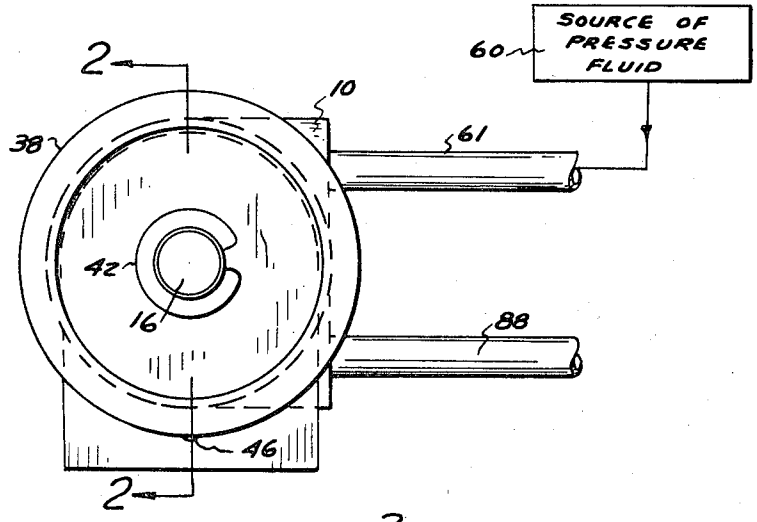
Jan. 21, 1969 N. GOTTLIEB 3,422,726

MOTORIZED SPINDLE

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FIG. 1



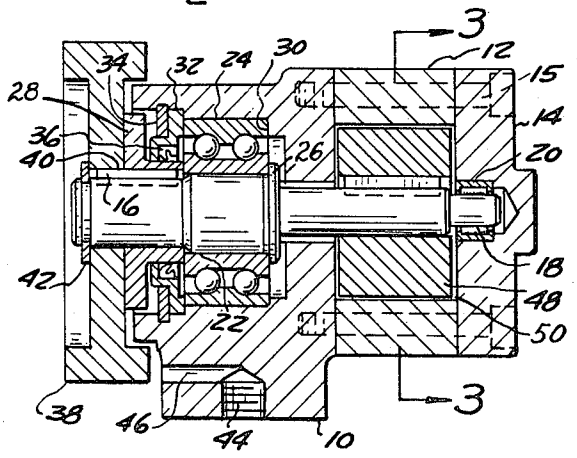


FIG. 2

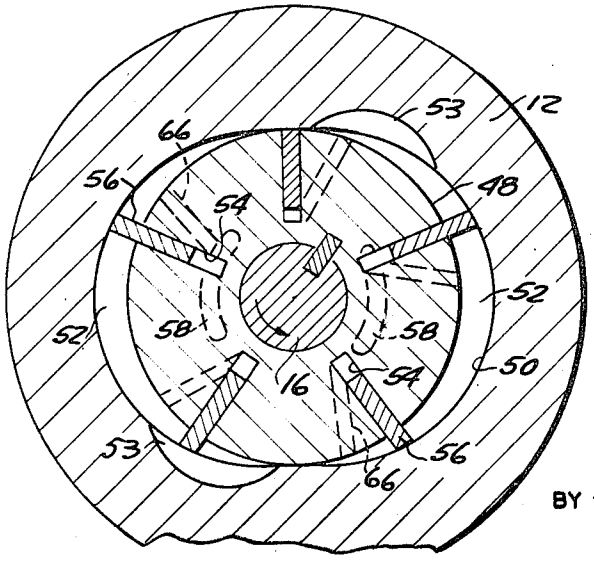


FIG. 3

INVENTOR
NATHAN GOTTLIEB

BY Hauke, Kraus, & Clifford

ATTORNEYS

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FIG. 4

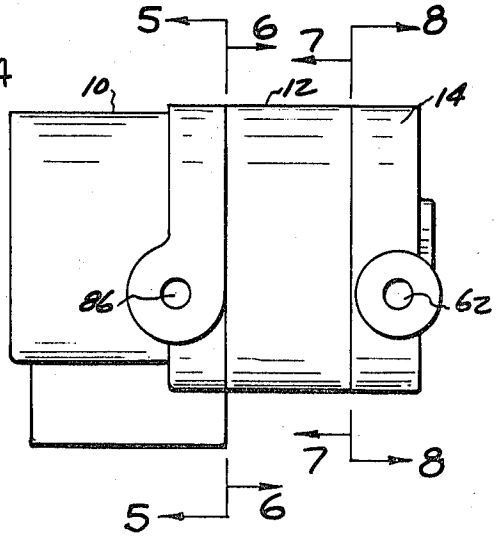


FIG. 9

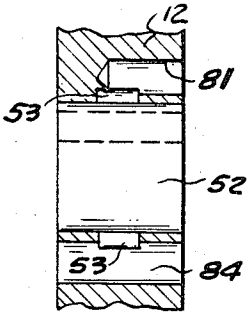


FIG. 7

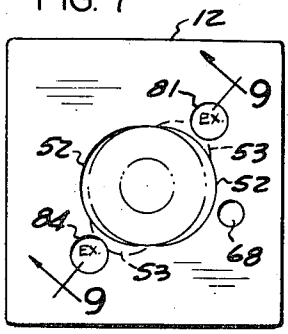


FIG. 8

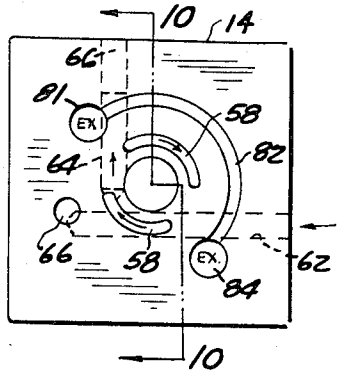


FIG. 5

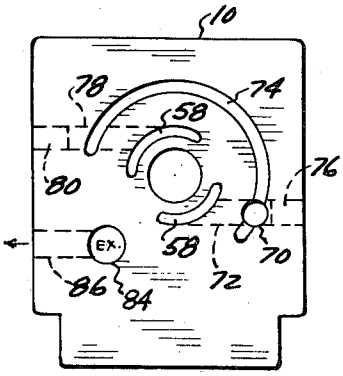
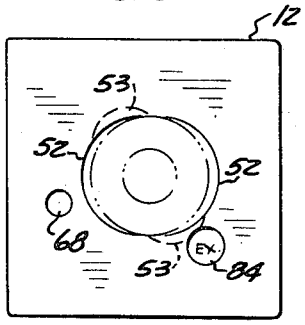


FIG. 6



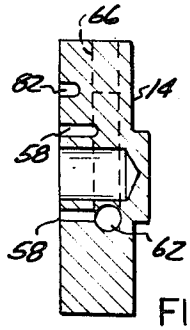


FIG. 10

INVENTOR
NATHAN GOTTLIEB

BY Hauke, Kram, & Gifford

ATTORNEYS

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3,422,726

MOTORIZED SPINDLE

Nathan Gottlieb, 23840 Condon, Oak Park, Mich. 48237

Filed June 27, 1966, Ser. No. 560,780
U.S. Cl. 91—136 5 Claims
Int. Cl. F01c 1/00, 21/12, 21/14

ABSTRACT OF THE DISCLOSURE

A motorized spindle consists of a stator having an elliptical chamber formed therein and a cylindrical rotor with a diameter equal to the minor diameter of the stator rotatably supported within the stator on a shaft. The rotor has five vanes slidably supported in radial slots. The stator includes surfaces which abut the sides of the rotor and communicate pressurized air to the rotor at certain angular positions thereof. The pressurized air urges the vanes outwardly and pressurizes chambers formed between the elliptical stator surface and the rotor, and bounded by the vanes. A pair of sinks to atmosphere are disposed at diametrically opposed points on the stator. The spacial relationship of the fluid chambers, vanes and sinks is such that working chambers are pressurized until they make fluid connection with the sink. The shaft is supported on bearings disposed adjacent to both faces of the rotor so as to provide a spindle.

This invention relates to a compact motorized spindle and more particularly to a spindle powered by a fluid motor having radially moving vanes.

A major problem associated with the working accuracy of grinding machines relates to the tools used in dressing or trueing the grinding wheel. Conventionally the means for dressing the grinding wheel comprises a single or cluster point diamond tool which periodically traverses the working surface of the grinding wheel. Tools of this type require frequent rotation and replacement due to rapid wear. Replacement of conventional dressing tools of this type presents a problem because of the costly downtime of the grinding machine. Therefore, there has been a demand for a dressing tool for such grinders which is durable, has a longer life than conventional single point or cluster type diamond tools, provides a better dressing, and which is capable of dressing and trueing the grinding wheel at a faster rate.

One effort in the prior art to provide a tool to satisfy the requirements for an improved dressing tool takes the form of a circular diamond impregnated dressing wheel mounted on a spindle and powered for rotary movement by a fluid motor of the turbine type. This effort to provide an improved dressing wheel has been only partially successful. A turbine powered spindle has severe limitations in that the turbine must be operated at a high rotational speed thus requiring a reduction gear to reduce the output to a speed corresponding to an efficient dressing wheel speed. The combination of turbine motor, reduction gear and spindle produces a device having a length requiring extensive modification to existing grinders for the purpose of installation.

The present invention obviates the problems encountered in the prior art in providing an improved dressing wheel for grinding machines which takes the form of a motorized spindle which has utility not only in providing rotary power for a dressing wheel, but is also useful as a source of compact rotary power for a wide variety of tools. The preferred embodiment of the present invention, which will subsequently be described in detail, takes the form of a shaft journaled in a pair of spaced bearings suitably chosen to support the shaft for radial and thrust

loads imposed on a tool carried by one end of the shaft. The bearings and the shaft carried therebetween are mounted in a housing defining a chamber having a generally elliptical cross-section including a narrow diameter and a large diameter. The shaft has an enlarged circular section disposed in the chamber and provided with a circular diameter corresponding to the narrow diameter of the chamber. The enlarged section of the shaft which will hereafter be referred to as a rotor is concentric with the axis of symmetry of the chamber so that a pair of diametrically opposed crescent shaped working chambers are formed with respect to the rotor.

The rotor preferably has an odd number of equiangularly spaced slots formed radially inwardly from its circumferenttial surface and which run the length of the rotor section. A vane is slidably disposed in each of the slots with a length corresponding to the length of the slot and a height less than the depth of the slot. A pair of arcuate fluid inlet ports are provided in the housing, each of which is associated with a working chamber. As the rotor rotates to bring a slot into registry with one of the crescent shaped working chambers, the inlet port delivers pressurized fluid, preferably compressed air, to the bottom of the slot and behind the vane to urge the vane into an extended position wherein its free edge moves into a fluid-tight sliding relationship with the outer surface of the working chamber.

A passage is associated with each of the slots and has one extreme end formed in the periphery of the rotor on the side of the slot opposite the direction of rotation of the rotor and an opposite extreme end communicating with the bottom of the slot. The vane is urged into an extended position by the pressurized fluid at the commencement of its power stroke. The pressurized fluid is then delivered through the passage and behind the extended vane to impose a working force against the surface of the extended vane, causing the vane to impart a rotary motion to the rotor. The vane traverses the crescent shaped working chamber to terminate its power stroke by registering with an exhaust port provided in the housing. As the working vane registers with the exhaust port of the working chamber, the slot of the vane moves out of communication with the inlet port so that the vane floats in its slot until it registers with the opposite working chamber where the cycle is repeated. Since there are two working chambers and preferably five equiangular spaced working vanes, there are always two vanes overlappingly progressing their power strokes one in each of the opposite chambers.

The motorized spindle embodying the present invention achieves a much smoother and vibration-free operation than has heretofore been available in motorized spindles by employing two working vanes in diametrically opposite working chambers, thereby balancing the radial forces imposed on the spindle. Furthermore, by employing two blades in simultaneous working engagement, greater torque is available at the tool than has heretofore been available as compared to the output from conventional fluid rotary motors of comparable size. When utilized as a power source for a dressing wheel in a centerless grinder the improved motorized spindle achieves a better dressing of the grinding wheel because of its generally vibration free characteristics.

Another feature of the improved powered spindle lies in its compact configuration. The inherently long configuration required in turbine power spindles is eliminated in the preferred spindle embodying the present invention in that the fluid vane type motor operates satisfactorily at a rotational speed corresponding to the desired rotational speed of the dressing wheel thus eliminating the requirement for a reduction gear connection. Because of this

more compact configuration, the preferred powered spindle can be incorporated in present conventional grinding machines without requiring costly and time consuming modifications to the frame of the grinders. An example of the greatly reduced size for a given power output is illustrated in the dressing wheel application where more rotary power is available to the wheel for the same power input in a unit having an overall length of four inches than is available from a conventional turbine type unit requiring an overall length of 8–10 inches.

It is to be understood that the utility of the present invention is not limited to dressing wheels, but that the free end of the spindle can be adapted to carry a drill head or other tool requiring a source of rotary movement.

A still further advantage of the improved fluid vane type motor is that the total horse-power of the spindle can be increased without increasing the overall diameter of the tool; thus it has been found that an additional one-quarter horse-power can be achieved by adding a module of one and a half inches of length or less to the rotary motor or alternatively by stacking a plurality of rotors. Because of its compact size, a handle can be incorporated with the preferred motorized spindle to develop a small durable hand carried drill of screwdriver.

It is therefore an object of the present invention to reduce the size of motorized spindles by providing a spindle of this type supported for rotation between a pair of spaced spindle bearings and providing a fluid motor between the two spindle bearings so that only one set of bearings is required for the spindle and the motor.

Another object of the present invention is to provide a motorized spindle having vibration-free characteristics by providing a spindle of this type forming an integral component of a fluid vane type motor and having a rotor forming an enlarged section of the spindle shaft and disposed in a motor housing defining a pair of diametrically opposed working chambers and wherein the rotor has a plurality of equiangularly spaced guide slots formed therein, a vane associated with each of the slots and adapted for movement between a retracted position within the slot and an extended position into the working chambers and including a source of pressurized fluid operative to impose a force on the surface of the extended vanes to cause the vanes to impart rotary motion to the spindle shaft and where at least one vane is devloping a power stroke in each of the working chambers at all times so that the forces of the power strokes are substantially equalized.

It is another object of the present invention to eliminate a "dead point" position in fluid vane-type motors by providing such a motor having a pair of oppositely disposed working chambers and a concentric rotor having an odd number of working vanes which move into and out of registry with the working chambers and wherein at least one vane is at all times extended in its power stroke in each of the chambers but because of the odd number of vanes there are never two vanes in their power stroke at exactly diametrically opposed positions.

Still other objects and advantages of the present invention will be made apparent from the following detailed description of a preferred embodiment of invention. The description makes reference to the accompanying drawings in which:

FIG. 1 is an end view of a motorized spindle carrying a dressing wheel which illustrates a preferred embodiment of the present invention;

FIG. 2 is a sectional view of the line 2—2 of FIG. 1;

FIG. 3 is an enlarged sectional view taken along line 3—3 of FIG. 2;

FIG. 4 is an elevational view of the housing sections with the moving parts removed for purposes of describing the porting configuration;

FIG. 5 is a view taken along line 5—5 of FIG. 4;

FIG. 6 is a view taken along line 6—6 of FIG. 5;

FIG. 7 is a view taken along line 7—7 of FIG. 5;

FIG. 8 is a view taken along line 8—8 of FIG. 5;

FIG. 9 is a sectional view taken along line 9—9 of FIG. 7; and

FIG. 10 is a sectional view taken along line 10—10 of FIG. 8.

Now refering to the drawings, FIG. 2 illustrates a preferred motorized spindle as comprising a front housing **10** at one end of which is secured a rotor housing **12** and a cap member **14** preferably by a plurality of bolts **15**. A shaft **16** extends longitudinally through the housing **10** and the rotor housing **12** and has a narrowed end **18** journaled for rotation in a needle bearing **20** seated in a recess in the cap **14**. The shaft **16** has an enlarged portion **22** near its mid-section which is journaled for rotation in a bearing **24** seated in the housing **10**. The bearing **24** is preferably of the double row angular contact ball bearing type capable of supporting the shaft **16** for both radial and thrust loads imposed on the free end. The inner race of the bearing **24** is held in place by a retainer ring **26** and a spacer **28**, both of which are carried by the shaft **16**. The outer race of the bearing **24** is held in place by a shoulder **30** and a spacer **32** which is positioned by a retaining ring **34** seated in the housing **10**. The spacer **32**, in addition to retaining the outer race of the bearing in position, defines an annular shoulder for housing a shaft seal **36**. Normally upon installation, the bearing **24** is fitted to the shaft which is then inserted in the housing **10** and a suitable lubricant provided for the bearing which is retained in the housing in lubricating contact with the bearing by the seal **36**. The extending end of the shaft **16** carries a dressing wheel **38** which is preferably fixed to the shaft **16** against relative rotation by a key **40**. An annular retaining ring **42** is secured to the outer end of the shaft and prevents axial displacement of the dressing wheel with respect to the shaft **16**.

The dressing wheel **38** is preferably of the diamond impregnated type. It is to be understood that although the prefered embodiment of the invention takes the form of a device for imparting rotary motion to a dressing wheel, that the preferred motorized spindle can accommodate a circular grinding wheel, a drill head, or other tools of the type requiring rotory motion without departing from the scope of the present invention.

Still referring to FIG. 2, the housing **10** is adapted to accommodate a suitable supporting apparatus having a hollow nut (not shown), and which is connected to the housing **10** by means of the threaded bore **44**. The supporting device delivers a cooling lubricant to the dressing wheel **38** through a passage **46**, formed in the housing **10** and which has an outlet adjacent the circumferential surface of the dressing wheel **38**.

An annular rotor section **48** is keyed to the shaft **16** and disposed in a chamber **50** provided in the rotor housing **12**. The rotor section **48** has a circular periphery and the chamber **50** preferably has an elliptical cross-section as can best be seen in FIG. 3. The chamber **50** has a narrow diameter at a perpendicular relationship with a large diameter. The rotor **48** has a diameter corresponding to the narrow diameter of the chamber **50** and is concentrically disposed therein to form a pair of similar, crescent shaped diametrically opposed working chambers **52**, having exhaust ports **53**. The rotor **48** has a length corresponding to the length of the working chambers.

The rotor **48** is provided with an odd number of longitudinal slots **54** which are circumferentially spaced inwardly from the outer surface of the rotor **48**. A close fitting vane member **56** is slidably disposed in each of the slots **54** and has a length corresponding to the length of the slot. Each of the vanes **56** has a height less than the depth of the slot **54** so that the vanes are free to float therein.

A pair of opposed elongated arcuate inlet ports **58** is associated with each of the working chambers **52** and are formed in the housing **10** and the cap **14** and radially spaced inwardly from the chambers **52** a distance corresponding to the depth of the slots **54**. A source of pres-

surized air **60** is connected through a hose **61** to a passage **62** formed in end cap **14** and which, as can best be seen in FIGS. 8 and 10 communicates with one of the ports **58**.

The passage **62** communicates with a longitudinal passage **66** in cap **14** which is aligned with a longitudinal passage **68** provided in rotor housing **12**. Passage **62** is fluidly connected to a short longitudinal passage **70** formed in front housing **10** and which, as can best be seen in FIG. 5 communicates with a transversely formed passage **72** and an arcuate slot **74**. Passage **72** delivers pressurized air to one inlet port **54** and has its outer end sealed by a plug **76**. The arcuate slot **74** curves around as shown so that it can be fluidly connected to the opposite inlet port **54** by a passage **78**. The outer end of passage **78** is sealed by a plug **80**.

Now referring to FIGURES 8, 9 and 10 for a description of the exhaust porting, a short longitudinal passage **81** fluidly connects one of the exhaust ports **53** with an elongated arcuate slot **82** formed in end cap **14**. Slot **82** curves around to register with a second longitudinal exhaust passage **84** which fluidly registers with the opposite exhaust port **53** and registers in front housing **10** with a passage **86**. The exhaust air from both of the working chambers is exhausted through passage **86** to an exhaust hose **88**. Preferably, a passage (not shown) is fluidly connected to passage **86** and bleeds sufficient exhaust air to cool bearings **24**.

In operation, the compressed air is delivered to the inlet ports **58**. Referring to FIG. 3, as the rotor **48** rotates, the slots **54** alternatively move into and out of registry with the working chambers **52**. As slots **54** rotate into registry with a working chamber **52**, the bottom end of the slot moves into alignment with the inlet port **58** so that the pressurized air is delivered into the slot and behind the vane **56**. The outer edge of the vane **56** is forced outwardly against the enlarged surface of the working chamber **52**. Preferably the vanes **56** are formed of a material suitable to form a fluid tight seal with the outer surface of the working chambers such as a fiber like graphite or plastic material. The pressurized air simultaneous with forcing the vane **56** into its extended position is also delivered through passages **66** into working chamber **52** and behind the extended vane to impose a force on the extended surface thereof and thus commence a power stroke. As the vane **56** rotates under the force of the pressurized air, it continues to extend to accommodate the enlarged radial surface of the working chamber and then begins to retract within the slot **54** as the radial surface is reduced. The vane **56** continues on its power stroke until its rearward surface registers with the exhaust port **53** thereby exhausting the pressurized air formed in the volume behind the vane **56** and the adjacent vane. Just before the vane **56** registers with the exhaust port **53** it passes out of the registration with the inlet port **58** and is generally free to float within its slot until it registers with the opposite working chamber **52**.

It will be seen that as a result of utilizing a pair of diametrically opposed working chambers and an odd number of vanes, there is always a working vane generating a power stroke in each of the working chambers **52**. Thus, there are at all times two working vanes which enable the preferred power or motorized spindle to have greater power output than conventional fluid vane type rotary motors characterized by a single working chamber accommodating a single working vane. It will further be seen that by providing diametrically opposed working chambers which are simultaneously associated with a power stroke that the forces imposed on the motorized spindle by the power stroke are substantially balanced to thereby provide a substantially vibration-free device.

Another major feature of the preferred spindle is that by providing an odd number of vanes, which are circumferentially spaced, the preferred motorized spindle has two vanes overlappingly progressing through their power strokes in diametrically opposed chambers, there is no possibility of a dead point position, that is, a position where all the forces on the vanes balance each other resulting in a zero net torque. The major feature of the preferred motorized spindle lies in the compact design resulting from the spindle and the motor utilizing a common pair of bearings as distinguished from those types of motorized spindles wherein the spindle has its own unique set of bearing and the motor associated therewith has its own set of bearings thereby necessitating an inherently larger configuration.

This compactness in structure is obtained, in part, by incorporating a motor between that portion of the spindle that is supported between a single pair of bearings and which normally occupies unused space. The preferred embodiment of my invention requires a single pair of bearings to support the spindle for the rotating forces imposed by the motor and the load imposed on the tool carried by the spindle.

It is to be understood that although we have described but one preferred embodiment of the present invention that many modifications and revisions may be made therein without departing from the spirit of the invention or the scope of the appended claims.

I claim:

1. A motorized spindle, comprising, in combination:

(a) a housing having an elliptical chamber defined therein, said chamber having a major axis and a normally extending minor axis;

(b) a shaft supported for rotation in said housing about an axis extending normally to the major and minor axes of the chamber;

(c) an enlarged annular section formed on said shaft and disposed in said chamber, said annular section having a diameter generally corresponding to the dimension of said chamber across its minor axis;

(d) an odd number of radial slots, greater than one, disposed at regular angular intervals about the annular section;

(e) vanes disposed in each of said slots and supported therein for movement between a retracted position wherein their radially outer ends are located in registry with the perimeter of the annular section, and an extended position wherein their radially outer ends extend beyond the perimeter of the annular section;

(f) an even number of means for injecting fluid under pressure into the cavities defined by an extending section of a vane, an adjacent surface of the annular section, and a section of the elliptical chamber, during a particular angle of rotation of said annular section, said means being disposed at equal angular intervals about said elliptical chamber, said fluid urging said vanes into the extended position from said slots so that the surfaces of said vanes move in fluid sealing contact with the surface of said chamber; and

(g) an even number of fluid sinks disposed at equal angular intervals about the elliptical chamber, and each being positioned so as to contact a cavity defined by an extending surface of a vane, the contiguous section of said annular member, and a section of said elliptical chamber, at a point of rotation of said annular member immediately following the termination of supply of pressured fluid to said cavity.

2. The motorized spindle of claim **1**, wherein five vanes are regularly spaced about the annular section, two regularly spaced means for injecting fluid are associated with the annular section and two fluid sinks are associated with the elliptical chamber.

3. The motorized spindle of claim **1**, wherein the means for injecting fluid constitute arcuate slots formed in sections abutting said annular section and spaced longitudinally thereof.

4. The motorized spindle of claim **1**, wherein shoulders are formed between the sides of the annular section and the shaft and the means for injecting fluid are contained within sections abutting the annular section at such

shoulders and are arranged to communicate with passages in said annular section at particular positions of rotation of the annular section.

5. The motorized spindle of claim 4 wherein the shaft is supported by a first bearing retained in one section abutting one shoulder of said annular section and a second bearing formed in a section abutting the other side of said annular section.

References Cited

UNITED STATES PATENTS

2,222,689	11/1940	Schott	91—119 X
577,304	2/1897	June	91—136
1,102,742	7/1914	Hauer	91—138 X
1,931,167	10/1933	Price	91—138 X
2,809,593	10/1957	Klessig	91—138 X

MARTIN P. SCHWADRON, *Primary Examiner.*

IRWIN CHARLES COHEN, *Assistant Examiner.*

U.S. Cl. X.R.

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