

[54] PNEUMATIC TOOL

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[22] Filed: June 29, 1971

[21] Appl. No.: 157,933

[52] U.S. Cl. 173/163, 128/305, 415/503, 418/15

[51] Int. Cl. A61b 17/32, A61c 1/02

[58] Field of Search 173/163, 169; 128/303, 305; 415/503; 32/26; 251/149.6; 418/15

[56] References Cited

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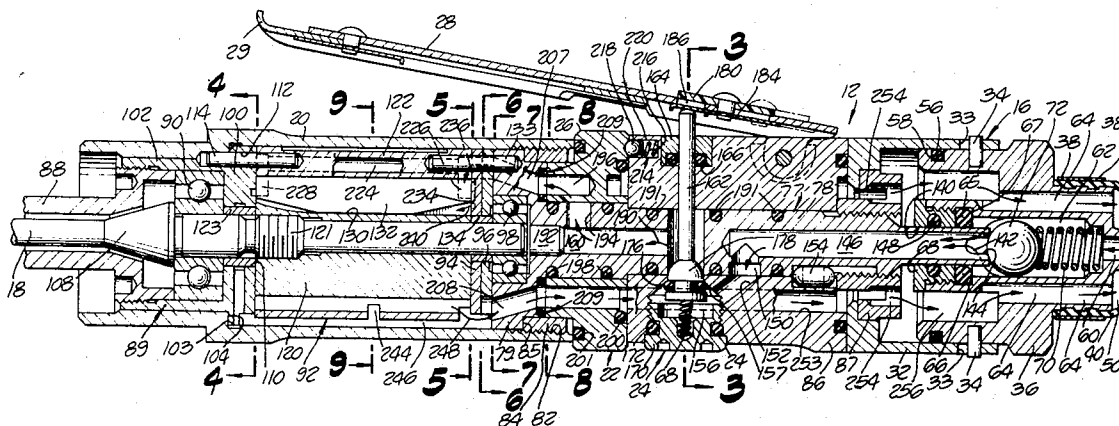
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Primary Examiner—Ernest R. Purser
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[57] ABSTRACT

A pneumatically operated surgical tool for driving various types of surgical attachments and cutters comprising a hand-held instrument which may be interconnected with a pneumatic supply and exhaust conduit for conducting gases under pressure to and away from the instrument. The hand-held instrument comprises, in coaxial alignment, a spindle rotatably driven by a pneumatic motor and a gas channeling conduit for channeling gases from the supply conduit to the pneumatic motor. Coarse and fine control valves for regulating the direction and speed of rotation of the pneumatic motor are structurally supported by the gas channeling conduit. The pneumatic supply and exhaust conduit is provided with a closure valve which automatically prevents a flow of gas therethrough when it is disconnected from the hand-held instrument.

20 Claims, 14 Drawing Figures



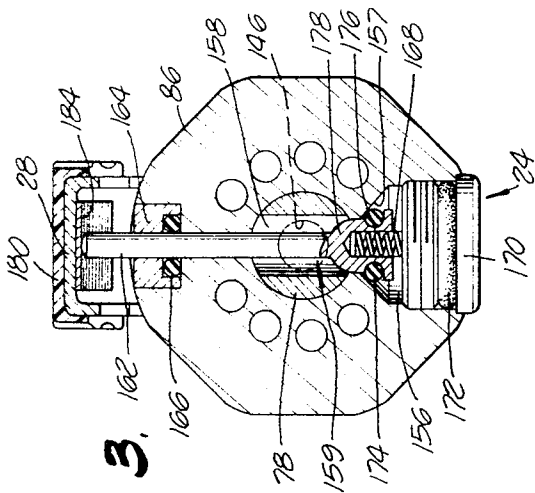


FIG. 3.

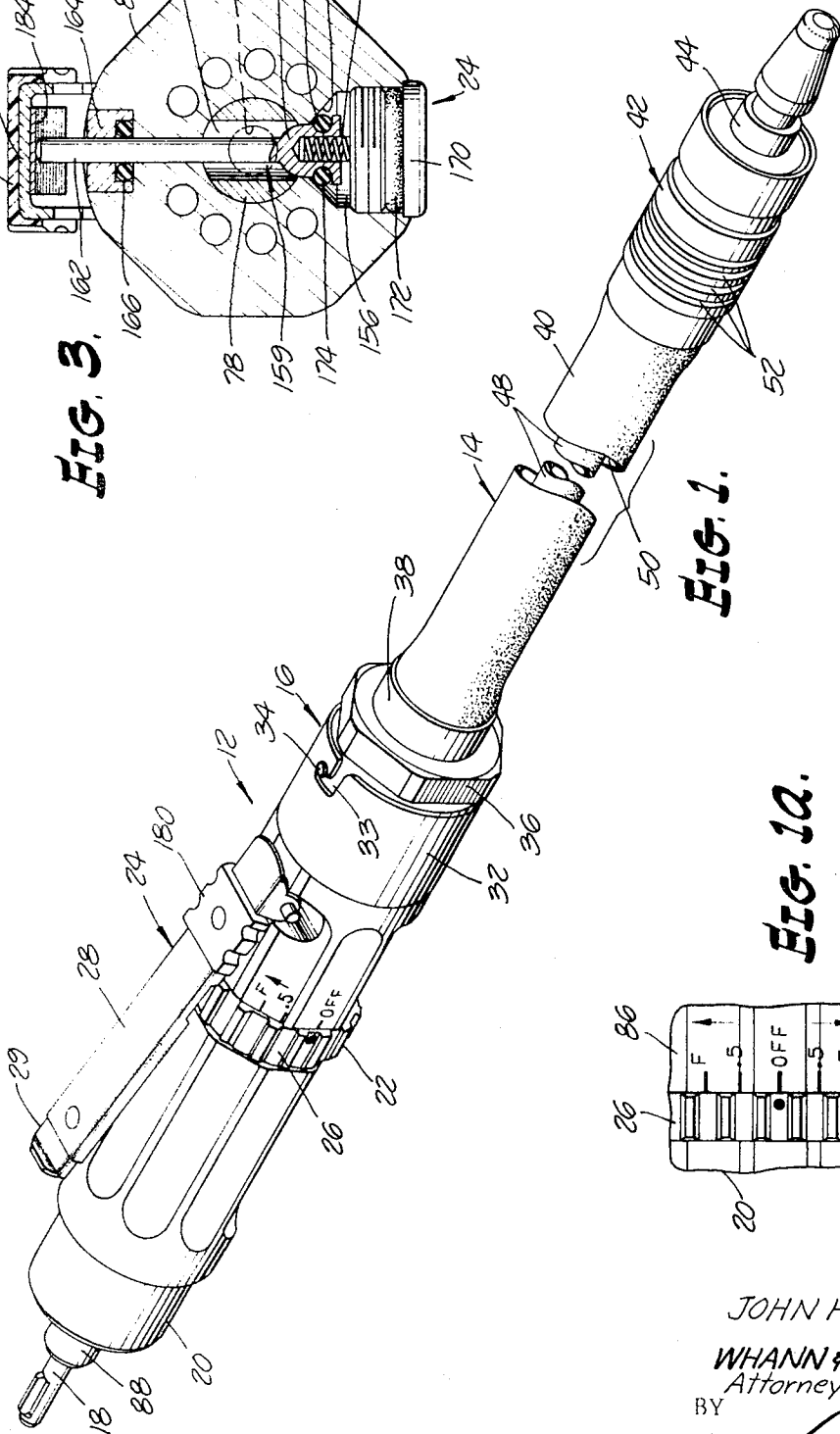


FIG. 1.

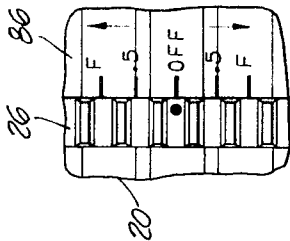


FIG. 1A.

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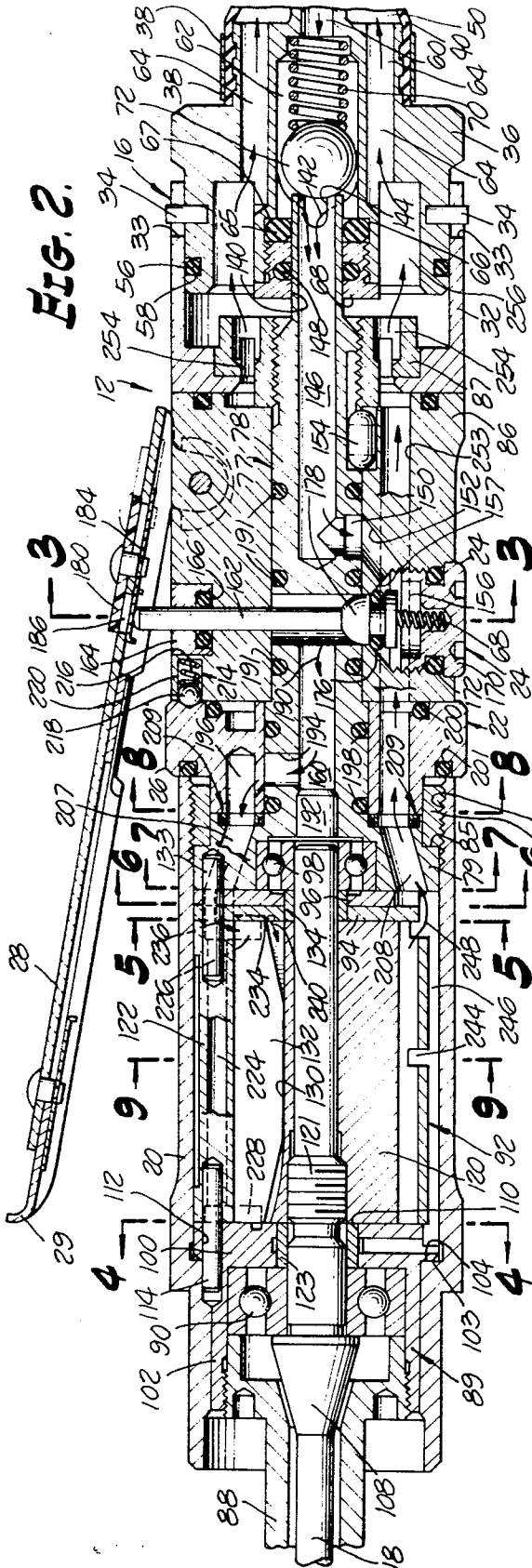


FIG. 2b.

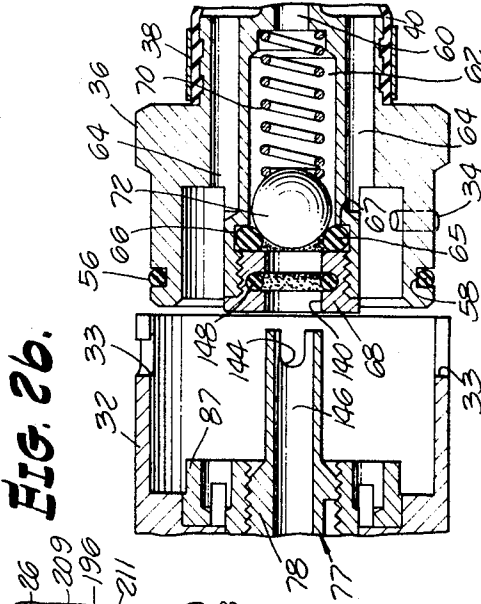


FIG. 2a.

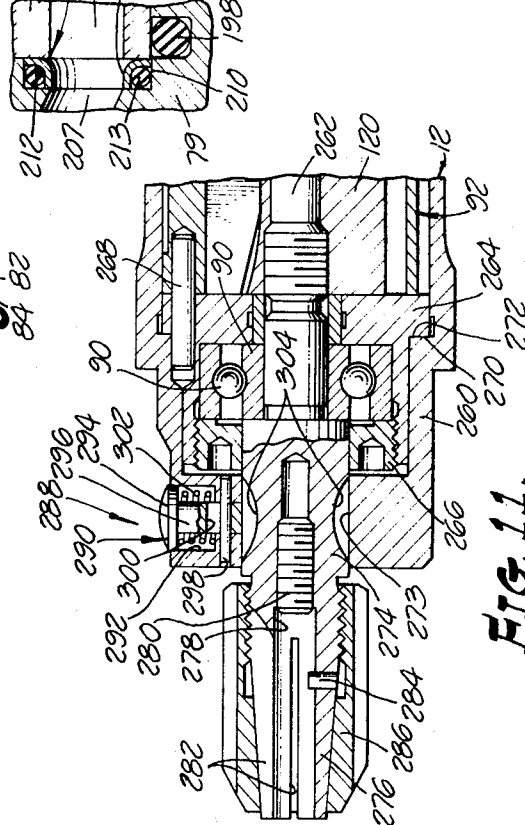


FIG. 11.

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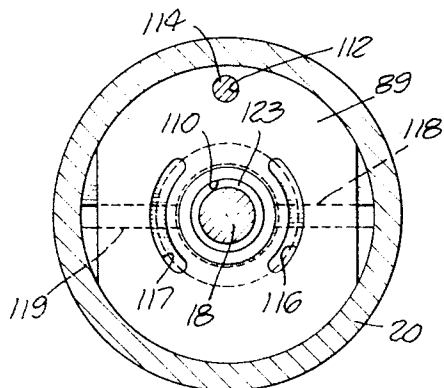


FIG. 4.

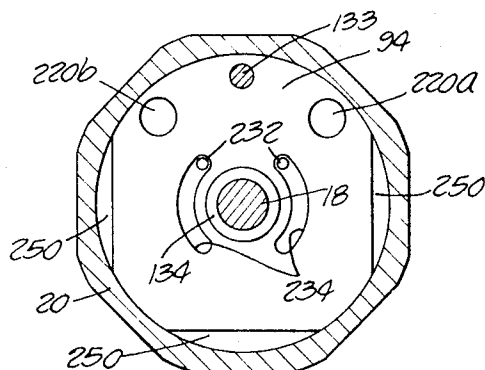


FIG. 5.

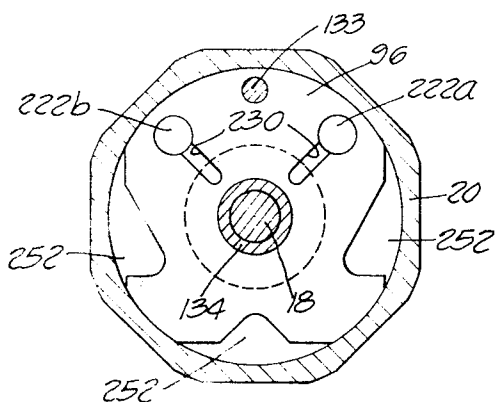


FIG. 6.

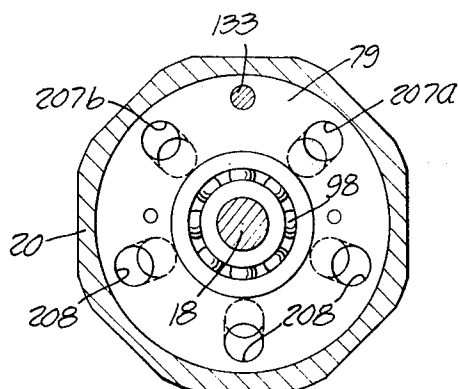


FIG. 7.

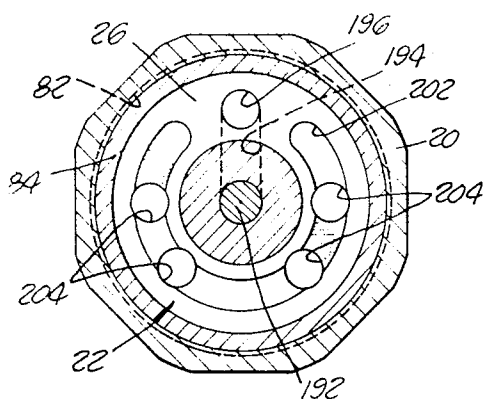


FIG. 8.

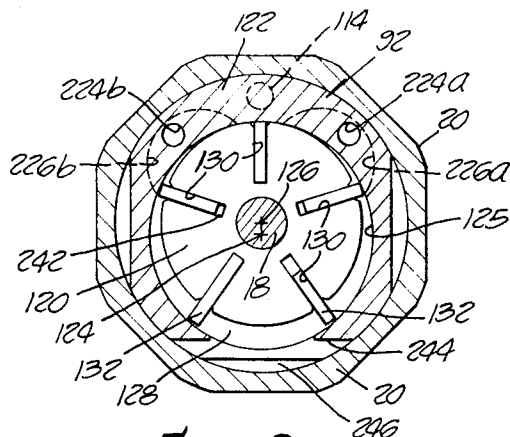
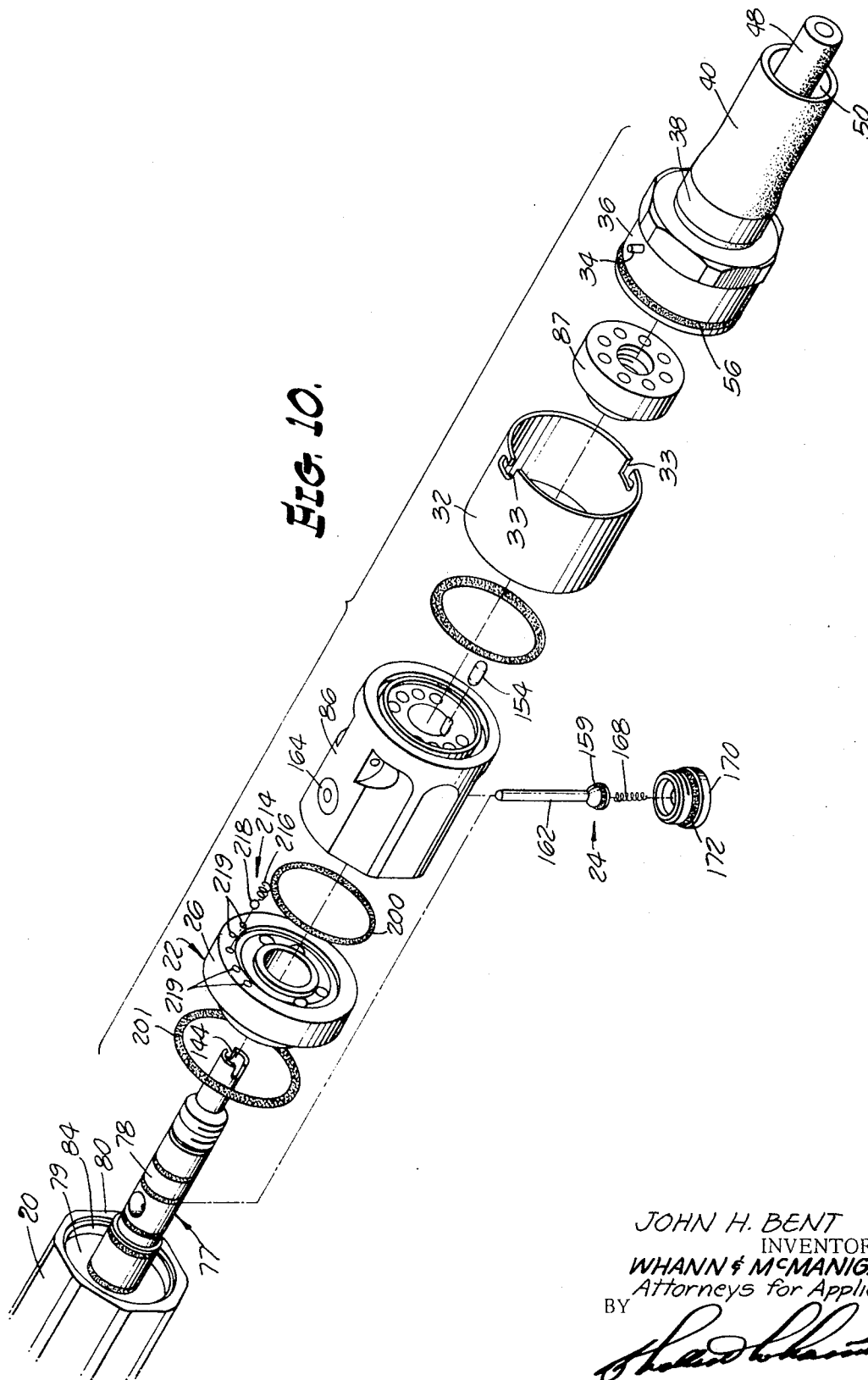


FIG. 9.

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PNEUMATIC TOOL

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates generally to pneumatic devices and more particularly to pneumatically operated surgical tools adapted to drive various types of attachments.

2. Description of the Prior Art

Pneumatically operated devices have been used in medical and dental surgery for many years and are ideally suited for such use since they are reliable, sanitary, and safe to use in potentially explosive atmospheres. To be acceptable for surgical applications, however, the devices must satisfy stringent performance requirements. They must be compact, easy for the surgeon to use, and precisely controllable. In order to satisfy these performance requirements, many prior art devices tend to be unduly complex. Often they embody numerous separately manufactured component parts which are threadably interconnected, and since many of the parts are irregularly shaped and often have a plurality of internal passageways, they are extremely difficult and costly to manufacture. Typical of threadably interconnected prior art devices is that disclosed in United States Letters Patent No. 3,472,323.

As a result of the new and novel structural configuration of the surgical tool of my invention, the need for threadably interconnected parts is significantly reduced, making the unit more reliable and easier to manufacture, assemble and maintain.

SUMMARY OF THE INVENTION

This invention relates to a pneumatically operated surgical tool comprising a hand-held instrument adapted to be detachably secured to a pneumatic supply conduit. The hand-held instrument comprises a housing, a pneumatic motor coaxially mounted within the housing, an axially aligned gas channeling conduit for channeling gases from the supply conduit to the pneumatic motor, and control valves carried by the gas channeling conduit and communicating therewith for regulating the flow of gases to the motor.

It is an object of my invention to provide a pneumatically operated surgical tool which has a hand-held instrument portion adapted to be quickly and easily detachably connected to a pneumatic supply conduit for supplying a gas under pressure to operate the tool.

It is a further object of my invention to provide a pneumatically operated surgical tool of the type described, in which the instrument has, disposed in axial alignment with its longitudinal axis, a spindle rotatably driven by a pneumatic motor, and a gas channeling conduit member for channeling gases under pressure from the supply conduit to the motor.

It is a further object of my invention to provide a pneumatically operated surgical tool as described in the previous paragraph in which the spindle is threadably connected to the rotor of the pneumatic motor to insure precise concentricity of rotation of the rotor and the spindle about the longitudinal axis of the instrument.

It is a further object of my invention to provide a pneumatically operated surgical tool of the class described, in which the axially disposed gas channeling conduit member not only insures an unrestricted flow of gas through the instrument, but also serves to structurally support and radially align a coarse control and

a fine control valve which cooperate to regulate the speed and direction of rotation of the pneumatic motor.

It is still a further object of my invention to provide a pneumatically operated surgical tool as described in the previous paragraph in which the coarse control valve cooperates with a detent mechanism to permit the operator to adjust the valve by feel for motor rotation at full or half speed in either a forward or reverse direction.

Another object of my invention is to provide a tool of the class described in which the fine control valve is operated by a lever pivotally connected to the instrument and in which a safety slide is provided on the lever to prevent accidental operation of the valve and consequent unintentional starting of the motor.

Another object of my invention is to provide a tool as previously described in which a variety of attachments such as surgical drills, saws and similar implements may be quickly interconnected with and driven by the rotatable spindle.

A further object of my invention is to provide, as an alternate embodiment, a pneumatically operated surgical tool in which there is provided a collet arrangement for driving various surgical attachments and cutters such as bar type cutters and in which a spring-loaded locking mechanism is provided to lock the spindle against rotation during interconnection of the attachments with the tool. Also provided is a key member in the spindle which is adapted to engage a flat portion on the shaft of the attachments in order to provide a positive drive to the attachment as the spindle rotates.

Still a further object of my invention is to provide a pneumatically operated surgical tool in which the supply conduit which supplies gases under pressure to the instrument includes a valving arrangement which automatically prevents the flow of gases through the supply conduit upon the decoupling therefrom of the instrument portion.

It is still a further object of my invention to provide a pneumatically operated surgical tool in which a novel sealing ring assembly is provided to sealably interconnect communicating passageways of first and second slidably interfacing members of the instrument. This unique sealing ring assembly comprises a metal seal ring used in conjunction with an elastomeric O-ring and is adapted to be interposed between the interfacing members in concentric alignment with a passageway in the first member. The metal ring is constructed to be urged by the O-ring into engagement with the second member so as to provide a reliable seal therewith and at the same time offer a minimum resistance to relative movement between the members.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of the pneumatically operated surgical tool of my invention showing a hand-held instrument portion interconnected with a pneumatic supply and exhaust conduit for conducting gases under pressure to and away from the hand-held instrument.

FIG. 1a is a fragmentary view showing indicia used by the operator to control the speed of the motor at one-half or full speed in a forward or reverse direction.

FIG. 2 is a longitudinal cross-section of the hand-held instrument and a portion of the supply conduit of my invention.

FIG. 2a is a cross-sectional view of the input end of the tool showing the supply conduit disconnected from the hand-held instrument portion of my invention.

FIG. 2b is a fragmentary view showing a cross-sectional view of a sealing ring assembly used in my invention.

FIG. 3 is a cross-sectional view taken along lines 3—3 of FIG. 2.

FIG. 4 is a cross-sectional view taken along lines 4—4 of FIG. 2.

FIG. 5 is a cross-sectional view taken along lines 5—5 of FIG. 2.

FIG. 6 is a cross-sectional view taken along lines 6—6 of FIG. 2.

FIG. 7 is a cross-sectional view taken along lines 7—7 of FIG. 2.

FIG. 8 is a cross-sectional view taken along lines 8—8 of FIG. 2.

FIG. 9 is a cross-sectional view taken along lines 9—9 of FIG. 2 showing the internal construction of the pneumatic motor housed within the hand-held instrument portion of my invention.

FIG. 10 is an exploded view of a portion of the hand-held instrument and pneumatic supply conduit of my invention showing the coaxial assembly of the various components about an axially disposed gas channeling conduit member.

FIG. 11 is a view of an alternate embodiment of my invention showing a rotatable spindle having a collet arrangement for holding bur type cutters or other attachments.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. 1 of the drawings, the preferred embodiment of the surgical tool is shown as comprising a hand-held instrument 12 and a conduit means 14 for conducting a gas under pressure to and away from instrument 12. Conduit 14 and instrument 12 are interconnected by a bayonet-type quick coupling means 16.

At the forward or output end of instrument 12 is a spindle 18 to which a variety of attachments such as surgical drills, saws and similar implements may be connected. Spindle 18 is rotatably driven by a pneumatic motor housed within a generally cylindrically shaped housing 20 having a first and second open end. The speed and direction of rotation of the motor are controlled by the surgeon through the operation of valving means comprising a first or coarse control valving means 22 and a second or fine control valving means 24. A valve ring 26, which may be rotated in a clockwise or counterclockwise direction, operates coarse control valving means 22 and, as indicated in FIG. 1a, may be positioned for motor rotation at full (F) or one-half (0.5) speed in both a forward and reverse direction. Second valving means 24 is operated by the surgeon through manipulation of lever 28, and is adapted to variably control the speed of rotation of the motor within the speed range selected through the positioning of valving means 22. Lever 28 is provided with an extension 29 which may be slidably extended toward the forward end of the tool for greater ease of operation of the valving means by the surgeon during certain types of surgical manipulations. The internal construction and method of operation of valving means 22 and 24 will be discussed in detail in the paragraphs which follow.

At the rearward end of instrument 12 is a female connector means in the form of ring 32 having L-shaped slots 33 adapted to receive locking pins 34 which protrude from the periphery of male connector means in the form of ring 36 of conduit 14. Instrument 12 and conduit 14 may be quickly coupled together by inserting pins 34 into the longitudinally disposed legs of slots 33 and rotating male connector ring 36 in a clockwise direction, causing pins 34 to move into the transverse legs of slots 33, thereby locking the male and female connector means together against axial separation.

A first length of flexible tubing 40 is connected at one end to ferrule 38 on connector ring 36 and is connected at its other end to adapter member 42. A fitting 44 is provided on adapter member 42 to allow interconnection, with a mating fitting on a line leading to a pneumatic supply such as a cylinder of compressed gas (not shown). Fitting 44 communicates with female connector ring 36 by means of a third length of gas inlet tubing 48 concentrically disposed within tubing 40. In a manner which will later be described, when conduit 14 is coupled with instrument 12, gas received at connector ring 36 is centrally channeled through the various parts of the instrument to rotatably drive the pneumatic motor. Gas is exhausted from the motor through a plurality of gas return passages formed in the various parts of instrument 12, and returns to adapter member 42 through the annular space 50 defined between tubing 40 and 48. The component parts of the surgical tool are joined together by gas-tight seals so as to form a closed system. In other words, gas entering the apparatus at fitting 44 flows through various parts of instrument 12 to the motor and then is returned to its point of entry where it is vented to atmosphere through a plurality of circumferential grooves 52 in adapter member 42.

Referring now to FIGS. 2 and 10 which illustrate the internal construction and method of assembly of the various component parts of the tool of my invention, male connector ring 36 can be seen to have an elastomeric O-ring 56 seated in a circumferential groove 58. When male connector ring 36 is mated with female connector ring 32, as illustrated in FIG. 2, O-ring 56 serves to provide a gas-tight seal between the connector rings. Male connector ring 36, which serves as the pneumatic supply input and exhaust terminal of instrument 12, has a gas inlet port 60 which communicates with a chamber 62 at a first location and a plurality of exhaust passages 64 which communicate with annular space 50 in conduit 14.

An important feature of my invention is the means for automatically sealing off the flow of gas through conduit 14 when, as shown in FIG. 2a, it is decoupled from instrument 12. Disposed within internal chamber 62 is an elastomeric O-ring 65 which is held captive in a groove 66. Groove 66 is located at a second location within chamber 62 and is defined by the combination of a shoulder 67 in chamber 62 and the end of a cap member 68 which is threadably connected at the forward end of chamber 62. A biasing means, shown as a compression spring 70, is held captive within chamber 62 and is adapted to continuously urge a sealing member, in the form of a ball 72, into a seating position against O-ring 65, thereby forming a gas-tight seal which precludes the flow of gas from chamber 62.

Turning again to FIGS. 2 and 10, the numeral 77 identifies a centrally disposed gas channeling means or conduit for channeling the input flow of gas from sup-

ply conduit 14 through the hand-held instrument 12 of the surgical tool. Channeling conduit 77, which is an important part of my invention, has an elongated stem 78, the input end of which is arranged for communication with chamber 62 at the second location. At the forward or output end of conduit 77 is an integral, generally cylindrically shaped head 79 which is adapted to closely fit within the second or rearwardly facing open end 80 of housing 20. Internal threads 82 are provided near open end 80 of housing 20 to threadably receive a locking ring 84. Locking ring 84, when in position within housing 20, engages a circumferential shoulder 85 on head 79 so as to rigidly support channeling conduit 77 within housing 20 in axial alignment with the longitudinal axis of assembly 12.

As can best be seen in FIG. 10, stem 78 of channeling conduit 77 serves not only to channel gases through the instrument to the pneumatic motor but also serves as a principal structural member for the support and alignment of various component parts of the tool. These components include first valving means 22, valve head member 86, within which is located second valving means 24, and female connector ring 32. Female connector ring 32, which is secured to stem 78 by a retainer ring 87, functions to hold the other components in correct longitudinal juxtaposition on stem 78.

For ease of description, the arrangement and operation of the component parts of the tool located on the output or motor side of head 79 of channeling conduit 77 will first be described. The configuration and function of the component parts on the input or control side of head 79 will later be described as a part of a detailed discussion of the operation of the apparatus.

The details of construction of the components on the output side of channeling conduit 77 are illustrated in FIG. 2, and in FIGS. 4 through 9. These components comprise spindle guard 88, a forward bearing plate 89, a forward bearing 90, the various component parts of the pneumatic motor which is generally designated as 92, an end plate 94, a vent plate 96, and a rear bearing 98.

Forward bearing plate 89 has a generally cylindrical first portion 100 and a smaller diameter cylindrical second portion, or skirt 102, which is constructed to closely fit within the forward portion of housing 20. A circumferential shoulder 103, formed at the juncture of first portion 100 and skirt 102, engages an internal shoulder 104 in housing 20 and serves to properly locate bearing plate 89 within housing 20. Disposed within skirt 102 and located between first portion 100 and a generally conically shaped boss 108 on spindle 18 is formed bearing 90. Bearing 90 rotatably supports the forward end of spindle 18 and is held captive within skirt 102 by spindle guard 88 which threadably engages skirt 102 near its forward end. Spindle guard 88 also serves to securely lock bearing plate 89 against shoulder 104 of housing 20.

As can be seen in FIG. 4, front bearing plate 89 has a centrally located aperture 110 which accommodates passage therethrough of spindle 18, and also has an aligning pin aperture 112 which accommodates an aligning pin 114 which serves to appropriately position bearing plate 89 relative to housing 20. Arcuate vent lanes 116 and 117 and diametrical passageways 118 and 119 are provided in first portion 100 for the removal of gases in a manner as will presently be described.

Referring to FIGS. 2 and 9, it can be seen that pneumatic motor 92 has a rotor 120 adapted to be threadably attached to spindle 18 at threaded portion 121. Rotor 120 rotates with spindle 18 about the longitudinal axis of housing 20 and within a generally cylindrically shaped rotor housing 122. Rotor housing 122 is concentrically mounted within housing 20 adjacent bearing plate 89 and is aligned therewith by aligning pin 114. A spacer 123 disposed within aperture 112 serves to maintain the proper spacing between bearing 90 and rotor housing 122. As can best be seen in FIG. 9, rotor housing 122 has a varying wall thickness due to the fact that the longitudinal axis 124 of the bore 125 therethrough is vertically displaced from the longitudinal axis of rotation of spindle 18, identified by the numeral 126. Because rotor 120 rotates with spindle 18 about axis 126, a crescent-shaped expansion chamber 128 is formed between the rotor and the internal surface of bore 125 as the rotor rotates within housing 122. The numeral 130 identifies a series of radial slots longitudinally disposed in rotor 120 for receiving rotor blades 132 which interact with the input gases to rotatably drive the rotor. The rotor blades are typically constructed from a fiber material and are permitted to move radially relative to the axis of rotation of the rotor as the rotor rotates. During rotation of the rotor, blades 132 are permitted to move radially in slots 130 and to extend into crescent-shaped expansion chamber 128.

Referring to FIG. 2, rear bearing 98 which rotatably supports the rearward extremity of spindle 18 is shown mounted within a cavity in head 79 of channeling conduit 77. Disposed between head 79 and rotor 120 and held in cooperative orientation within housing 20 by aligning pin 133 is the end plate 94 and the vent plate 96. A spacer 134 disposed within a central aperture in plates 94 and 96 accommodates passage of spindle 18 and serves to hold bearing 98 and rotor 120 in a properly spaced relationship. Plates 94 and 96 function to direct input and exhaust gases toward and away from motor 92 in a manner as will be described in the following section.

OPERATION

Referring to FIGS. 2 and 2a, when instrument 12 and pneumatic supply conduit portion 14 are coupled together by the user in the manner previously described, male connector ring 36 moves from the position shown in FIG. 2a to the locked position shown in FIG. 2. During the coupling operation the rearward extremity of stem 78 is guided into aperture 140 in cap member 68 and is moved into contact with sealing member or ball 72. When sufficient force is applied to overcome the resistance of spring 70, ball 72 will disengage from O-ring 65 and, as indicated by arrows 142, gas under pressure within chamber 62 will be permitted to flow through slots 144 into a central passageway 146 within stem 78. An elastomeric O-ring 148 within cap member 68 serves to form a gas-tight seal between stem 78 and cap member 68.

As seen in FIG. 2, passageway 146 terminates in a radially extending passageway 150 which is adapted to communicate with a passageway 152 in the valve head member 86 carried by stem 78. Passageways 150 and 152 are held in proper alignment by a key 154 so that gas may flow into a first or lower chamber 156 in second valving means 24. As can be more clearly seen by also referring to FIG. 3, valving means 24 has an ad-

joining smaller second upper chamber 158 which communicates with a second passageway 160 in stem 78 of conduit 77. Because of the different sizes of chambers 156 and 158, a shoulder defining a valve seat 157 is formed at their juncture.

Disposed within head member 86 is a control means 159 for controlling the flow of gases between chambers 156 and 158. Control means 159 has a valve stem 162 which extends through chamber 158 and outwardly through head member 86, passing through a seal ring 164 which has a captive O-ring 166 for sealably engaging stem 162. The outer extremity of stem 162 protrudes from head member 86 and engages lever 28 which is adapted to operate control means 159. Lever 28, when depressed, will cause stem 162 to move inwardly into head member 86 against the urging of a spring 168 positioned in lower chamber 156. A retainer cap 170 having a captive O-ring 172 is threadably secured within lower chamber 156. Cap 170 serves to effectively seal chamber 156 and also to locate and support spring 168. At the lower extremity of valve stem 162 is a groove 174 in which is located an elastomeric O-ring 176. When valve stem 162 is in its normal position as shown in FIG. 2, spring 168 holds O-ring 176 firmly against shoulder 157, thereby providing a gastight seal between chambers 156 and 158. Adjacent groove 174 in valve stem 162, and normally located for communication with the walls of chamber 158, is a generally spherically shaped section 178. When the forward end of lever 28 is depressed, valve stem 162 will move inwardly, causing O-ring 176 to separate from seat 157, allowing gas to flow from chamber 156 into chamber 158. Due to the fact, however, that spherical section 178 closely communicates with upper chamber 158, the rate of flow of gas into chamber 158 is small when O-ring 176 first separates from seat 157. As valve stem 162 is moved further inwardly by depression of lever 28, the annular space between chamber 158 and section 178 becomes gradually larger, permitting a controllably greater rate of flow of gas into chamber 158. This unique arrangement provides means for accurately controlling the rate of gas flow through conduit 77 to motor 92, thereby allowing precise incremental speed control of the motor.

A novel and important safety feature of my invention which is appropriate for discussion at this point, involves means for disabling lever 28 so as to prevent accidental operation of control means 159 and unintentional starting of the pneumatic motor. Referring to FIG. 1, the safety means can be seen to comprise a safety slide member 180 held in slidable engagement with lever 28 where it interconnects with a guard clip 184. Lever 28 has an aperture 186 which is covered by guard clip 184 when slide member 180 is in its forwardmost position, as shown in FIG. 2. When the safety means is slidably moved into the position shown by the phantom lines, however, aperture 186 is uncovered, allowing valve stem 28 to freely protrude therethrough making lever 28 ineffective to operate valve means 24.

When the tool is being used by the surgeon, slide 180 is in its forward position, enabling valving means 24 to be opened so as to permit gas to flow into passageway 160 in stem 78 in the direction of arrows 190. A plurality of O-rings 191 serves to prevent leakage of gas between stem 78 and valve head member 86. A plug 192 at the forward end of passageway 160 diverts the gas into a radial channel 194 which is positioned to com-

municate with a passageway 196 in valve ring 26 of coarse control valving means 22. Valve ring 26 is rotatably carried by stem 78 with O-rings 198, providing a gastight seal between ring 26 and stem 78. O-ring 200 provides a seal with valve head member 86 and O-ring 201 provides a seal with housing 20.

The unique construction and operation of valving means 22, as will now be described, form an important part of my invention. Referring to FIG. 8, valve ring 26 is seen to have an arcuate groove 202 and a plurality of communicating passageway 204 adapted to accommodate the flow of spent gases which are exhausted from motor 92. Passageway 196 which communicates with passageway 160 of stem 78 to conduct input gases to motor 92 is shown near the top of FIG. 8. As can be seen in FIG. 7, head 79 of conduit 77 has two input ports 207a and 207b, and three output or exhaust ports 208 disposed at an angle with the longitudinal axis of the tool. When valve ring 26 is rotated, passageway 196 may be aligned to communicate with either input port 207a or 207b, thereby controlling the direction of rotation of motor 92. In either alignment position, however, because of the location of groove 202 and passageways 204 in valve ring 26, output ports 208 will be in communication with groove 202 so that spent gases coming from the motor may be efficiently conducted away through passageways 204.

To sealably interconnect the communicating passageways between valve ring 26 and head 79, I have developed a novel sealing means in the form of sealing ring assembly 209, illustrated in FIG. 2b. When, as is the case here, it is necessary to sealably interconnect communicating pneumatic passageways in slidably interfacing first and second members, conventional sealing means have proved unsatisfactory. The use of conventional O-rings alone in such situations is unsatisfactory since the O-ring impedes the freedom of movement between the parts and also tends to wear quite rapidly, causing it to lose its sealing ability.

I have solved this unique sealing problem through the use of ring assembly 209 which is adapted to be interposed between valve ring 26 and head 79 in counter-sinks 210 which are concentrically formed around input ports 207 in head 79. Ring assembly 209 comprises a metal seal ring 211 having an annular groove 212 adapted to receive an elastomeric O-ring 213. O-ring 213 is constructed so that it continually urges the outer face of ring 211 into engagement with valve ring 26. In this way there is formed a highly efficient and reliable seal between the communicating passageways in valve ring 26 and head 79 and one which offers minimum resistance to the rotation of the valve ring relative to head 79.

To enable the user of the tool to, by feel, easily and precisely locate valve ring 26 relative to input ports 207a and 207b in head 79, I have provided a novel valve ring locating means shown in the form of a detent assembly 214. As illustrated in FIG. 2 and FIG. 10, detent assembly 214 comprises a coil spring 216 and a ball bearing 218 housed within a cavity 220 formed in valve head member 86. Spring 216 is adapted to urge ball bearing 218 selectively into seating engagement with one of a plurality of indentations 219 located in the rearwardly facing surface of ring 26. The indentations are spaced so as to correspond with the spacings of the indicia shown in FIG. 1a, and provide a means for frictionally locating ring 26 in the various control

positions. For example, when valve ring 26 is in the off position as illustrated in FIG. 1a, ball bearing 218 is in engagement with an indentation which positions input passageway 196 out of alignment with either of the input ports 207a or 207b in head 79. When ring 26 is turned clockwise to align the index mark with indicia "0.5," ball 218 will move into engagement with a second indentation which locates ring 26 so that passageway 196 is in partial alignment with input port 207a, allowing approximately one-half of the total input gas to flow into the pneumatic motor. When the ring is further rotated to indicia "F," an indentation is provided to position the ring so that passageway 196 is fully aligned with input port 207a, allowing full flow of gas into the motor. Additional indentations in ring 26 are provided so that when it is rotated counter-clockwise it may similarly be located in various control positions for full or half speed reverse rotation of the motor.

Referring now to FIGS. 2, 5, 6 and 9, end plate 94 and vent plate 96 which direct gases to motor 92 can be seen to have pairs of input ports 220 and 222, respectively, which are adapted to be held in precise alignment with the forward end of input ports 207 in head 79 by aligning pin 133. Ports 220 and 222 in turn align with passageway 224 and pairs of arcuate relief grooves 226 and 228 in rotor housing 122. Vent plate 96, as shown in FIG. 6, has radial grooves 230 which communicate with apertures 232 in plate 94 which, in turn, communicate with arcuate grooves 234 disposed around the central aperture in end plate 94.

As can best be understood by referring to FIGS. 2 and 9, valve ring 26 may be rotated to align passageway 196 for communication with either a first or a second input means or path within motor 92 for directing gases against blades 132 so as to cause rotation of rotor 120 in either a first or second direction. When valve ring 26 is rotated to align passageway 196 with input port 207a, for example, gas will flow along the first or a path through the communicating input ports in vent plate 96 and end plate 94. A portion of the gas will be directed by groove 226a in the direction of arrow 236 where it strikes the rearward outer extremities of rotor blades 132. A portion of the gas will also flow through passageway 224a in rotor housing 122 where it will be directed by groove 228a toward the forward outer extremities of blades 132. The force of the gas against the blades causes rotation of rotor 120 and spindle 18 in a first or clockwise direction. If valve ring 26 is rotated so as to align passageway 196 with input port 207b, gas will flow along the second input means or path, identified in the drawings by numerals followed by the letter b, and rotor 120 will be caused to rotate in a second or counter clockwise direction. The speed of rotation of rotor 120 is, of course, governed by the rate of flow of gas into the rotor housing as controlled by valving means 22 and 24. If desired, the degree of rotation of valve ring 26 can, of course, be restricted so as to permit rotation of the motor in only one direction. In such a case, the indicia shown in FIG. 1a would be appropriately changed to eliminate one set of reference indicia.

To assist in forcing blades 132 radially outward into crescent-shaped chamber 128 as the rotor rotates, a portion of the gas received at vent plate 96 is diverted into the communicating radial groove 230. As indicated in FIG. 2 by arrow 240, the gas then flows into arcuate groove 234 in end plate 94 where it is directed toward the root portions 242 of slots 130 in rotor 120,

forcing blades 132 radially outward. To aid in relieving the gas pressure thus formed between blades 132 and the root portions of slots 130 so that they may retract into slots 130 at the appropriate point in the cycle of rotation of the rotor, arcuate vent lanes 116 and 117 are provided in bearing plate 89.

The gases which are entrapped between adjacent blades 132 as the rotor rotates are permitted to escape through ports 244 into passageway 246 and then, as indicated by arrows 248, through the exhaust passageways 250 and 252 in end plate 94 and in vent plate 96, respectively, into passageways 208 in head 79 and 204 in valve ring 26. The gases then flow through passageways 253 in valve head 86, through vent lanes 254 in retainer ring 87, into chambers 256 in male connector ring 36, and finally into annular space 50 for return to adapter 42 at the input end of the apparatus.

Another embodiment of the surgical tool of my invention is illustrated in FIG. 11. To interconnect certain types of attachments with the surgical tool, it is necessary to have a gripping means for gripping the shank portion of the attachment. This embodiment of my invention, which provides such a gripping means, is identical with the embodiment previously described except for the construction of the forward portion thereof, as shown in FIG. 11. For this reason, discussion in the paragraphs which follow will be limited to a discussion of the portion of tool illustrated in FIG. 11. In describing this embodiment, like numbers will be used to identify like components as previously described.

The numeral 260 designates the forward housing of the hand-held instrument 12 to which a pneumatic supply and exhaust conduit 14 may be interconnected. Mounted within housing 260 is a pneumatic motor 92 having a spindle 262 which is rotatably supported in a forward bearing 90. Bearing 90 is mounted in a forward bearing plate 264, and is held captive therein by a retainer ring 266 threadably connected to bearing plate 264 at its forward end. An aligning pin 268 coupled with the interaction of shoulders 270 and 272 serve to properly orient bearing plate 264 within housing 260.

Near the forward end of spindle 262 is an increased diameter portion 274 which rotates within and in close proximity to the inner walls of an aperture 273 formed in the forward end of housing 260. Immediately adjacent portion 274 at the forward end of spindle 262 is a tapered section 276 which is threaded near its larger diameter end. An axial bore 278 extends through section 276 into portion 274 and is adapted to threadably receive an adjusting set screw 280. A plurality of longitudinal slots 282 extend through the walls of the forward portion of tapered section 276, and a torque transmitting means in the form of key 284 protrudes radially therethrough into bore 278. A spindle nut or collet 286 having an internal taper is adapted to be threadably received over tapered section 276, and is so constructed as to urge the contraction of bore 278 as it is tightened onto tapered section 276, thus providing means for gripping the shank of the surgical cutter which is to be connected to the tool. Surgical cutters used with the tool have a flat portion on the shank which, when inserted into bore 278, may be oriented so as to engage torque transmitting means or key 284. The engagement of key 284 with the flat portion of the shank of the cutter provides positive transmission of

torque to the cutter instead of the torque of the spindle being transmitted by friction alone.

For certain applications it is desirable that the collet be formed with a plurality of flats on its outer periphery. For example, the collet may be constructed to be hexagonally or octagonally shaped in outer cross-section. In such configuration the collet may be inserted into a female adapter or mating configuration and serve to rotatably drive the female adapter which in turn may be adapted to carry various types of surgical attachments.

To hold the spindle from rotating during tightening of collet 28, a spindle gripping means designated by the numeral 288 is provided. Spindle gripping means 288 has a member 290 disposed within a radial aperture 292 in the forward portion of housing 260. First member 290, which has a head 294 and a shank 296, is secured within aperture 292 by means of a dowel pin 298 which extends through a larger diameter passageway 300 in shank 296 of member 290. A spring 302 is disposed within aperture 292 and is adapted to normally urge member 290 in a radially outward direction to the extent permitted by dowel pin 298. Passageway 300 in shank 296 has a diameter large enough to permit member 290 to be manually depressed inwardly against the urging of spring 302 sufficiently to bring the inner extremity of shank portion 296 into engagement with one of a plurality of depressions 304 in spindle 262, thereby holding the spindle against rotation.

I claim:

1. A pneumatically operated surgical tool comprising a hand-held instrument and means for conducting a flow of gas under pressure to and away from said instrument, said hand-held instrument comprising:

- a. a housing;
- b. a pneumatic motor including a rotor housing and a rotor said rotor being coaxially mounted within said housing;
- c. means disposed in axial alignment with the longitudinal axis of said housing for channeling gas from said gas conducting means to said pneumatic motor; and
- d. valving means carried by said channeling means and operably communicating therewith for regulating the flow of gas to said pneumatic motor.

2. A pneumatically operated surgical tool as defined in claim 1, having a spindle adapted for rotation by said pneumatic motor about the longitudinal axis of said housing, said spindle having means for detachably interconnecting a variety of surgical attachments.

3. A pneumatically operated surgical tool as defined in claim 1, in which said valving means comprises a first valving means for coarse regulation of the flow of gases through said channeling means and a second valving means for fine regulation of the flow of gases through said channeling means.

4. A pneumatically operated surgical tool as defined in claim 3, in which said pneumatic motor comprises:

- a. a rotor housing;
- b. a rotor mounted for rotation within said rotor housing about an axis coaxial with the longitudinal axis of said housing;
- c. a plurality of blades carried by said rotor; and
- d. a first input means for directing gases under pressure against said blades so as to cause rotation of said rotor in a first direction of rotation.

5. A pneumatically operated surgical tool as defined in claim 4, in which said pneumatic motor has a second input means for directing gases under pressure against said blades so as to cause rotation of said rotor in a second direction of rotation.

6. A pneumatically operated surgical tool as defined in claim 4, in which said first valving means has a valve ring rotatably carried by said channeling means, said valve ring having a passageway therethrough adapted to operably communicate with said channeling means and with said first input means of said pneumatic motor.

7. A pneumatically operated surgical tool as defined in claim 6, including means for locating said valve ring so as to position the passageway therethrough for either total or partial communication with said first input means.

8. A pneumatically operated surgical tool as defined in claim 5, in which said first valving means has a valve ring rotatably carried by said channeling means, said valve ring having a passageway therethrough adapted to operably communicate with said connecting means and with either said first or second input means of said pneumatic motor.

9. A pneumatically operated surgical tool as defined in claim 8, including means for locating said valve ring so as to position the passageway therethrough either for total or partial communication with said first or said second input means.

10. A pneumatically operated surgical tool as defined in claim 1, in which said means for conducting gases to and away from said hand-held instrument is detachable from said instrument and includes means for preventing the flow of gases therethrough when said instrument is detached therefrom, comprising:

- a. a connector ring having a chamber therein adapted for communication with said channeling means, said chamber having an input and an output end;
- b. an O-ring fixedly secured within the chamber of said connector ring near its output end;
- c. a sealing member disposed within the chamber of said connector ring and adapted to engage said O-ring to seal the output end of the chamber; and
- d. a biasing means for urging said sealing member into engagement with said O-ring.

11. A pneumatically operated surgical tool having a hand-held instrument comprising:

- a. a housing having a first and second open end;
- b. a pneumatic motor fixedly mounted within said housing;
- c. a spindle protruding from the first end of said housing and rotatably driven by said pneumatic motor about the longitudinal axis of said housing;
- d. a coaxially disposed gas channeling means comprising a conduit member supported by and protruding from the second end of said housing for channeling gases through said instrument to drive said motor; and
- e. a first coarse control and second fine control valving means carried by and in operative communication with said gas channeling means for regulating the flow of gases therethrough said valving means being held in radial alignment with respect to said housing by said gas channeling means.

12. A pneumatically operated surgical tool as defined in claim 11, in which said first valving means comprises a valve ring rotatably carried by said gas channeling

13

means and adapted for rotation about the longitudinal axis thereof, said valve ring having:

- a. at least one passageway for channeling the flow of gases from said channeling means through said valve ring in the direction of said pneumatic motor; and
- b. at least one passageway for channeling the flow of gases therethrough in a direction away from said pneumatic motor.

13. A pneumatically operated surgical tool as defined in claim 11, in which said second valving means comprises:

- a. a valve head coaxially carried by said gas channeling means having:
 1. first and second communicating chambers therein defining a shoulder therebetween;
 2. a passageway connecting said first chamber with said gas channeling means;
 3. a passageway connecting said second chamber with said gas channeling means;
 4. means for controlling the flow of gases between said first and second chambers; and
 5. at least one passageway therethrough adapted to carry gases in a direction away from said pneumatic motor; and
- b. a lever pivotally connected to said valve head for operating said control means of said valve head.

14. A pneumatically operated surgical tool as defined in claim 13, including safety means operably associated with said lever for disabling it from operating said control means of said valve head.

15. A pneumatically operated surgical tool as defined in claim 11, in which said channeling means comprises:

- a. a generally cylindrically shaped head portion adapted to be coaxially mounted within said housing near its second end; and
- b. a coaxially disposed integral stem portion having a plurality of passageways therein for channeling gases therethrough.

16. A pneumatically operated surgical tool as defined

14

in claim 15, in which said head portion of said channeling means has at least one passageway for accommodating the flow of gases therethrough, and in which said first valving means comprises a valve ring rotatably carried by said stem portion, said valve ring having at least one passageway therethrough adapted to channel the flow of gases from said stem portion into the passageway in said head portion.

17. A pneumatically operated surgical tool as defined in claim 16, in which sealing means is provided between said head portion of said channeling means and said valve ring of said first valving means for sealably interconnecting the passageways therethrough, said sealing means comprising:

- a. a sealing ring interposed between said valve ring and said head portion in concentric alignment with the passageway through said head portion; and
- b. an elastomeric O-ring interposed between said sealing ring and said head portion, said O-ring being adapted to urge said sealing ring into slidable engagement with said valve ring.

18. A pneumatically operated surgical tool as defined in claim 11, in which said pneumatic motor comprises a rotor housing and a rotor rotatably mounted in said rotor housing for rotation about the longitudinal axis of said hand-held instrument, said rotor being adapted to be threadably interconnected to said spindle.

19. A pneumatically operated surgical tool as defined in claim 11, including gripping means on said spindle for holding surgical cutters, said gripping means comprising:

- a. a collet threadably connected to said spindle; and
- b. locking means carried by said collet for engaging the shank portion of a surgical cutter so as to prevent slipping between said collet and the cutter.

20. A pneumatically operated surgical tool as defined in claim 19, including means for locking said spindle against rotation during interconnection of surgical cutters with said gripping means.

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