AIR DRIVER FOR DENTAL HAND PIECE

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This invention relates to driving motors for dental tools, and more particularly to a dental hand piece driven by compressed air.

A main object of the invention is to provide a novel and improved air-driven dental motor in the form of a hand piece, the motor being simple in construction, being very compact in size, being reversible in action, and developing high torque.

A further object of the invention is to provide an improved air-driven dental hand piece which is relatively inexpensive to manufacture, which is durable in construction, which is easy to hold, which develops high torque, and which is efficient in operation.

A still further object of the invention is to provide an improved dental hand piece driven by compressed air and being reversible in operation, the hand piece being shaped so that it is comfortable to hold and to manipulate, being relatively light in weight, and being provided with easily accessible valve means for controlling its direction of operation.

Further objects and advantages of the invention will become apparent from the following description and claims, and from the accompanying drawings, wherein:

FIGURE 1 is a fragmentary side elevational view, partly in longitudinal vertical cross section, of an improved air-driven dental hand piece constructed in accordance with the present invention.

FIGURE 2 is a transverse vertical cross sectional view taken substantially on line 2--2 of FIGURE 1.

FIGURE 3 is a transverse vertical cross sectional view taken substantially on line 3--3 of FIGURE 1.

FIGURE 4 is a transverse vertical cross sectional view taken substantially on line 4--4 of FIGURE 1.

FIGURE 5 is a transverse vertical cross sectional view taken substantially on line 5--5 of FIGURE 1.

FIGURE 6 is a fragmentary cross sectional view taken substantially on line 6--6 of FIGURE 5.

FIGURE 7 is a fragmentary cross sectional detail view taken substantially on line 7--7 of FIGURE 1, showing the reversing valve structure employed in the hand piece.

FIGURE 8 is a fragmentary elevational view taken substantially on the line 8--8 of FIGURE 1.

Referring to the drawings, the improved air-driven hand piece is designated generally at 11 and comprises a main housing 12 formed integrally with the multiple-bore conduit portion 13 which extends at an obtuse angle to the axis of the main body 12 and which is formed with the compressed air inlet bore 14 and the exhaust bore 15. The bore 14 is connected to a suitable source of compressed air. The conduit member 13 is formed with a pair of additional bores at its upper portion, shown at 16 and 17 which may be selectively connected to the compressed air supply passage 14 by the provision of a transversely extending selector valve 18 which is slidably mounted in a transverse bore 19 provided in the angulated conduit member 13. As shown in FIGURES 7 and 8, the valve member 18 comprises a generally cylindrical body formed with the reduced intermediate portion 20 defining an annular groove 21 which is of sufficient width so that it can establish communication between supply passage 14 and either one of the passages 16 and 17, as desired. Thus, in the position shown in FIGURE 7, the valve member 18 connects supply passage 14 to the passage 16, providing forward drive of the device, as will be presently described. By moving the valve member 18 toward the right, the groove 21 may be positioned so as to connect the inlet passage 14 with the passage 17, to provide reverse drive, as will be presently explained.

The valve body 18 is provided at the opposite ends of the groove 21 with two annular grooves 22 and 23 receiving the respective resilient deformable sealing rings 24 and 25 which seal the valve body 18 in the bore 19. The body 18 is located so that it can be easily manipulated by the fingers of the hand holding the body 12, whereby the user may readily reverse the direction of movement of the burr or other implement attached to the hand piece.

A retaining screw 26 is threaded into the conduit portion 13 adjacent the mid-portion of the bore 19, said screw having a reduced inner end portion 27 receivable in the groove 21 and cooperating therewith to limit the endwise movement of the valve body 18 either to the position shown in FIGURE 7 or to the opposite position thereof wherein passage 14 is connected to passage 17, as above described.

The valve body 18 as illustrated in the drawings has a generally circular cross section, but obviously, may be made with any desired cross sectional shape.

Designated at 28 is a hollow shaft which is rotatably mounted axially in the body 12, for example, being rotatably supported on spaced ball bearings 29 and 30, the ball bearing assembly 29 being located adjacent the right end of the housing 12, as viewed in FIGURE 1, and the ball bearing assembly 30 being located adjacent the end of member 31 threaded and secured inside housing member 12.

Secured on the hollow shaft 28 is a turbine wheel 32 having the rightward facing blades 33 and the leftward facing blades 34, as viewed in FIGURE 1. As viewed in FIGURE 2, the blades 33 are located so that their concave surfaces face in a clockwise direction, as viewed in FIGURE 2, whereas the concave surfaces of the blades 34 face in a counterclockwise direction. The compressed air inlet passage 16 is formed at its top end with a nozzle portion 35 discharging into the annular space containing the blades 33, whereas the compressed air inlet section 17 is formed at its top end with a nozzle portion 36 communicating with the annular space containing the turbine blades 34.

Thus, when the valve member 18 is in the position shown in FIGURE 7, the compressed air supplied from the passage 14 enters the passage 16 and is discharged through the nozzle 35 against the concave surfaces of the turbine blades 33, driving the shaft 28 in a clockwise direction, as viewed in FIGURE 2. Similarly, when the valve member 18 is pushed rightward to connect passage 14 to passage 17, the compressed air discharges through the nozzle 36 against the concave surfaces of the blades 34 to rotate the shaft 28 in a counterclockwise direction, as viewed in FIGURE 2.

The turbine wheel 32 is formed with a plurality of apertures 37 located at the inner portion of the wheel so as to connect the opposite sides thereof. An annular space or groove 38 is provided in the end wall of housing 12 which acts as a receiving space to receive decompressed air after it impinges against the turbine blades 33 and to thereby prevent pressure build up in this region. The groove 38 allows the air to pass into the inner space of the turbine wheel 32 and through the apertures 37. This air then passes through apertures 39 provided in the plug 40 and flows to a space 41 in the intermediate portion of the body 12 which is in communication with the conduit portion 13, as shown in FIGURE 15. The air is thus discharged through said exhaust passage and leaves the device.

Shaft 28 is formed with an annular groove 41 and the plug 31 is provided with a cavity 42 whose inner periphery...
3 concentric with the annular groove 41. Two diametrically opposed rings 42, 43, making tight frictional contact with the grooves and having normal outside diameters slightly greater than the radial distances between grooves 41 and 43 so that the rings are tightly compressed. Due to the tight frictional contact between the rings 44 and the surfaces of grooves 41 and 43 engaged thereby, rotation of shaft 28 causes the rings to roll with planetary motion around shaft 28. 10 namely, causes the rings to revolve in the space 42.

Designated at 45 is a hollow pulley member rotatably mounted in the housing 12, said pulley member being provided with respective ball bearing assemblies 47, 48, receiving within the rings 44, 44 so that the rings 44 engage the outer race elements of the ball bearing assemblies and transfer torque to the pulley member 45 as the rings revolve around the shaft 28 in their planetary motion. The driving connection is thus defined between the turbine wheel 32 and the pulley 45 which is effective in either direction of rotation of said turbine wheel.

Designated at 48 is the driven shaft of the hand piece, which is rotatably mounted in the forward housing extension 49. The housing extension member 12 is connected to the main housing body 12 by an annular coupling member 50, the extension member 49 being threadedly secured in the forward end of the coupling member 50 and the rear end of said coupling member being threadedly secured in the forward end portion of the main housing member 12, as is clearly shown in FIGURE 1. A ball bearing assembly 52 rotatably supports the hollow shaft 48 in the rear end portion of the housing extension 49. Keyed on the rear end portion of the driven shaft 48 is a wheel 53 having a forwardly convergent conical sleeve portion 54. The wheel 53 also has a forwardly convergent conical rim portion 55. A sleeve member 56 is rotatably disposed within coupling member 50, surrounding the wheel 53 and its sleeve portion 54. Sleeve 56 has a forwardly convergent conical bore 57 biased toward driving engagement with the conical sleeve portion 54 by an annular resilient ring 58 bearing between an annular flange 59 on shaft member 48 and the forward end of sleeve member 56, the ring 58 being of frusto-conical configuration and being under sufficient tension to urge the conical bore 57 of sleeve member 56 against the conical element 54 with driving contact. Bore 57 is normally disengaged from conical member 54 by a pair of opposed inclined slots 60, 62, the slots being carried by a speed-controlling ring member 61 rotatably mounted on the coupling member 50, the pins 60 extending through inclined slots 62, 62 provided in the coupling member 50. The pins 60 are engageable against an annular flange 62' provided on the sleeve 56 so as to normally oppose the tension of the frusto-conical biasing ring 58, but in the normal position of the ring member 61, rotation of sleeve member 56 is not prevented. Said sleeve member may be locked against rotation by rotating ring 61 in a counterclockwise direction, as viewed in FIGURE 5, whereby the slots 62 force the pins 60 against the flange 62', locking the sleeve 56 against rotation.

Also, with the ring 61 is rotated counterclockwise, as viewed in FIGURE 5, the forwardly convergent conical rear end portion of member 56 is brought into wedging engagement with a correspondingly shaped forwardly convergent conical bore portion 63 provided in the rear end of the sleeve member 56, cooperatively with pins 60 and flange 62 to lock the sleeve member 56 against rotation.

When the ring 61 is rotated in a clockwise direction, as viewed in FIGURE 5, from the normal position thereof illustrated in FIGURES 5 and 6, the member 56 is free to rotate in the coupling sleeve 50 and, as above mentioned, is freely communicative to the cone element 54 at the conical bore surface 57. Also, the conical periphery of flange portion 55 is forced into driving contact with the conical inside surface 65 of the rearwardly flaring member 66 and a corresponding conical bearing force of the resilient frusto-conical biasing ring 58.

Secured on the member 53 are a plurality of shaft elements 67 extending parallel to the axis of shaft 28 and located at equal radial distances therefrom, each of the shaft elements 67 being provided with a ball bearing unit 68, said ball bearing units being located in an annular cavity 69 provided in the member 56 and receiving the forward portion of the wheel 45. Said forward portion is formed with the annular groove 70 which is concentric with the inwardly facing annular groove 71 provided in the member 56. Interposed between the ball bearing units 68 are respective resilient drive rings 72 whose normal outside diameters are slightly greater than the radial distance between the grooves 70 and 71 so that the rings are somewhat under compression and thereby make frictional driving contact with both the grooves 70 and 71.

When the ring 61 is rotated in a clockwise direction from its normal position, as viewed in FIGURE 5, releasing the member 56, as above described, said member is driven at the same rate as the pulley member 45 by the coupling action of the rings 72 acting on the member 63 through the member 61. Ring member 61 free to rotate, the rotation of the pulley member 45 causes the rings 72 to roll into engagement with the ball bearing units 68 and to transmit torque directly from the pulley member 45 to the member 53 through the shaft elements 57, thereby providing direct coupling between pulley member 45 and shaft 48. However, when the ring member 61 is rotated in a counterclockwise direction, as viewed in FIGURE 5, from its normal position, the member 56 is locked to the coupling sleeve 50, as above described, and the rings 72 are forced to roll along the inwardly facing annular groove 71, driving the shaft element 67 through the roller bearings 68 and thus driving the shaft 48 at a speed substantially slower than the speed of the pulley member 45. Therefore, when the ring 61 is rotated in a counterclockwise direction from the middle position illustrated in FIGURE 5, the shaft 48 will be driven at progressively slower speeds until finally when the pin elements 60, 60 reach the limiting positions in the slots 72 preventing further counterclockwise rotation of the ring 61, the shaft 48 will be driven at its lowest speed, corresponding to complete clamping without slippage of the movable clutch element 53 to the stationary coupling sleeve member 59.

Conversely, projecting rings 61 is rotated in a clockwise direction from the position thereof shown in FIGURE 5, the pin elements 60, 60 provide an increasing degree of release of the clutch member 53 so that the speed of shaft 48 increases and begins to approach the speed of the driving pulley 45. Finally, when the limit of clockwise rotation of the engagement of the pins 60, 60 with the corresponding ends of the slot 62, 62, the movable clutch member 53 is completely released relative to the coupling sleeve 50 and the sleeve 53 is coupled directly to the driving pulley 45, so that the shaft 48 rotates at the same speed as said driving pulley. Under these conditions, the forward ends of the shaft member 67, shown at 75, engage in apertures 76 provided in the movable clutch member 56, the clutch member 56 being moved into such engagement by the action of spring 58, ensuring positive locking of clutch member 56 to the driven clutch member 53.

As will be readily apparent, the conical tapered surfaces cocasting with each other, such as the conical surface on member 54 and the conical receiving surface 57, and the conical surface on member 55 and the conical receiving surface 65, as well as the frusto-conical surface on the member 56 and the mating conical receiving surface associated therewith on the coupling sleeve 50,
function to provide a centering action to maintain the components in centered relationship and to minimize vibration and wear over the entire range of speed adjustment of the device.

The hand piece 11 is provided with conventional chuck means, not shown, for holding burrs and other dental implements. Said chuck means is controlled by longitudinal central shaft 80 which extends axially through the hollow shaft assembly 48, through the pulley member 45 and through the hollow shaft member 28, and is provided at its rear end with an operating knob 81. The chuck means can be tightened by rotating the knob 81 in one direction and can be loosened by rotating said knob 81 in the opposite direction, in a conventional manner. For holding the driving shaft 48 stationary during such tightening or during replacement of the burrs or other dental implements employed with the hand piece, a toothed locking wheel 82 is provided on the forward end of the shaft assembly 48, said locking wheel being engageable by a manually operated plunger member 83 slidably mounted and extending transversely through the wall of member 49. The plunger member 83 is provided with an external actuating head 84 and is biased outwardly by suitable means, such as a coil spring 85 surrounding the plunger member and bearing between head 84 and the external wall surface of member 49, as shown in FIGURE 1, outward movement of the plunger member being limited by a transverse stop pin 86 extending through the inner portion of the plunger member 83. The plunger member 83 is located so that when it is pushed inwardly, for example, by exerting inward pressure on the head 84, the inner end of the plunger member is engageable between the teeth of the toothed locking wheel 82, whereby the shaft assembly 48 may be held locked against rotation. With the assembly 48 thus locked, the required tightening or replacement of the burrs or other dental implements may be easily accomplished. When the pressure on the head 84 is released, the plunger member 83 disengages from the toothed locking wheel 82, releasing the shaft assembly 48 for rotation.

Lubrication of the interior of the hand piece is accomplished by particles of oil carried by the compressed air employed for driving the apparatus. Thus, when the compressed air is admitted into the housing 12, for either forward or reverse drive of the device, the particles of oil carried thereby are distributed into the interior of the housing 12 and various moving parts therein, providing the required lubrication of said moving parts.

While a specific embodiment of an improved air-driven dental hand piece has been disclosed in the foregoing description, it will be understood that various modifications within the spirit of the invention may occur to those skilled in the art. Therefore it is intended that no limitations be placed on the invention except as defined by the scope of the appended claims.

What is claimed is:

1. A dental hand piece comprising a housing, a driven shaft journaling in said housing, said housing being provided with a turbine chamber, a turbine wheel journaling in said chamber, means to admit fluid under pressure to the periphery of said turbine wheel, a driven clutch element on said driven shaft, an axially movable clutch sleeve surrounding said driven clutch element, means to move the sleeve axially, a pulley wheel rotatably mounted adjacent to and driven by said turbine wheel, means on said sleeve drivingly engageable with said driven clutch element when the sleeve is moved axially in one direction, speed reduction means when the sleeve is moved in said opposite direction.

2. A dental hand piece comprising a housing, a driven shaft journaling in said housing, said housing being provided with a turbine chamber, a turbine wheel journaling in said chamber, said turbine wheel being provided with a first set of concave peripheral blades facing in one direction and a second set of concave peripheral blades facing in the opposite direction, said housing being provided with a fluid pressure conduit, means to selectively supply fluid from said conduit either to said first set of blades or to said second set of blades, whereby to reversibly drive the turbine wheel, a driven clutch element on said driven shaft, an axially movable clutch sleeve surrounding said driven clutch element, means to move the sleeve axially, a pulley wheel rotatably mounted adjacent to and driven by said turbine wheel, means on said sleeve drivingly engageable with said driven clutch element when the sleeve is moved axially in one direction, means to lock the sleeve against rotation when the sleeve is moved axially in the opposite direction, means to couple said sleeve directly to said pulley wheel responsive to the movement of the sleeve in said one direction, speed reduction means, and means to drivingly couple said pulley wheel to said driven shaft through said speed reduction means when the sleeve is moved in said opposite direction.

3. A dental hand piece comprising a housing, a driven shaft journaling in said housing, said housing being provided with a turbine chamber, a turbine wheel journaling in said chamber, means to admit fluid under pressure to the periphery of said turbine wheel, a driven clutch element on said driven shaft, an axially movable clutch sleeve surrounding said driven clutch element, means to move the sleeve axially, a pulley wheel rotatably mounted adjacent to and driven by said turbine wheel, friction driving means coupling the turbine wheel to said pulley wheel, means on said sleeve drivingly engageable with said driven clutch element when the sleeve is moved axially in one direction, means to lock the sleeve against rotation when the sleeve is moved axially in the opposite direction, means to couple said sleeve directly to said pulley wheel responsive to the movement of the sleeve in said one direction, speed reduction means, and means to drivingly couple said pulley wheel to said driven shaft through said speed reduction means when the sleeve is moved in said opposite direction.

4. A dental hand piece comprising a housing, a driven shaft journaling in said housing, said housing being provided with a turbine chamber, a turbine wheel journaling in said chamber, said turbine wheel being provided with a first set of concave peripheral blades facing in one peripheral direction and a second set of peripheral blades facing in the opposite peripheral direction, said housing being provided with a fluid pressure conduit, means to selectively supply fluid from said conduit either to said first set of blades or to said second set of blades, whereby to reversibly drive the turbine wheel, a driven clutch element on said driven shaft, an axially movable clutch sleeve surrounding said driven clutch element, means to move the sleeve axially, a pulley wheel rotatably mounted adjacent to and driven by said turbine wheel, friction driving means coupling the turbine wheel to said pulley wheel, means on said sleeve drivingly engageable with said driven clutch element when the sleeve is moved axially in the opposite direction, means to couple said sleeve directly to said pulley wheel responsive to the movement of the sleeve in said one peripheral direction, speed reduction means, and means to drivingly couple said pulley wheel to said driven shaft through said speed reduction means when the sleeve is moved in said opposite peripheral direction.

5. A dental hand piece comprising a housing, a driven shaft journaling in said housing, said housing being pro-
vided with a turbine chamber, a turbine wheel journaled in said chamber, means to admit fluid under pressure to the periphery of said turbine wheel, a driven clutch element on said driven shaft, an axially movable clutch sleeve surrounding said driven clutch element, means to move the sleeve axially, a pulley wheel rotateably mounted adjacent said turbine wheel, said turbine wheel having a reduced shaft portion extending adjacent said pulley wheel, a coupling sleeve rotateably mounted coaxially with said reduced shaft portion, means to couple said sleeve directly to said driven clutch element responsive to the movement of the sleeve in said one axial direction, whereby the driven clutch element is substantially directly driven by the pulley wheel, and whereby the driven clutch element is coupled to the pulley wheel through said projection and friction wheel to provide a speed reduction when the sleeve is moved in said opposite axial direction.

8. A dental hand piece comprising a housing, a driven shaft journaled in said housing, a sleeve being provided with a turbine chamber, a turbine wheel journaled in said chamber, said turbine wheel being provided with a first set of concave peripheral blades facing in one peripheral direction and a second set of concave peripheral blades facing in the opposite peripheral direction, said housing being provided with a fluid pressure conduit, means to selectively supply fluid from said conduit either to said first set of blades or to said second set of blades, whereby to reversibly drive the turbine wheel, a driven clutch element on said driven shaft, an axially movable clutch sleeve surrounding said driven clutch element, means to move the sleeve axially, a pulley wheel rotateably mounted adjacent said turbine wheel, a coupling sleeve rotateably mounted coaxially with said reduced pulley wheel portion, a projection on said driven clutch element extending adjacent to said sleeve having a reduced portion received in said annular rear portion, a transverse resilient friction ring engaged between the inside surface of said hollow rear portion and said reduced pulley wheel portion, a projection on said driven clutch element extending adjacent to and in the path of rolling movement of said friction ring, and means to couple said sleeve directly to said driven clutch element responsive to the movement of the sleeve in said one axial direction, whereby the driven clutch element is substantially directly driven by the pulley wheel, and whereby the driven clutch element is coupled to the pulley wheel through said projection and friction wheel to provide a speed reduction when the sleeve is moved in said opposite axial direction.

9. A dental hand piece comprising a housing, a driven shaft journaled in said housing, said housing being provided with a turbine chamber, a turbine wheel journaled in said chamber, said turbine wheel being provided with a first set of concave peripheral blades facing in one peripheral direction and a second set of concave peripheral blades facing in the opposite peripheral direction, said housing being provided with a fluid pressure conduit, means to selectively supply fluid from said conduit either to said first set of blades or to said second set of blades, whereby to reversibly drive the turbine wheel, a driven clutch element on said driven shaft, an axially movable clutch sleeve surrounding said driven clutch element, means to move the sleeve axially, a pulley wheel rotateably mounted adjacent said turbine wheel, a coupling sleeve rotateably mounted coaxially with said reduced pulley wheel portion, a projection on said driven clutch element extending adjacent to said sleeve having a reduced portion received in said annular rear portion, a transverse resilient friction ring engaged between the inside surface of said hollow rear portion and said reduced pulley wheel portion, a projection on said driven clutch element extending adjacent to and in the path of rolling movement of said friction ring, and means to couple said sleeve directly to said driven clutch element responsive to the movement of the sleeve in said one axial direction, whereby the driven clutch element is substantially directly driven by the pulley wheel, and whereby the driven clutch element is coupled to the pulley wheel through said projection and friction wheel to provide a speed reduction when the sleeve is moved in said opposite axial direction.
axial direction, whereby the driven clutch element is substantially directly driven by the pulley wheel, and whereby the driven clutch element is coupled to the pulley wheel through said projection and friction wheel to provide a speed reduction when the sleeve is moved in said opposite axial direction, a toothed locking ring on said driven shaft, and a locking plunger slidably mounted in the wall of said housing substantially radially relative to said locking ring and being movable at times into locking engagement therewith.

10. A dental hand piece comprising a housing, a driven shaft journaled in said housing, said housing being provided with a turbine chamber, a turbine wheel journaled in said chamber, said turbine wheel being provided with a first set of concave peripheral blades facing in one peripheral direction and a second set of concave peripheral blades facing in the opposite peripheral direction, said housing being provided with a fluid pressure conduit, means to selectively supply fluid from said conduit either to said first set of blades or the said second set of blades, whereby to reversibly drive the turbine wheel, a driven clutch element on said driven shaft, an axially movable clutch sleeve surrounding said driven clutch element, a speed controlling ring rotatably mounted on said housing, an inwardly projecting pin element carried by said ring, said housing having an inclined cam slot slidably receiving said pin element, a pulley wheel rotatably mounted adjacent to and driven by said turbine wheel, means on said sleeve drivingly engageable with said driven clutch element when the sleeve is moved axially in one direction, means to lock the sleeve against rotation when the sleeve is moved axially in the opposite direction, spring means biasing the sleeve in said one axial direction, said sleeve having an outwardly projecting annular flange engageable by said pin element and located so that the pin element opposes the force of said spring means, whereby the sleeve moves axially responsive to rotation of said speed controlling ring, means to couple said sleeve directly to said pulley wheel responsive to the movement of the sleeve in one axial direction, speed reduction means, and means to drivingly couple said pulley wheel to said driven shaft through said speed reduction means the sleeve is moved in said opposite axial direction.

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