

[54] **SMALL DIAMETER CYLINDRICAL AIR MOTOR FOR DRIVING GRINDERS AND THE LIKE**

[76] Inventor: **Masakazu Kakimoto**, 78, Azaosshima Ooazaasda, Nishincho, Aichi-gun, Aichi-ken, Japan

[22] Filed: **July 25, 1972**

[21] Appl. No.: **274,905**

[30] **Foreign Application Priority Data**

Feb. 19, 1972 Japan..... 47-17424

[52] U.S. Cl..... **418/15, 418/47, 418/70, 418/181, 418/270, 51/134.5 F, 138/46**

[51] Int. Cl. ... **F01c 21/00, F04c 15/00, F04c 29/00**

[58] Field of Search..... **418/15, 47, 70, 181, 270; 415/503; 51/134.5 F; 138/43, 46; 251/122; 173/163**

[56] **References Cited**

UNITED STATES PATENTS

1,007,664	11/1911	Baker.....	138/46
1,041,040	10/1912	Darlington.....	418/47
3,129,642	4/1964	Sorensen et al.	173/163
3,190,183	6/1965	Walker et al.	418/270
3,439,422	4/1969	Doeden et al.	415/503

FOREIGN PATENTS OR APPLICATIONS

997,904	8/1952	France.....	173/163
842,253	7/1960	Great Britain.....	418/270

Primary Examiner—Carlton R. Croyle

Assistant Examiner—John J. Vrablik

Attorney, Agent, or Firm—McGlew and Tuttle

[57] **ABSTRACT**

The air motor has substantially the size of a standard

fountain pen and includes an extruded outer cylindrical casing formed with a circular cross-section eccentric inner surface which has annular grooves in its forward part and a smooth surface, substantially coincident with the bases of the grooves, in its rear part. The grooves constitute air supply and exhaust passages, a retainer groove and a pin groove. A front retainer closes the forward end of the casing and has a tongue projecting into the retainer groove to maintain a predetermined angular orientation in the casing, and a rear retainer is seated against the ribs defining the grooves in the forward portion of the casing and has a tongue projecting into the retainer groove to maintain a relative angular orientation with respect to the front retainer. A motor cylinder is mounted in the casing between the two retainers and has air supply and exhaust ports communicating with the air supply and exhaust passages, respectively. A vane type rotor is rotatably supported in the two retainers, through bearings, and is eccentric to the motor cylinder. The forward end of the rotor is formed with a shaft by means of which a grinder or another tool can be secured to the rotor. The portion of the casing rearwardly of the rear retainer constitutes an air supply and control chamber in which there is an air filter means, and the air passing through the filter means flows through supply passages in the rear retainer into the air supply passage. A connection is provided at the rear of the casing for connecting the air motor to a source of air under pressure, and a manually operable grip threaded on this connection controls the supply of air under pressure to the supply and control chamber. In a modification of the air motor, the exhaust air flows rearwardly along the exterior surface of the motor cylinder and through sound absorbing means to exhaust ports leading to the atmosphere or to an exhaust line.

9 Claims, 10 Drawing Figures

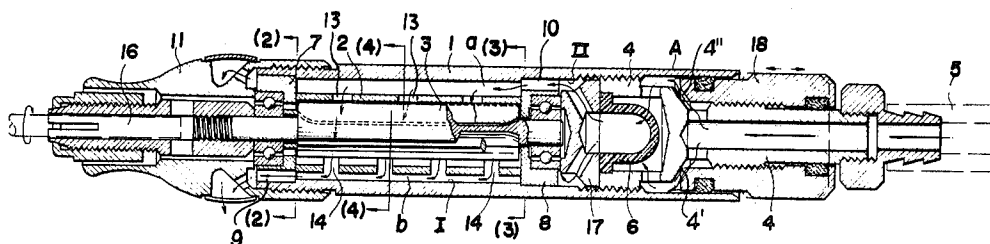


Fig-1

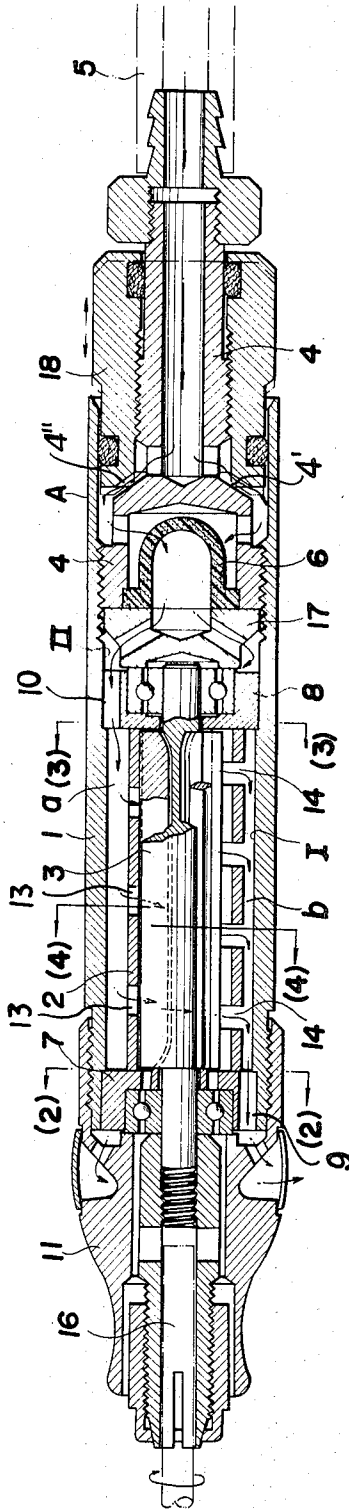


Fig-2

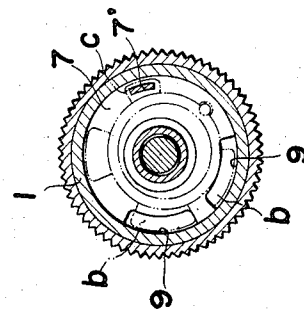


Fig-3

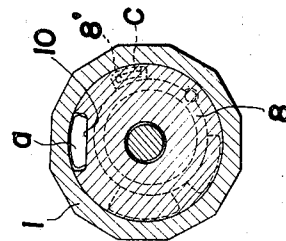


Fig-4

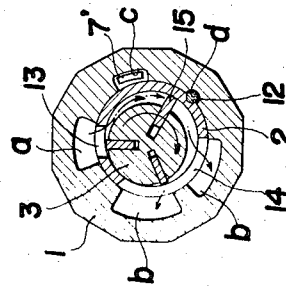


Fig-5

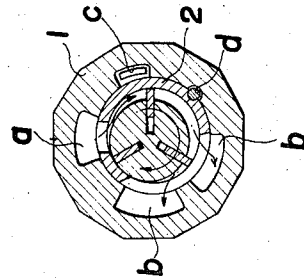


Fig - 6

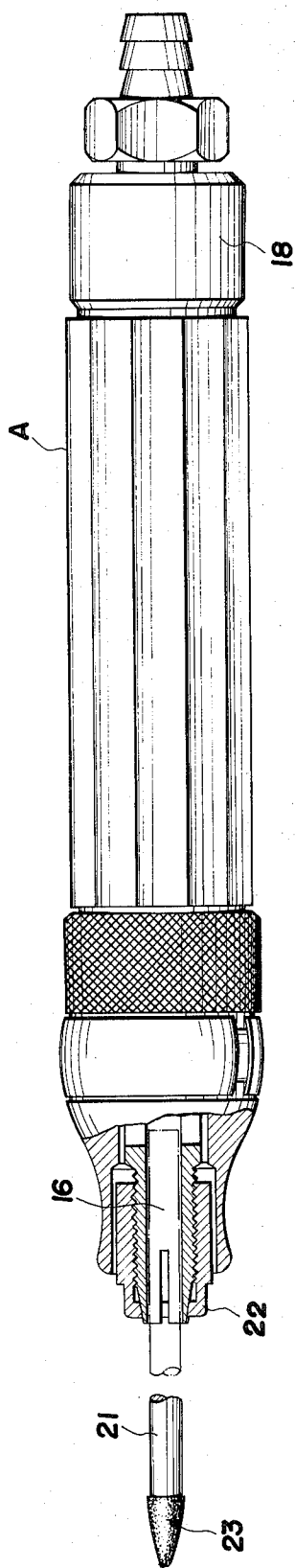
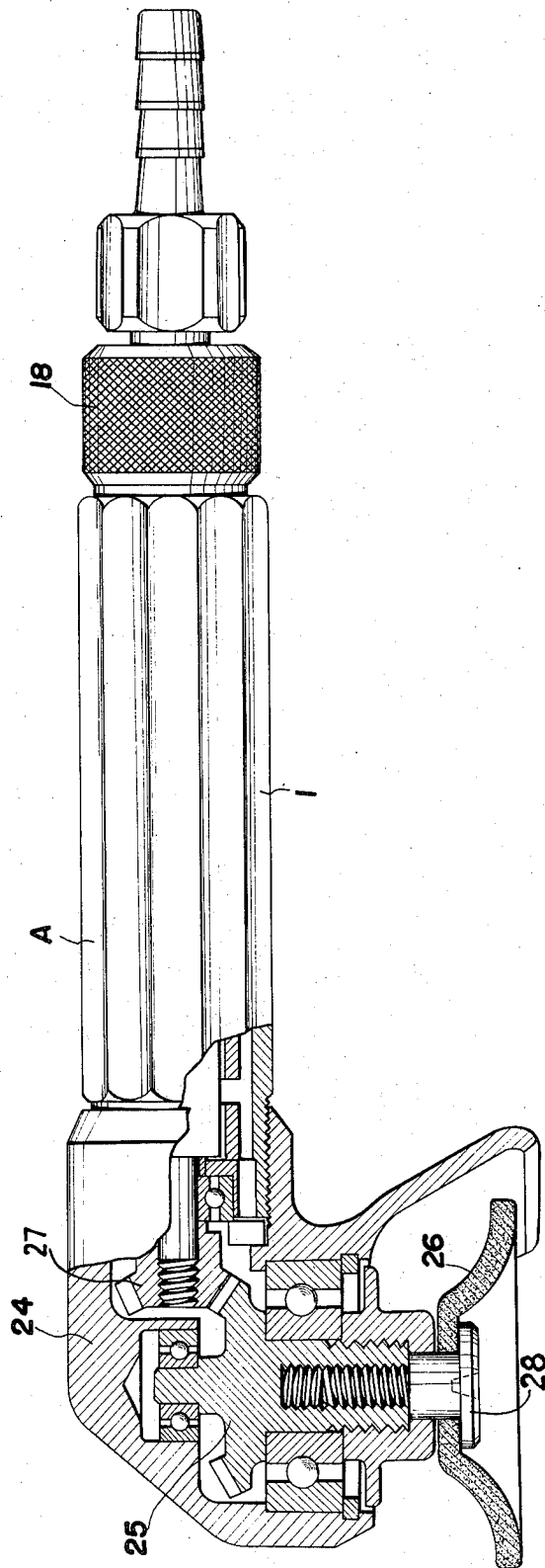
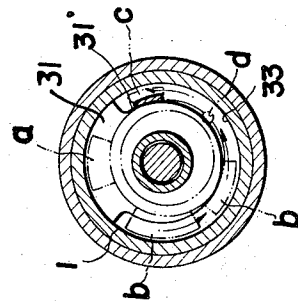
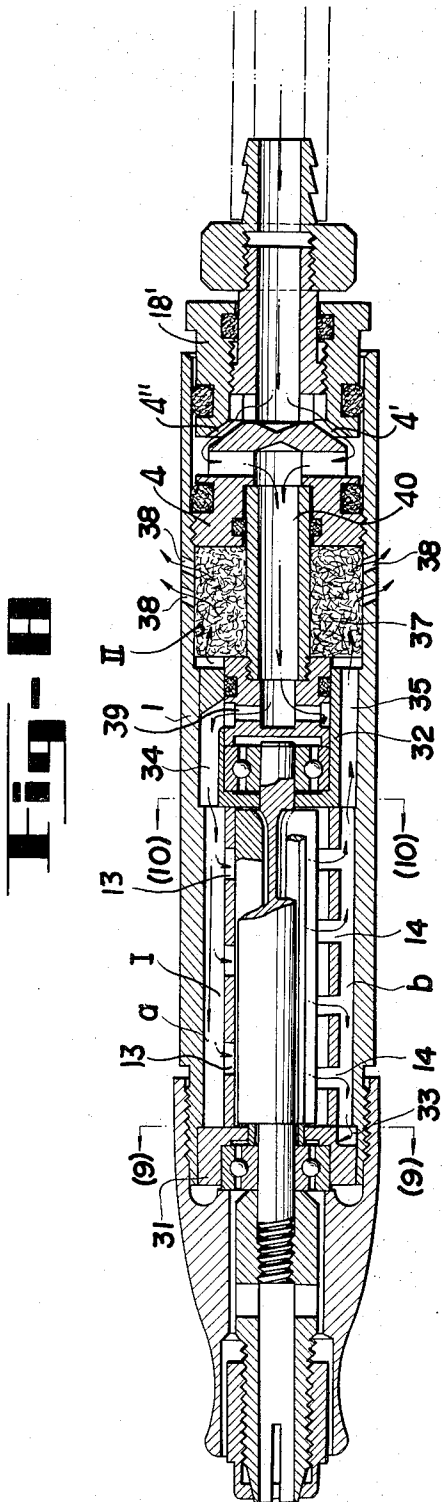


Fig - 7





SMALL DIAMETER CYLINDRICAL AIR MOTOR FOR DRIVING GRINDERS AND THE LIKE

FIELD AND SUMMARY OF THE INVENTION

This invention relates to air motors of the rotary type operated by compressed air, and to an air-operated grinder operable by the air motor.

The objective of the invention is to provide an air motor of high efficiency which can be manufactured in mass production or at a reduced cost.

Another objective of the invention is to provide an air motor of small size, only a little larger than a standard fountain pen, and which is extremely convenient to use.

A further object of the invention is to provide a small-size grinder operatively connected to the small-size air motor.

For an understanding of the principles of the invention, reference is made to the following description of typical embodiments thereof as illustrated in the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. 1 is an axial sectional view of the air motor;

FIG. 2 is a cross-sectional view taken on the line 2—2 of FIG. 1;

FIG. 3 is a cross-sectional view taken on the line 3—3 of FIG. 1;

FIG. 4 is a cross-sectional view taken on the line 4—4 of FIG. 1;

FIG. 5 is a cross-sectional view similar to FIG. 4 but illustrating the rotor in a different angular position;

FIG. 6 is a side elevation view, partly in section, illustrating one form of air grinder connected to the air motor;

FIG. 7 is a view similar to FIG. 6 illustrating another form of grinder connected to the air motor;

FIG. 8 is a view, similar to FIG. 1, illustrating a modified form of the air motor;

FIG. 9 is a cross-sectional view taken on the line 9—9 of FIG. 8; and

FIG. 10 is a cross-sectional view taken on the line 10—10 of FIG. 8.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring first to FIGS. 1 through 5, an air motor embodying the invention includes a cylindrical casing 1, a motor cylinder 2, and a rotor 3 rotatable in cylinder 2. The motor further includes an air supply valve member 4 having a connection member for connecting the air motor through a hose 5, indicated in dot and dash lines, to a source of air under pressure. The air flows from valve member 4 through an filter 6 and through air supply ports in a back retainer 8. From the ports in back retainer 8, the air flows through an air supply passage *a* and through air supply ports 13 into motor cylinder 2 to drive the vaned rotor 3 which is eccentric with respect to motor cylinder 2 and carries radially displaceable vanes or blades 15. Air leaves motor cylinder 2 through air ports 14 and flows through air passages *b*, *b* to exhaust ports 9 in front retainer 7, from which the exhaust air is discharged to atmosphere. As stated, the air motor, generally indicated at A, is a small size air motor, having dimensions only slightly larger than those of a standard fountain pen.

Tubular or cylindrical casing 1 is formed of a suitable material, such as aluminum, by extrusion, during which the eccentric circular cross-section inner surface of casing 1 is formed with longitudinal grooves *a*, *b*, *b*, *c*, and *d*, the grooves being spaced angularly from each other. After the extrusion operation, the rear half of the casing 1 is machined to remove the ribs defining the longitudinal grooves, so as to have a relatively smooth inner surface with an inner diameter slightly larger than the base diameter of the longitudinal grooves.

Longitudinal groove *a* constitutes an air supply passage and longitudinal grooves *b* constitute exhaust passages. Groove *c* is a locking or retaining groove, and groove *d* is a pin groove for receiving a retaining pin. Front retainer 7 is seated against a shoulder at the forward end of casing 1, and rear retainer 8 is seated at a shoulder formed by the machining of the rear half of the casing 1. Rear retainer 8 divides the casing into a front motor chamber I and a rear air supply and control chamber II. Chamber I is provided with the longitudinal grooves *a*, *b*, *b*, *c*, and *d*, and chamber II does not have any grooves.

Front and back retainers 7 and 8 are provided with respective projecting tongues 7' and 8' engaged in retainer or locking groove *c*, so as to maintain a predetermined angular relation between the front and back retainers. In this predetermined angular relation, exhaust ports 9, 9 of front retainer 7 are aligned with respective exhaust grooves *b*, while the front ends of grooves *a*, *c*, and *d* are blocked or closed by front retainer 7. In the predetermined angular relation orientation, the air supply port 10 in back retainer 8 is aligned with air supply passage or groove *a*, whereas the rear ends of grooves *b*, *b*, *c*, and *d* are closed by back retainer 8. Front retainer 7 and back retainer 8 mount anti-friction bearings which rotatably support the motor rotor 3, and front retainer 7 is maintained in position by a front cover 11 threaded on to casing 1. Back retainer 8 is maintained in position by the valve member 4 threaded into casing 1 and this valve member also retains filter 6 clamped in position.

The motor cylinder 2 is disposed in the front motor chamber I, and clamped between the front retainer 7 and a rear retainer 8. Motor cylinder 2 is retained in a predetermined orientation by means of a pin 12 engaged in the longitudinal groove *d* and in a longitudinal groove in the outer surface of motor cylinder 2. In this predetermined orientation of motor cylinder 2, axially spaced air supply ports 13 are in communication with air supply passage or groove *a*, and axially spaced exhaust ports 14 are in communication with both exhaust grooves or passages *b*.

As mentioned, rotor 3 is rotatably mounted in the anti-friction bearings in front retainers 7 and back retainer 8, in such a fashion that it rotates eccentrically in motor cylinder 1. Also as mentioned, rotor 3 has the radially reciprocable blades 15 mounted therein. A drive shaft 16 extends from the front end of rotor 3 to project outwardly of the front end of the motor for connection to a grinder or the like to be driven by the motor.

The valve member 4 retains back retainer 8 in position through the medium of a ported plug 17 engaged between valve member 4 and back retainer 8. The filter 6 is located in the path of air supply from hose 5 into the air supply and control chamber II. A manually operable grip 18 is threaded onto valve member 4 so that

its inner end may be displaced axially relative to the valve seat 4' on valve member 4 to control the cross sectional areas of air supply ports 4''. It will be noted that manually operable grip 18 extends rearwardly from the rear end of casing 1.

To operate the motor, the air hose 5 is connected to a source of air under pressure, and grip 18 is manually turned to open the air flow ports 4''. Air under pressure then flows through the interior of valve member 4 and through air ports 4'' to flow through filter 6 and the ports or plugs 17 to the air supply port 10 in rear retainer 8. The air flows into air supply passage or groove *a* and through inlet ports 13 in with the interior of motor cylinder 2 where it acts on blades 15 to rotate rotor 3. The air is discharged from motor cylinder 2 through exhaust ports 14 into exhaust passages or grooves *b* and then is discharged to atmosphere through ports 9, 9 in front retainer 7. Thus, rotor 3 rotates to rotate the shaft 16.

Referring to FIGS. 6 and 7, as shown in FIG. 6, the air motor A is connected to operate a grinder by inserting the grinder shaft 21 into shaft 16 and retaining the grinder shaft in position by means of chuck 22. When the air motor is operated, a grinding stone 23 at the tip of the shaft 21 is rotated through shaft 16 and shaft 21.

In the embodiment of the invention shown in FIG. 7, a grinder housing 24 is screwed onto the front end of air motor A. A bevel gear 27 secured to the output shaft of motor A meshes with a bevel gear 25 which is rotatably mounted in housing 24 to rotate about an axis perpendicular to the axis of the output shaft of motor A. A grinding disc 26 is secured to the hub of bevel gear 24 by a headed retaining screw or bolt 28. As indicated in FIG. 7, the manually operable grip 18 may be knurled if desired.

In the embodiment of the invention shown in FIGS. 8, 9 and 10, the casing 1 is formed essentially the same as is the casing 1 of the embodiment of the invention shown in FIGS. 1 through 5. That is, the air supply groove *a*, the air exhaust grooves *b*, the retainer or locking groove *c* and the pin groove *d* are formed only in the front half or motor chamber of the casing, and the rear half or supply or control chamber of the casing does not have these grooves. Front retainer 31 and back retainer 32 are formed with respective tongues 31' and 32' extending into retainer groove *c* to lock the retainers with a predetermined relative angular orientation. The motor cylinder 2, rotor 3, and control valve member 4, together with manually operable grip 18' are essentially the same as in the embodiment of the invention as shown in FIGS. 1 through 5, so that further description thereof is not believed necessary.

In this embodiment of the invention, the rearwardly facing surface of front retainer 1 is formed with an arcuate groove 33 interconnecting the forward ends of the two exhaust passages *b* with the retainer passage *c*. Front retainer 31 blocks the forward ends of air supply groove or passage *a* and pin groove *b*.

Back retainer 32 is formed with an air supply port 34 communicating with the air supply passage *a*, and supplied with air under pressure through radial passages 39 communicating with a supply pipe 40 in turn communicating with the valve member 4 having the valve seating surface 4' cooperating with grip 18' to define the ports 4''. Back retainer 32 is also formed with two exhaust ports 35 each communicating with a respective air ex-

haust passage *b*, and the forward surface of back retainer 32 is formed with an arcuate groove 36 interconnecting the rear ends of the two exhaust passages *b* and the retainer groove *c*.

As in the embodiment of the invention shown in FIGS. 1 through 5, back retainer 32 divides casing 1 into a front motor chamber and the rear air supply and control chamber. The rear air supply and control chamber, in the embodiment of the invention shown in FIGS. 8, 9, and 10, contains a sound arrester 37, and is formed with the exhaust ports 38 through the wall of casing 1. While exhaust ports 38 discharge to atmosphere, the design can be changed so that the exhaust air is discharged when exhaust pipe or hose communicating with ports 38.

As distinguished from the embodiment of the invention shown in FIGS. 1 through 5, in the embodiment of the invention shown in FIGS. 8, 9, and 10, the air discharged through exhaust ports 14 of motor cylinder 2 flows rearwardly through exhaust passages or grooves *b*, with part of the exhaust air flowing into arcuate groove 33 and then rearwardly through retainer groove *c*. At the back retainer 32, the air flowing through exhaust grooves or passages *b* and that by-passed through retainer groove *c* flows into arcuate passage or groove 36 and thence through discharge port 35 and arrester 37 to be discharged through exhaust ports 38 in casing 1. Thus, the retainer groove *c* serves as a by-pass exhaust passage, and it is also possible to provide by-pass exhaust passages or grooves in addition to retainer groove *c*.

In the embodiment of FIGS. 8, 9, and 10, the air discharged from motor cylinder 2 flows rearwardly over the outer surface of the cylinder, thus preventing overheating of the cylinder due to the high speed rotation of rotor 3. Additionally, the arrester 37 is very useful in preventing or reducing noise during operation.

With the present invention and with the inner surface of cylindrical or tubular casing 1 formed with the longitudinal grooves for air supply and exhaust, stop or retainer, and the like, the supply and exhaust passages and the others are formed as parts of the casing and are formed at the same time as the casing is formed by extrusion. Thus, the air motor of the present invention overcomes the shortcomings of conventional air motors in which the cylinder is molded and formed with an extremely complicated exterior surface. That is to say, that the present invention enables both the casing 1 and the motor cylinder 2 to be manufactured by mass production methods and produced at the lowest cost.

As the air supply and the exhaust passages are shaped in the form of grooves, the air under pressure flowing through these passages flows quite smoothly with little resistance. As a result, the driving force of the rotor can be greatly increased with a corresponding great increase in the efficiency of the motor.

Moreover, as the interior of tubular casing 1 is divided into two chambers, namely the front motor chamber and the rear air supply and control chamber with the valve member 4, the air motor A can be a little larger in size than the standard fountain pen. As the control of the air flow, including fine adjustment of the air flow, is effected by rotating the grip 18 or 18', the casing 1 can be handled manually thus enabling elaborate grinding work to be performed efficiently. The ad-

vantages in using the air motor of the present invention cannot be over emphasized.

As the air supply and control chamber is provided with a filter through which the compressed air flows through the air supply passage, the motor cylinder 2 can be prevented from becoming filled with dust, so that a high efficiency can be maintained for many hours.

While specific embodiments of the invention have been shown and described in detail to illustrate the application of the principles of the invention, it will be understood that the invention may be embodied otherwise without departing from such principles.

What is claimed is:

1. An air motor comprising, in combination, a tubular casing defining a relatively elongated tubular casing having a circular cross-section inner surface which is eccentric to the axis of said casing and which is formed with angularly spaced longitudinal grooves extending through at least a portion of the length of said casing and defining air supply and exhaust passage means; means dividing the interior of said casing into a front motor chamber having said grooves therein and a rear air supply and control chamber; a tubular motor cylinder in said motor chamber having a smooth cylindrical outer surface engaging the circular cross-section inner surface of said casing and having radial ports communicating with said air supply and exhaust passage means; an air pressure rotated cylindrical rotor rotatably mounted in said motor cylinder; a shaft projecting from the front end of said rotor for connection to a tool to be driven by said motor; said dividing means having ports connecting said supply and control chamber to said air supply passage means; exhaust port means connecting said exhaust passage means to atmosphere; a connection at the rear of said casing for connecting said air motor to a source of air under pressure; and manually operable control valve means controlling communication between said air supply and control chamber and said connection.

2. An air motor, as claimed in claim 1, in which said grooves defining said air supply and exhaust passage means are formed in said inner surface in portions thereof spaced circumferentially from the zone of minimum eccentricity thereof.

3. An air motor, as claimed in claim 1, including a filter in said air supply and control chamber and interposed between said control valve means and said ports in said dividing means.

4. An air motor, as claimed in claim 1, in which said manually operable control valve means comprises a first member formed with a valve seat; and a second

member threaded on said first member and projecting from the rear end of said casing, said second member having an inner end cooperating with said valve seat to provide valve passages; the cross sectional area of said valve passages being variable by rotation of said second member to adjust the position of its inner end relative to said valve seat.

5. An air motor, as claimed in claim 1, including a front retainer positioned in the front end of said casing and closing the forward end of said air supply passage means and having exhaust port means communicating said exhaust passage means to atmosphere; and a rear retainer, constituting said dividing means, closing the rear end of said exhaust passage means and having an air supply port communicating said air supply passage means with said control valve means.

6. An air motor, as claimed in claim 5, in which each of said front and rear retainers has a tongue projecting into one of said grooves and retaining said front and rear retainers with a predetermined relative angular orientation.

7. An air motor, as claimed in claim 6, including a pin engaged in one of said grooves and engaged with said motor cylinder and maintaining a predetermined angular orientation of said motor cylinder.

8. An air motor, as claimed in claim 1, including a front retainer mounted in the front end of said casing and closing the front end of said air supply passage means; a rear retainer constituting said dividing means and formed with a port communicating said air supply passage means with said control valve means; said longitudinal grooves including a retainer groove and each of said front and rear retainers having a tongue projecting into said retainer groove to maintain a predetermined angular orientation of said front and rear retainers; said grooves including a single air supply passage and plural exhaust passages; said front retainer being formed with an arcuate groove interconnecting the front ends of said exhaust passages and said retainer groove; said rear retainer being formed with an arcuate groove interconnecting said exhaust passages and said retainer groove, and being formed with an exhaust port communicating with the arcuate groove therein; and exhaust port means formed in said casing in said air supply and control chamber and communicating with the exhaust port in said rear retainer.

9. An air motor, as claimed in claim 8, including a sound arrester in said air supply and control chamber and interposed between the exhaust port in said rear retainer and said exhaust port means in said casing.

* * * * *