

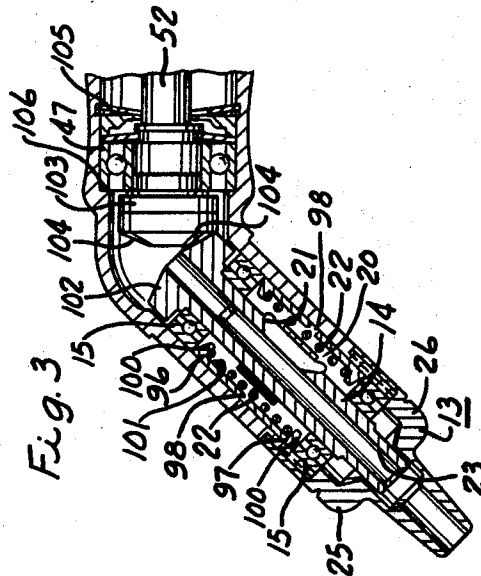
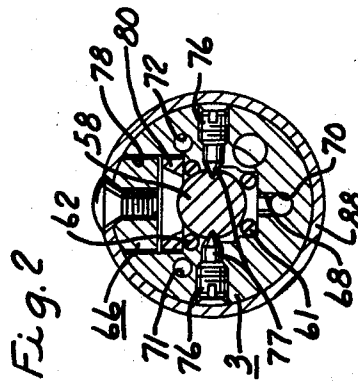
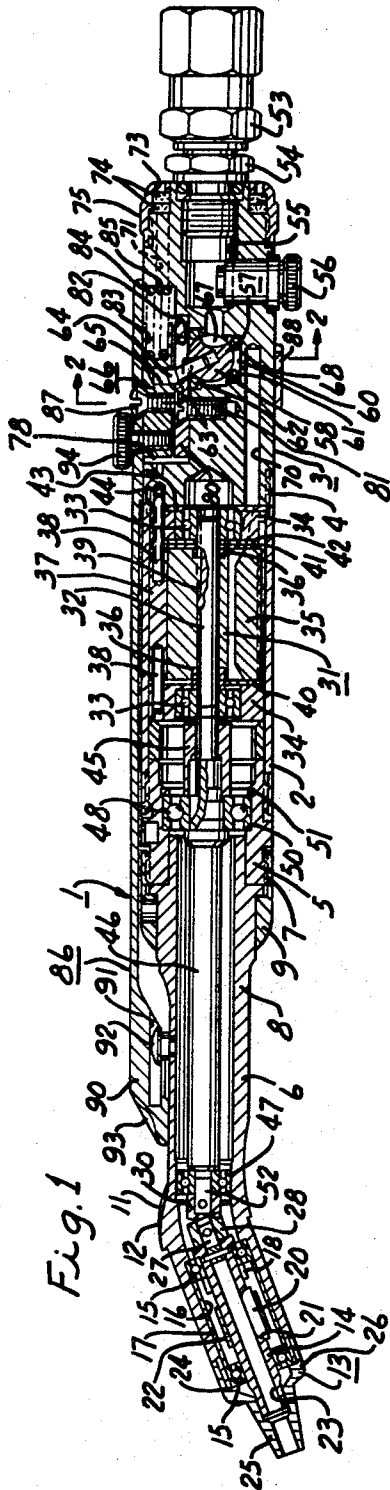
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PNEUMATICALLY DRIVEN SURGICAL INSTRUMENT AND CONTROL THEREFOR

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PNEUMATICALLY DRIVEN SURGICAL INSTRUMENT AND CONTROL THEREFOR
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ABSTRACT OF THE DISCLOSURE

A pneumatically driven surgical instrument having control valve actuator means longitudinally of the housing of the instrument which precise variable finger tip control slidably guidable along the housing body, the forward end of the housing and actuator means adapted to be received with a pen-like grip. The rotary output spindle of the instrument is angularly disposed relative to the housing for clarity of vision.

BACKGROUND OF THE INVENTION

Field of the invention

The pneumatically driven surgical instrument comprising this invention relates to a class of instruments for surgical application in treatment of the living body including inspection and treatment of diseases, wounds, and other abnormal conditions of the bodies of man and animals. These instruments are sometimes referred to as appliances and designed for use in operative surgery together with auxiliary devices used in surgical procedures.

Description of the prior art

The art of pneumatic driven surgical instruments in the surgical armamentarium field is relatively new. Such surgical appliances began to appear in the early 1950's, such as Patent No. 2,740,406. Two more recent instruments are those disclosed in Patents Nos. 3,128,079 and 3,223,088. Of these, Patents Nos. 2,740,406 and 3,223,088 make provision only for pneumatic control of the pressurized gas to the surgical instrument through the use of a slide valve at the rear of the instrument. Not only do these types of control fail to give a precise variable but uniform control and require additional manipulative steps but also are inconveniently located at the rear of the instrument, resulting in necessity of employing of two hands to properly operate and control the instrument.

Many times during surgical procedures, a surgeon's hands must each perform a different task. This is especially true in surgery requiring great dexterity and precision of skills such as in neurosurgical and endaural procedures and procedures under the operation microscope, now commonly referred to as "microsurgery." The application of these types of controls of the prior art would necessitate the use of both hands of the surgeon and at the same time would bring about muscle fatigue quickly which would clearly affect the manual dexterity of the surgeon which, in turn, has a resultant adverse effect on the surgeon's surgical skills.

In the case of Patent No. 3,128,079, a pivotal lever type of control is provided which requires the constant controlling attention of the surgeon's grasping of the handpiece. Muscle fatigue sets in soon in the surgeon's hand and it becomes increasingly difficult for the surgeon to maintain a constant controlled pressure on the lever without "tension shaking" of the surgeon's hand, adversely affecting the surgeon's surgical skills. Moreover, such a pivotal type of lever control requires the application of lateral manually applied force relative to the longitudinal

axis of the handpiece which, upon variance, during the use of such an instrument in a surgical procedure, will result in the application of a jerky or jarring movement on the handpiece. This movement, of course, will be directly transferred to the operative area where it may interfere with not only the talented surgical skills of the surgeon but also cause undesired cutting procedures in the operative area.

The present invention is to provide an instrument that provides the best clarity of surgical procedure being performed and permits precise feather-tip variable control of operating speeds without disadvantages enumerated above.

SUMMARY OF INVENTION

The present invention relates to a pneumatically driven surgical instrument for application in precision surgery where clarity of vision is imperative and precise variable finger tip speed control is necessary over a large range of speeds, acquired by the application of an angularly disposed output housing and spindle and a control valve actuator means slidably guided along the housing of the instrument to extend the manual dexterity of the surgeon without compromising any of his skills.

The offset angle of the output spindle, which may be thirty degrees or more, allows clear vision and excellent maneuverability in microsurgery.

The precise variable finger tip control needs only a feather light touch to allow the application of delicate and highly difficult bone techniques. The variable speed finger tip control allows a range of speeds, from 20 r.p.m. to 20,000 r.p.m., depending on the needs of surgical application, such as adequate torque, the best of which is obtainable at the highest speeds permitting rapid gross bone cutting and removal.

The precise variable control lever actuating the pneumatic inlet valve assembly being slidable longitudinally of the housing of the handpiece or instrument eliminates the cause of any lateral motion to be created to be carried by the handpiece output spindle to the end of the burr or tool inserted into the collet of the spindle having unwanted and undesirable effects in the area of surgical application.

The surgical instrument comprising this invention is designed to reduce and maintain, at a low level, the causes of muscle fatigue of the skillful surgeon's hands with the purpose to extend the application of the surgeon's skills and dexterical ability with the least possible sacrifice.

The instrument is completely autoclavable and the expended gas from the pneumatic rotor is exhausted and diffused at the rearward end of the instrument at a safe distance from the surgical field.

Other objects and advantages of this invention appear hereinafter in the following description and claims.

The accompanying drawings show, for the purpose of exemplification without limiting the present invention and claims thereto, certain practical embodiments illustrating the nature and principles of this invention and application thereof wherein:

FIG. 1 is a longitudinal sectional view of the pneumatically driven surgical instrument comprising this invention.

FIG. 2 is a cross-sectional view along the line 2—2 of FIG. 1.

FIG. 3 is a longitudinal sectional view of a modified form of coupling linkage of the output spindle of the surgical instrument comprising this invention.

Referring to FIG. 1, there is shown a side elevation in cross section of a pneumatically driven surgical instrument 1 for use in surgery and particularly surgery involv-

ing an operation requiring the use of a microscope as in the case of many neurosurgical procedures, comprising housing or shell 2. The valve body 3 is provided on the rear end of the shell 2 and is secured thereto as shown at 4 which may have a threaded engagement or any other convenient form of engagement.

A spindle housing 5 is supported on the forward end of the shell 2 and in turn supports the angle housing 6 as shown at 7 through the use of the lock ring 9. The angle housing 6 comprises the forward end 8 of the handpiece 10 and this portion of the handpiece is contoured to be firmly grasped by the fingers. For example, the sides of the forward end 8 may be recessed for grasping by the thumb and middle finger. The knoll 11 of the forward end may be recessed as shown at 12 to receive the end of the index finger.

The angle housing 6 forward nose position designated as the front housing 13 to rotatably support the output spindle 14 within the aligned bearings 15. The bearings 15 are supported in the cylindrical recess 16 on the inner surface of the front housing 13 and are secured in their aligned position by the sleeve 17 and the bearing retainer 18 and the shoulder 24 of the nose cap 25.

The output spindle 14 may be in the form of a friction collet and/or have a collet insert 20 in the slot 21. The collet spring 22 retains the insert 20 normally within the slot 21 so that the collet insert 20 may frictionally engage the tool or burr within the spindle collet 23.

The nose cap 25 may be threadably secured at 26 to the front housing 13.

The rear portion of the output spindle 14 is secured by the shaft 27 to the knee gear 28, the latter being in angular gear engagement with the knee gear 30.

The shell 2 houses the pneumatic rotor 31 which comprises the rotor shaft 32 supported by the aligned bearings 33 which, in turn, are concentrically supported in the shell 2 on the bearing rings 34. The rotor blades 35 are held to rotate the shaft 32 by being keyed to the shaft 32 as shown at 39, the rotor inserts 36 providing a hermetic seal between the rotor housing encasement and the shaft 32 and bearings 33.

The rotor housing comprises the housing cylinder 37 which is maintained in aligned and secure position by the alignment pins 38, which are recessed in the bearing rings 34. The end walls of the rotor housing encasement comprises the front and rear end plates 40 and 41, respectively, the rear plate 41 being backed up by the vent plate 42 both aligned by the pins 38. The cover plate 43 abuts the rear end of the rotor housing and receives forward end of the valve body 3 and is provided with aligned holes to receive the alignment pins 38.

It should be noted that the alignment pins 38 extend also into the recesses 44 of the valve body 3. Thus, the above mentioned components making up the rotor housing encasement together with the bearings rings 34 and the valve body 3 are maintained in aligned and secured position.

The forward end of the rotor shaft 32 is provided with the coupling driver 45, the latter of which is connected to the spindle 46 in the forward end 8 of the angle housing 6. The spindle 46 is rotatably supported at one end in the angle housing 6 by the bearing 47 and is rotatably supported at its other end by the bearing 48 which is secured in the spindle housing 5 against the shoulder 50 by the retaining ring 51.

The spindle 46 has at its forward end the extension shaft 52 to which is secured the knee gear 30 for interengagement with the knee gear 28.

It can readily be seen that upon application of pneumatic pressure to the rotor blades 35, the rotor shaft 32 will drive the spindle 46 which, in turn, drives the output spindle 14 through the knee gear assembly 28 and 30.

The valve body 3 is provided with the swivel connector 53 secured to the valve body 3 by the nut 54. The swivel connector 53 is connected to a flexible tubing (not shown)

which supplies pneumatic pressure to the chamber 55 in the valve body 3. The oil fitting or plug 56 is provided in the inlet chamber 55 in order that oil may be introduced into the pneumatic supply to provide continual lubrication of the rotor 31.

The gas supply proceeds from the inlet chamber 55 to the valve means 57 which comprises the ball valve 58 supported in the valve chamber 60 on the lower and upper O-rings 61 and 62, respectively. The ball valve 58 is provided with the valve stem 63 which has a rounded end portion 64 to be received in the recess 65 of the valve actuator 66.

The ball valve 58 is provided with the cup-shaped recess 67 which, upon rotation of the ball valve 58, permits a selected amount of pressurized gas to pass from the inlet chamber 55 through the base of the valve chamber 60, out the valve chamber outlet 68 to the passageway 70. The cup-shaped recess 67 is unique in that its particular contour or shape permits a controlled amount of pressurized gas to be supplied to the rotor 31 permitting the pneumatically driven surgical instrument to have a wide variable range of speeds beginning at 20 r.p.m. up to 20,000 r.p.m. upon the mere rotation of the ball valve 58 of an arcuate length of approximately forty-five degrees or less. Thus, the ball valve 58 together with its cup-shaped recess 67 and the O-rings 61 and 62 cooperate to provide a means for throttling the pressurized gas to the rotor 31 in a precision manner to permit a selected desired amount of pressurized gas to flow out of the valve chamber 60 into the passageway 70.

From the passageway 70 the pressurized gas is directed through a transverse opening through the cover plate 43, the bearing ring 34, through the vent plate 42 and end plate 41. The pressurized gas thus enters the encasement of the rotor 31 where it is applied against the rotor blades 35 to rotatably drive the shaft 32 and spindle 46.

Atop the housing encasement there is provided radial openings through another area of the end plate 41 and vent plate 42 for exhausting the expended gases from the pneumatically driven rotor 31 through the passageways 71 and 72 as shown in FIG. 2. The expended gas passageways 71 and 72 traverse the entire length of the valve body 3 and are exhausted out of the valve body 3 at the exhaust outlet 73 through the muffler ring or diffuser 74. The muffler ring 74 is retained in its proper position on the end of the valve body 3 by the muffler ring 75.

In providing more than one expended gas passageway in the valve body 3, the expended gas from the pneumatically driven rotor 31 is permitted to exit from the surgical instrument 1 as efficiently as possible and thus prevent any possibility of gas build-up in the rotor housing encasement. This reduces the possibility of gas leakage through other internal components of the surgical instrument 1 or otherwise reducing the efficient operation of the rotor 31.

As noted in FIG. 2, the ball valve 58 is supported on the pivot screws 76 which are secured within the valve body 3 and are provided with the pivoting points 77 to rotatably support the ball valve 58 within the O-rings 61 and 62.

As mentioned previously, the valve stem 63 of the ball valve 58 has the rounded portion 64 which fits into the recess 65 of the valve actuator 66. The recess 78 is provided in the valve body 3 for the valve actuator 66. The retainer plate 80 is secured to the bottom of the recess 78 by the screw member 81 in order to retain the ball valve 58 together with its O-rings 61 and 62 within the valve chamber 60. The retainer plate 80 is provided with the opening 82 which is frusto-conical in cross section to permit the passage of the valve stem 63 for rotatable encasement in the recess 65 of the valve actuator 66.

The rearward portion of the valve actuator 66 is provided with an annular opening 83 for retaining the coil spring 84 in the recess 78, which spring is biased against the back wall 85 of the recess 78. Thus, the valve actuator 66 is maintained in a normally forward position in the

recess 78 as shown in FIG. 1 until the valve actuator 66 is forced rearwardly in the recess 78 to rotatably operate the valve means 57.

A unique principal feature of the surgical instrument 1 comprising this invention resides in the type of valve control wherein there is provided the lever control 86 which is attached to the valve actuator 66 at its rearward end by the screw member 87 and is slidably engageable on the valve body 3 in view of the collar 88. The forward end of the lever control 86 is provided with a buttress 90 which has an inwardly disposed guide groove 91 for guided slidable engagement on the lever pin guide 92, the latter of which is secured to the forward end 8 of the surgical instrument 1. The buttress 90 is provided with the recessed area 93 to receive the pad of the first phalanx of the index finger to forcibly operate the lever control 86 and valve actuator 66 against the coil spring 84 to rotate the ball valve 58 within the valve chamber 60. The amount of pressure applied on the buttress 90 may be varied in a precise manner to bring about the rotational speed of the output spindle 14 desired. Thus, only the light feather touch of the index finger is needed to operate the surgical instrument 1 thereby enhancing the surgeon's dexterity in permitting him to extend without any compromise whatsoever his skills to the immediate surgical procedure needs.

For extended application of the surgical instrument 1 the lever control 86 together with the valve actuator 66 may be provided with the locking means 94 in the form of a lock screw threadably secured within the valve actuator 66 as indicated at 95 to project against the retainer plate 80 and, thus, maintain the lever control 86 in the desired position. It should be noted the importance of the collar 88 in that it not only provides for smooth operation of the lever control 86 but also retains the valve actuator 66 within the recess 78 of the valve body 3.

The controlling of a pneumatically driven surgical instrument for use in surgical procedures involving precision work, such as neurosurgical procedures or operations performed under an operation microscope, requires a unique valve actuating means and control lever as against the previously known type of valve actuating controls found in the prior art. A slidable guided control lever permits precise movement of the control lever and therefore precise control of the valve means especially like the control lever 86 of the present application which permits a grasping of the surgical instrument 1 in the palm of one's hand which results in complete freedom of use of the index finger and thus the best possible manual dexterity of the same in applying a variable but selective force on the buttress 90 of the lever control 86. In this connection, it is also very important to note that control levers utilized in the prior art, such as an outwardly pivoting control lever as in Patent No. 3,128,079, permit the application of a hand squeezing maneuver in controlling the surgical instrument which is undesirable in precision surgery of the type heretofore mentioned since the results of such a maneuver are carried on to the surgical instrument itself and thus to the area of surgical application of the instrument. In other words, there is a greater tendency on the part of pivotal lever controls previously known in the prior art to bring about a jerking movement on the grasped surgical instrument and after long periods of use bring about muscle fatigue having a detrimental effect on the manual dexterity of the surgeon. Such jerking or jarring movements in controlling surgical instruments of this type are eliminated by the type of lever control comprising this application since all movement of the lever control 86 is longitudinal relative to the surgical instrument 1.

Thus, the important features of the present invention reside in the precise finger tip control of the valve means 67 to produce the desired selective operating speed of the rotor 31 and the application of an output spindle 14 rotatably driven by the rotor 31 through the spindle 46, being angularly disposed relative to the latter permitting

a clarity of vision for the surgeon in the application of the surgical instrument 1 to the area of surgery.

FIG. 3 is a modification of the angularly disposed front housing 13 of FIG. 1 wherein the front housing 13 has the nose cap 25 which retains the spindle assemblage within the front housing 13. The output spindle 14, as in the case of FIG. 1, is rotatably supported in the bearings 15 and is provided with the collet insert 20 for engagement in the slot 21 in the spindle 14. The collet insert 20 is maintained in the slot 21 by the collet spring 22 to frictionally engage the shaft of a cutting tool or burr inserted into the spindle collet 23 of the output spindle 14.

Unlike the sleeve 17 of FIG. 1, the structure of FIG. 3 is provided with two separate sleeves 96 and 97 which are spaced apart as shown at 98 and each having a shoulder 100 at their opposite opposed ends to not only retain the coil spring 101 but also to retain the bearings 15 in a secured relationship as was the function of the bearing retainer 18 of FIG. 1.

The rotor coupling assemblage of the structure of FIG. 3 comprises the knee discs 102 and 103 which have angularly disposed frictional engaging surfaces 104 to properly transfer the rotary power of the spindle 46 through its shaft 52 secured to the knee disc 103 to the angularly disposed output spindle 14 through the knee disc 102. Continuous engagement of the frictional surfaces 104 is maintained by the application of the stored energy in the coil spring 101 against the shoulder 100 of the sleeve 96 and, thus, against the bearing 15 together with the knee disc 102. The retaining ring 105 shoulders the support bearing 47 against the shoulder 106.

It should be readily noted that the application of the friction disc assemblage of FIG. 3 performs the function of a clutch through the transmission of power to the output spindle 14. Thus, if the burr inserted in the collet 23 becomes overloaded, the friction disc assemblage will permit slippage between the knee discs 102 and 103 and protect the rotor 31 of the surgical instrument 1.

I claim:

1. In a pneumatically driven surgical instrument, an elongated housing having a pneumatically driven rotor mounted to turn within said housing, a front housing extending from said elongated housing rotatably supporting an output spindle in the form of a collet for receiving a cutting tool, means for connecting said rotor in driving relationship with said spindle, valve means in said housing to pneumatically supply said rotor, said surgical instrument characterized by valve actuator means comprising a slidable lever control adjacent of said elongated housing with its rearward end connected to a valve actuator slidably biased in a recess in said elongated housing, a valve stem in said valve means with its end extending into said valve actuator, a buttress slidably guidable on the forward end of said elongated housing and secured to the forward end of said lever control, said valve means comprising a valve body on said elongated housing having a valve chamber and having an inlet on the valve chamber side and an outlet in a valve chamber end wall, a ball valve seated in said valve chamber for pivotal rotation between a pair of aligned elastomer O-rings and having a cup-shaped recess therein to direct a desired amount of pneumatic supply from said inlet to said outlet upon operation of said valve actuator means.

2. In the pneumatically driven surgical instrument of claim 1, said valve actuator block provided with actuator lock means to hold and maintain said valve actuator means in a selected position, said buttress having a finger pad receiving area.

3. In the pneumatically driven surgical instrument of claim 1, said front housing characterized by being angularly disposed relative to said elongated housing, said means for connecting said rotor in driving relationship with said output spindle comprising an angularly disposed power transferring coupling assembly.

4. In the pneumatically driven surgical instrument of claim 3, said power transferring coupling assembly comprising a pair of angular disposed rotatably supported knee gears, one secured to said output spindle and the other secured to said rotor.

5. In the pneumatically driven surgical instrument of claim 3, said power transferring coupling assembly comprising a pair of angular disposed, rotatably supported discs having friction engaging surfaces, one secured to said output spindle and the other secured to said rotor, at least one of said discs spring biased toward the other to maintain continuous frictional contact between said friction engaging surfaces.

6. In the pneumatic control for a pneumatically driven surgical instrument, an elongated housing for supporting a pneumatically driven rotor mounted to turn within said housing, a valve body secured to said housing having a valve chamber to receive a spherical valve having a cup-shaped recess, a pneumatic supply inlet to said valve chamber and a pneumatic supply outlet connected to a passageway to said rotor, said spherical valve having a valve stem and rotatably supported in said valve chamber within a pair of aligned elastomer O-rings, a valve actuator means comprising a longitudinally disposed lever control adjacent to said housing and slidably guided therealong, a valve actuator secured to one end of said lever control and slidably biased in a recess in said valve body and having an opening to receive said valve stem, a buttress secured to the other end of said lever control and slidably guidable on said housing.

7. The pneumatic control for a pneumatically driven surgical instrument of claim 6 characterized by an actuator lock means to hold and maintain said valve actuator means in a selected position, said buttress having a finger pad receiving area.

8. In the pneumatic control for a pneumatically driven surgical instrument, an elongated housing for supporting a pneumatically driven rotor mounted to turn within said housing, a valve body secured to said housing having a valve chamber to receive a rotary valve having a cup-shaped recess, a pneumatic supply inlet to said valve chamber and a pneumatic supply outlet from said valve chamber connected to a passageway to said rotor, said rotary valve having a valve stem and rotatably supported in said valve chamber within a pair of aligned elastomer O-rings, a valve actuator means including a longitudinally disposed lever control adjacent to said housing and slidably guided therealong and having an opening in the rearward portion thereof to receive said valve stem.

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U.S. Cl. X.R.

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