable exhaust noises unless muffled, as herein. To reduce this objectionable noise, the muffler herein is designed to allow expansion of the compressed exhaust air more gradually and to keep it confined until the pressure has been lowered nearly to atmospheric. The exhaust puffs are thoroughly intermingled and issue from the housing exhaust holes 57 in a steady low velocity stream. Exhaust mufflers in order to be efficient as sound silencers must decrease the exhaust velocity and should have volumes at least several times the motor displacement. Moreover, in the present case the air space 31 between the housing 2 and the motor 3 except at the web 8 and end cap 5 minimizes transmission of motor 3 vibrations directly to the housing 2.

As an illustrative example, the aggregate area of the stator exhaust holes 5 was about 0.5 in.^{2} whereas the aggregate area of the housing exhaust holes 57 and the aggregate flow area of the holes 56 in the web 8 was somewhat less say, about 0.3 in.^{2} to about 0.35 in.^{2}. In that example the motor 3 displacement was about 1 in.^{3}, whereas the volume of the exhaust chambers 31 was about 18 in.^{3}, i.e. 3 ½ mean diameter with a radial width of nine-sixteenth inch and an axial length of 3 inch.

Another characteristic of the muffler herein which is thought to contribute to its effectiveness in noise level reduction is the devious path of exhaust air flow through the web holes 56 which may be effective to cancel sound waves by interference since the air stream

is broken up into three streams passing through said web holes **56** and said streams again meet in the upper exhaust chamber **31**. Moreover, as the exhaust air flows through the long and large exhaust chambers **31** there is an air pressure drop therealong first across the stator exhaust holes **54**, across the web holes **56** and then across the housing exhaust holes **57**, thus to create some back pressure at the stator exhaust holes **54** for decreased velocity air flow therethrough.

I, therefore, particularly point out and distinctly claim as my invention:

1. An air operated tool comprising a tubular housing having end caps secured thereto; an air motor in said housing comprising a stator assembly clamped between said end caps, and a rotor journaled in said stator assembly and having a shaft portion extending through one end cap for connection of a rotary tool thereto; said housing and motor having inlet and exhaust passages through which air under pressure is supplied to drive said rotor and through which air is exhausted from said motor and housing; said stator assembly being clamped in said housing in radially spaced relation therewithin to form a relatively large volume annular exhaust chamber through which air exhausted from said motor exhaust passage flows to said housing exhaust passage thereby to decrease air velocity and reduce noise during operation of the tool; said housing having a radially extending handle by which the tool may be held and manipulated, said handle having an air control valve therein and a manually operable valve actuating means to control admission of air pressure from a supply source through said handle into said housing inlet passage; and adjusting means rendering said handle rotatably adjustable about its longitudinal axis to position said actuating means as desired; said adjusting means comprising a bushing having threads of opposite hands at its ends respectively in threaded engagement in said housing and in said handle; and ring means axially slidably keyed on said bushing adapted to be frictionally engaged between said housing and said handle to lock said handle in desired rotary position.

2. An air operated tool comprising a tubular housing having end caps secured thereto; an air motor in said housing comprising a stator assembly clamped between said end caps, and a rotor journaled in said stator assembly and having a shaft portion extending through one end cap for connection of a rotary tool thereto; said housing and motor having inlet and exhaust passages through which air under pressure is supplied to drive said rotor and through which air is exhausted from said motor and housing; said stator assembly being clamped in said housing in radially spaced relation therewithin to form a relatively large volume annular exhaust chamber through which air exhausted from said motor exhaust passage flows to said housing exhaust passage thereby to decrease air velocity and reduce noise during operation of the tool; said housing having a first radially extending handle by which the tool may be held and manipulated, said first handle having an air control valve therein to control admission of air pressure from a supply source through said first handle into said housing inlet passage; a second radially extending handle secured to said housing in angularly spaced relation to said first handle; said second handle having a radially inner end portion which conforms to and contacts the outer surface of said housing and which is inclined with respect to the longitudinal axis of said second handle so that said second handle will extend from said housing at different angles according to which of two 180° rotated positions said second handle is secured to said housing; and screw means threaded into said housing operative to clamp said second handle to said housing in either of said 180° rotated positions.

3. An air operated tool comprising a tubular housing having end caps secured thereto; an air motor in said housing clamped between said end caps and comprising a stator assembly including end plates with an intervening stator having an eccentrically disposed bore therethrough; each said end plate having a bore in which the outer ring of a ball bearing is closely fitted, and a rotor having shaft portions closely fitted in the inner rings of the respective ball bearings; one of said shaft portions extending axially through the adjacent end cap and being adapted to have mounted thereon a rotary tool; said rotor having an intermediate radially enlarged and radially slotted portion in the slots of which vanes are radially slidably movable in engagement with said eccentrically disposed bore and defining with said bore motor chambers which alternately increase and decrease in volume as said rotor rotates in said stator; said housing and motor having intercommunicating inlet passages through which air under pressure enters the motor chamber which is increasing in volume; said stator having exhaust passages therethrough leading from the motor chamber which is decreasing in volume as the rotor rotates in said stator; said stator being radially spaced from the interior wall of said housing thus to define a relatively large volume annular exhaust chamber through which air exhausted from said motor must pass before exiting through exhaust passages through the wall of said housing, thus to provide for muffling of air noise; said housing having a radially extending handle by which the tool may be held and manipulated, said handle having an air control valve therein and a manually operable valve actuating means to control admission of air pressure from a supply source through said handle into said housing inlet passage; and adjusting means rendering said handle rotatably adjustable about its longitudinal axis to position said actuating means as desired; said adjusting means comprising a bushing having threads of opposite hands at its ends respectively in threaded engagement in said housing and in said handle; and ring means axially slidably keyed on said bushing adapted to be frictionally engaged between said housing and said handle to lock said handle in desired rotary position.

4. An air operated tool comprising a tubular housing having end caps secured thereto; an air motor in said housing clamped between said end caps and comprising a stator assembly including end plates with an intervening stator having an eccentrically disposed bore therethrough; each said end plate having a bore in which the outer ring of a ball bearing is closely fitted, and a rotor having shaft portions closely fitted in the inner rings of the respective ball bearings; one of said shaft portions extending axially through the adjacent end cap and being adapted to have mounted thereon a rotary tool; said rotor having an intermediate radially enlarged and radially slotted portion in the slots of which vanes are radially slidably movable in engage-

ment with said eccentrically disposed bore and defining with said bore chambers which alternately increase and decrease in volume as said rotor rotates in said stator; said housing and motor having intercommunicating inlet passages through which air under pressure enters the motor chamber which is increasing in volume; said stator having exhaust passages therethrough leading from the motor chamber which is decreasing in volume as the rotor rotates in said stator; said stator being radially spaced from the interior wall of said housing thus to define a relatively large volume annular exhaust chamber through which air exhausted from said motor must pass before exiting through exhaust passages through the wall of said housing, thus to provide for muffling of air noise; said housing having a first radially extending handle by which the tool may be held and manipulated, said first handle having an air control valve therein to control admission of air pressure from a supply source through said first handle into said housing inlet passage; a second radially extending handle secured to said housing in angularly spaced relation to said first handle; said second handle having a radially inner end portion which conforms to and contacts the outer surface of said housing and which is inclined with respect to the longitudinal axis of said second handle so that said second handle will extend from said housing at different angles according to which of two 180° rotated positions said second handle is secured to said housing; and screw means threaded into said housing operative to clamp said second handle to said housing in either of said 180° rotated positions.

5. An air operated tool comprising an open ended tubular housing having a radially inwardly extending annular web between its ends; end caps secured to the ends of said housing by screw means having threaded engagement with said web; an air motor in said housing comprising a stator assembly piloted in said web and clamped between said end caps to define first and second annular chambers on opposite sides of said web, and a rotor journaled in said stator assembly and having a shaft portion extending through one end cap for connection of a rotary tool thereto; said housing and motor having an inlet passage through which air under pressure is supplied to drive said rotor; said motor having exhaust passages opening into said first chamber; said web having passages therethrough which are circumferentially displaced with respect to said motor exhaust passages for flow of exhaust air circumferentially in said first chamber and through said web passages into said second chamber; said housing having exhaust passages opening into said second chamber in circumferentially spaced relation to said web passages for flow of exhaust air circumferentially in said second chamber; said first and second chambers forming a relatively large volume exhaust chamber through which air exhausted from said motor exhaust passages follows a devious path to said housing exhaust passages thereby to decrease air velocity and to reduce noise during operation of the tool.

6. The tool of claim 5 wherein said second chamber has an axially extending partition from said web to the other end cap circumferentially beyond said housing exhaust passages to form a pocket for trapping exhaust air.

7. The tool of claim 5 wherein said second chamber has an axially extending partition from said web toward the other end cap, said partition containing said housing inlet passage; and wherein a motor engaging and sealing plate is clamped by the other end cap to said housing and to the adjacent end of said motor, said plate having radially offset passages therethrough which are intercommunicated with each other by a space between said plate and other end cap and which respectively register with said housing inlet passage and with said motor inlet passage.

8. An air operated tool comprising an open ended tubular housing having a radially inwardly extending annular web between its ends; end caps secured to the ends of said housing by screw means having threaded engagement with said web; an air motor in said housing piloted in said web and clamped between said end caps to define first and second annular chambers on opposite sides of said web; said motor comprising a stator assembly including end plates with an intervening stator having an eccentrically disposed bore therethrough; each said end plate having a bore in which the outer ring of a ball bearing is closely fitted, and a rotor having shaft portions closely fitted in the inner rings of the respective ball bearings; one of said shaft portions extending axially through the adjacent end cap and being adapted to have mounted thereon a rotary tool; said rotor having an intermediate radially enlarged and radially slotted portion in the slots of which vanes are radially slidably movable in engagement with said eccentrically disposed bore and defining with said bore motor chambers which alternately increase and decrease in volume as said rotor rotates in said stator; said housing and motor having intercommunicating inlet passages through which air under pressure enters the motor chamber which is increasing in volume; said stator having exhaust passages therethrough leading from the motor chamber which is decreasing in volume as the rotor rotates in said stator to said first chamber; said web having passages therethrough which are circumferentially displaced from said stator exhaust passages for flow of exhaust air from said first chamber into said second chamber; said housing having exhaust passages therethrough from said second chamber which are circumferentially displaced from said web passages; said first and second chambers defining a relatively large volume tortuous annular exhaust chamber through which air exhausted from said motor must pass before exiting through said housing exhaust passages, thus to provide for muffling of air noise.

9. The tool of claim 8 wherein said housing inlet passage includes a lateral inlet opening intersected by an axial passage which extends axially toward one end cap within an axial partition in said second chamber; wherein a motor hold-down and seal plate is clamped between said one end cap and said housing and has an opening which registers with said axial passage; said one end cap defining with said plate a chamber through which air passes to a central opening in said plate which leads to said motor inlet passage which comprises an inlet chamber within a shirt portion of the adjacent end plate which extends axially into engagement with said plate, and an inlet slot through said one end plate which leads into motor chamber.

10. The tool of claim 9 wherein said one end plate has a starting slot on the axially inner side thereof which opens to admit air to act on the radially inner edges of said vanes to urge them radially outwardly into engagement with said eccentric bore thus to provide increased torque at low speeds; said one end plate having an angularly disposed passage communicating said starting slot with said inlet chamber.

11. The tool of claim 8 wherein said second chamber has an axial partition circumferentially beyond said housing exhaust passages whereby exhaust air is trapped to serve as a cushion and silencer.

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