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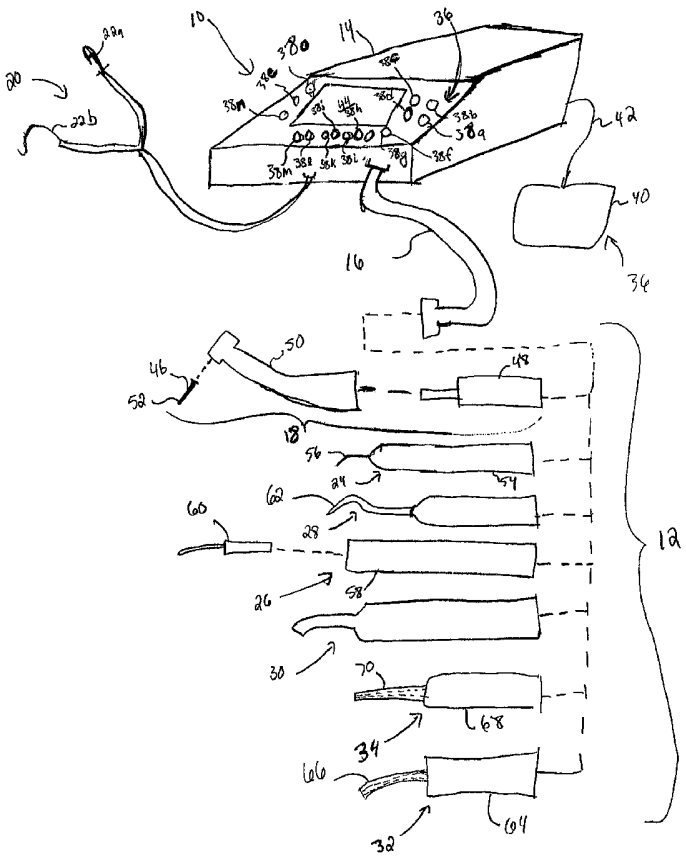

(57) Abstract: A system for performing dental/medical procedures includes a housing, and control circuitry disposed within the housing that is operable to modify a performance characteristic of each of the following tools: a motor assembly, an apical-foramen locator, a scaler, an obturator, a condenser, a light for curing a material, an irrigator, and a pneumatic assembly. The system may also include a cable that can connect the control circuitry with each of the tools to transmit data and, as required, power, liquid and gas to the tools. With the control circuitry disposed in the housing, and the cable to connect the control circuitry to the tools, a dentist or other medical technician can perform a dental/medical procedure with a single tool system, and thus reduce clutter in the operational area.

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SYSTEM FOR PERFORMING A VARIETY OF MEDICAL/DENTAL PROCEDURES, AND RELATED METHODS

Cross-Reference To Related Applications

This application claims priority from commonly owned US Provisional Patent Application 60/472,948, titled Single Console For Controlling A Variety Of Endodontic Tools, presently pending, which is hereby incorporated by reference in its entirety.

This application is related to the following patent applications: US Patent Application serial no. 10/177,559 titled A MOTOR SYSTEM FOR USE IN DENTAL/MEDICAL PROCEDURES, AND RELATED METHODS, filed on 21 June 2002; US Patent Application serial no. 10/205,966 titled SYSTEMS AND METHODS FOR LOCATING A TOOTH'S APICAL FORAMEN, filed on 26 July 2002; US Patent Application serial no. 10/431,296 titled ENDODONTIC OBTURATOR WITH DISPOSABLE CARTRIDGE, filed on 6 May 2003; and US Patent Application serial no. 10/772,104 titled DETECTING AND INDICATING A PROXIMITY OF A DENTAL INSTRUMENT TO A TOOTH APICAL FORAMEN, filed on 4 February 2004; which are incorporated by reference.

Background

Dentists and other medical technicians perform a variety of dental/medical procedures. For example, the dentist or medical technician may repair a tooth having an infected pulp, may clean a tooth and its surrounding gum by removing plaque and other unwanted materials from the tooth and gum, and may repair a tooth having damaged enamel.

When performing dental/medical procedures, a dentist or other medical technician typically uses one or more specialized tool systems. For example, when repairing a tooth with an infected pulp, the dentist or other medical technician may use three different tool systems. One tool system may be a motorized hand-piece with a drill bit that the dentist or other medical technician may use to remove the infected pulp, and clean and shape the root canal. Another tool system that the dentist or other medical technician may use is an obturator to inject gutta percha into the vacant root canal. And another tool system that the dentist or other medical technician may use is a condenser to pack the gutta percha into the canal.

As another example, when restoring a chipped or broken tooth, the dentist or other medical technician may use three different tool systems. One tool system may

be a scaler to remove plaque and other materials from the portion of the tooth remaining in the jaw and the adjacent gum. Another tool system that the dentist or other medical technician may use is a motorized hand-piece with a burr to prepare the portion of the tooth remaining in the jaw for a prosthetic. And another tool system that the dentist or other medical technician may use is a UV curing light to cure an adhesive, and thus fix the prosthetic to the remaining portion of the tooth.

Each tool system typically includes a tool and control circuitry to control various performance characteristics of the tool. The tool typically includes a tool accessory, for example a drill bit, burr, cannula, or tube, a motor or some other device to power the tool accessory, and a hand-piece to connect the motor or other power device to the tool accessory. Each tool system also typically includes a housing to protect the control circuitry of the system, and a cable to connect the tool with the control circuitry. Thus, when a dentist or other medical technician performs a dental/medical procedure, the operational area frequently includes many cables and housings, each corresponding to a respective tool system.

Unfortunately, the presence of many cables and housings can be a nuisance for the dentist or other medical technician. The operational area in which the dentist or other medical technician works can get cluttered during a procedure and the subsequent cleaning and storing of each tool system can be time consuming. The operational area is typically small and frequently lacks sufficient space for all the tool systems. Thus, the dentist or other medical technician has to retrieve the desired tool system during a procedure and then remove the system when finished to make room for a different system. In addition, because each tool system typically includes a foot switch to input data to the control circuitry, positioning many tool systems in the operational area can also cause many foot switches to be positioned in the area too. The presence of many foot switches can confuse the dentist or other medical technician, and require the dentist or other medical technician to divert his attention away from the patient to make sure he/she operates the correct foot switch.

Summary

In one aspect of the invention, a system for performing dental/medical procedures includes a housing, and control circuitry disposed within the housing that is operable to modify a performance characteristic of a motor assembly, an apical-foramen locator, and an obturator. The motor assembly includes a motor to power a tool accessory, for example a file or a drill bit, to abrade, drill or ream material. The apical-foramen locator may be used to determine the proximity of a

tooth's apical foramen relative to a tip of a tool accessory disposed inside the tooth. And the obturator may be used to inject material, for example gutta percha, into a tooth. The system also may include a cable that can connect the control circuitry to the motor assembly and the obturator to transmit data to the tools. With the control circuitry disposed in the housing, and the cable to connect the control circuitry to the motor assembly and the obturator, a dentist or other medical technician can perform a dental/medical procedure with a single tool system, and thus reduce clutter in the operational area.

In another aspect of the invention, the system may include a foot switch to input data to the control circuitry. Furthermore, the foot switch may be used to input data to the control circuitry to modify any tool connected with the control circuitry. Thus, with the foot switch a dental or other medical technician can further reduce clutter in the operational area by reducing the number of foot switches located in the operational area.

In yet another aspect of the invention, the system may include a housing, and control circuitry disposed within the housing that is operable to modify a performance characteristic of a motor assembly, an apical-foramen locator, a scaler, an obturator, a condenser, a curing light for curing an adhesive, an irrigator, and a pneumatic assembly. The scaler may be used to clean a tooth with an oscillating tool accessory. The obturator may be used to inject material, for example gutta percha, into a tooth. The condenser may be used to heat the material injected into a tooth and pack the material into the tooth. The irrigator may be used to dispense a liquid toward a tool accessory. And the pneumatic assembly may be used to generate a vacuum in a tool accessory.

Brief Description Of The Figures

FIG. 1 is a perspective view of a system, according to an embodiment of the invention, and an exploded, perspective view of tools that may be connected to the system.

FIG. 2 is a plan view of a display included in the system of FIG. 1.

FIG. 3 is a cross-sectional view of a cable included in the system of FIG. 1.

Detailed Description

The following discussion is presented to enable one skilled in the art to make and use the invention. Various modifications to the disclosed embodiments will be

readily apparent to those skilled in the art, and the generic principles herein may be applied to other embodiments and applications without departing from the spirit and scope of the present invention as defined by the appended claims. Thus, the present invention is not intended to be limited to the embodiments shown, but is to be accorded the widest scope consistent with the principles and features disclosed herein.

FIG. 1 is a perspective view of a system 10, according to an embodiment of the invention, that a dentist or other medical technician may use to perform a variety of dental/medical procedures. The system 10 includes control circuitry (not shown but discussed in greater detail elsewhere herein) to modify a performance characteristic of a plurality of tools 12, and a housing 14 to protect the control circuitry. The system 10 also includes a cable 16 (discussed in greater detail in conjunction with FIG. 3) to connect one of the plurality of tools to the control circuitry and transmit data from the control circuitry to the tool. The plurality of tools 12 may include any combination of two or more of the following tools (discussed in greater detail elsewhere herein): a motor assembly 18, an apical-foramen locator 20 whose circuitry is disposed within the housing 14 but whose leads 22a and 22b are shown outside the housing 14, a scaler 24, an obturator 26, a condenser 28, a curing light 30, an irrigator 32 which also may be a component of one or more of the other tools, and a pneumatic assembly 34, which also may be a component of one or more of the other tools.

With the system 10, a dentist or other medical technician can perform a dental/medical procedure that requires more than one tool system without the presence of more than one cable 16 and more than one housing 14 in the operational area. This can reduce clutter in the operational area, and thus reduce a dentist's or other medical technician's confusion during an operation. Furthermore, this can reduce the time spent cleaning after completing an operation.

The system 10 also includes input devices 36 to allow a dentist or other medical technician to provide data to the control circuitry. In one embodiment, the input devices 36 include switches 38a – 38o (discussed in greater detail in conjunction with FIG. 2), that a dentist or other medical technician may operate with his/her hand, and a foot switch 40 that a dentist or other medical technician may operate with his/her foot. The foot switch 40 is connected to the control circuitry by the cable 42 that transmits data from the foot switch 40 to the control circuitry. With

the foot switch 40, the dentist or other medical technician may input data to the control circuitry while one or more of the tools 12 occupy his/her hands.

Other embodiments are contemplated. For example, the system 10 may include a microphone that can receive spoken audio voice data, and a processing component that can identify a command in the spoken audio voice data and provide appropriate data to the control circuitry. For another example, the system 10 may include a bar code reader for reading bar codes, and a processing component that can identify a command in the bar code and provide appropriate data to the control circuitry.

Still referring to FIG. 1 the system 10 also includes a display 44 coupled with the control circuitry to display data, for example the current performance characteristics of a tool connected to the system or desired performance characteristics. The display 44 can be any desired type of display. For example, in one embodiment the display 44 can be a backlit liquid crystal display. Additionally or alternatively, the display can include an array of lights that can indicate the current or desired performance characteristics. In other embodiments, however, the display 44 may include a speaker for aurally displaying data.

Still referring to FIG. 1, the control circuitry may be any desired circuitry for modifying a performance characteristic of a tool connected to the system 10. For example, in one embodiment the control circuitry may be conventional circuitry for modifying a performance characteristic of the motor assembly 18, the apical-foramen locator 20, the scaler 24, the obturator 26, the condenser 28, the curing light 30, the irrigator 32, and the pneumatic assembly 34, when each is connected to the control circuitry.

The motor assembly 18 may be used by a dentist or other medical technician to perform endodontic procedures, for example removing decayed pulp from a tooth, preparing a fractured tooth for mounting a prosthetic to it, and cleaning a cavity in a tooth. In one embodiment, the motor assembly 18 includes a removable tool accessory 46, for example a file or a drill bit, to abrade, drill or ream material, a motor 48 to power the tool accessory 46, and a hand-piece 50 to connect the motor 48 to the tool accessory 46. When the motor assembly 18 is connected to the control circuitry, the circuitry may be used to modify the rotational speed of the tool accessory 46 and the torque the motor 48 provides the tool accessory 46, which is further discussed in U.S. Patent Application serial no. 10/177,559 titled A MOTOR

SYSTEM FOR USE IN DENTAL/MEDICAL PROCEDURES, AND RELATED METHODS, filed on 21 June 2002.

The apical-foramen locator 20 may be used by a dentist or other medical technician to determine the proximity of a tooth's apical foramen relative to a tip of a tool accessory disposed inside the tooth. In one embodiment, the apical foramen locator 20 includes circuitry (not shown) disposed within the housing 14 and incorporated in the control circuitry of the system 10, lead 22a to couple the apical foramen locator's circuitry with a tool accessory 46, and lead 22b to couple the apical foramen locator's circuitry with a patient's lip (not shown). The apical-foreman locator 20 determines the proximity of a tool accessory's tip 52 by measuring the impedance between the tip 52 and the lead 22b and comparing the impedance to empirically derived data that correlates impedance to proximity of a tool accessory's tip, which is further discussed in U.S. Patent Applications serial no. 10/205,966, titled SYSTEMS AND METHODS FOR LOCATING A TOOTH'S APICAL FORAMEN, filed on 26 July 2002, and serial no. 10/772,104 titled DETECTING AND INDICATING A PROXIMITY OF A DENTAL INSTRUMENT TO A TOOTH APICAL FORAMEN, filed on 4 February 2004.

The scaler 24 may be used by a dentists or other medical technician to remove material, for example plaque, tartar and bacterial debris, from a tooth. In one embodiment, the scaler 24 includes a piezoelectric oscillator 54, and a removable tool accessory 56, for example a tip, connected to the oscillator 54. The piezoelectric oscillator 54 includes one or more piezoelectric crystals (not shown) that become internally stressed, and thus deform, when electrically charged. When the electric charge applied to the crystals oscillates, the crystal's deformation also oscillates at the same or approximately the same frequency. Thus, when an oscillating voltage powers the piezoelectric oscillator 54, the oscillator 54 oscillates the tool accessory 56, whose motion can be used to remove plaque, tartar and bacterial debris from a tooth. When the scaler 24 is connected to the control circuitry of the system 10, the circuitry may be used to modify the voltage applied to the piezoelectric crystals.

The obturator 26 may be used by a dentist or other medical technician to inject material, for example gutta percha, into a tooth. In one embodiment, the obturator 26 includes a body 58, and a disposable cartridge 60 that contains the material to be injected into a tooth and that may be easily removed from the body 58, which is further discussed in U.S. Patent Application serial no. 10/431,296 titled

ENDODONTIC OBTURATOR WITH DISPOSABLE CARTRIDGE, filed on 6 May 2003. The body 58 includes a mechanism (not shown) to generate pressure in the cartridge 60, and a heater (not shown) to heat the material in the cartridge 60. The mechanism and heater are electrically powered. When the dentist or other medical technician wants to inject gutta percha into a patient's tooth, he/she inserts the cartridge 60 into the body 58 and operates the obturator 26. When the obturator 26 is connected to the control circuitry of the system 10, the circuitry may be used to modify the pressure the mechanism generates in the cartridge and the heat the heater provides the material in the cartridge.

The condenser 28 may be used by a dentist or other medical technician to heat and pack material injected into a tooth. In one embodiment, the condenser 28 includes a removable tool accessory 62, for example a tip, that includes a heating element (not shown) made of material having a high temperature coefficient of resistance, i.e. about .005/°C, and whose electrical resistance changes linearly or substantially linearly as its temperature changes. With this combination of material properties, the temperature of the heating element can be accurately monitored in real time by monitoring the electrical current powering the heating element. In one embodiment, a Hall sensor (not shown) monitors the current powering the heating element. When the condenser 28 is connected to the control circuitry of the system 10, the circuitry may be used to modify the heat generated by the heating element.

The curing light 30 may be used by a dentist or other medical technician to cure an adhesive, and thus fix a prosthetic to a portion of a fractured tooth that remains in the patient's jaw. In one embodiment, the curing light 30 includes a bulb (not shown) to generate ultra-violet light for initiating a chemical reaction in an adhesive that bonds a restorative material to the tooth. When the curing light 30 is connected to the control circuitry of the system 10, the circuitry may be used to turn the light 30 on or off.

The irrigator 32 may be used by a dentist or other medical technician to dispense a liquid, for example water. As previously mentioned, the irrigator 32 may be a component of one or more of the other tools, and if so, the irrigator 32 typically dispenses liquid toward a tool accessory of the tool. In one embodiment, the irrigator 32 includes a valve 64 to control the flow of liquid through the irrigator 32, a pump (not shown) to provide liquid to the valve 64, and a removable tool accessory 66, for example a nozzle, to dispense the liquid. The pump may or may not be mounted to the system 10, and if the irrigator 32 is a component of one or more of the other

tools, the valve 64 may be mounted to the system 10 or disposed within the housing 14. When the irrigator 32 is connected to the control circuitry of the system 10, the circuitry may be used to modify the pressure of the liquid generated by the pump, and the amount of liquid the valve 64 allows to flow through the irrigator 32.

The pneumatic assembly 34 may be used by a dental or other medical technician to generate a vacuum for removing a fluid, for example a patient's saliva, from an area of operation. The pneumatic assembly 34 may also be used to blow a gas, for example air, onto an area of operation to remove debris from the area. As previously mentioned, the pneumatic assembly 34 may be a component of one or more of the other tools. In one embodiment, the pneumatic assembly 34 includes a valve 68 to control the flow of gas through the assembly 34, a pump (not shown) to generate a vacuum in or provide gas to the valve 68, and a tool accessory 70, for example a nozzle. The pump may or may not be mounted to the system 10, and if the assembly 34 is a component of one or more of the other tools, the valve 68 may be mounted to the system 10 or disposed within the housing 14. When the assembly 34 is connected to the control circuitry of the system 10, the circuitry may be used to modify the pressure generated by the pump, and the amount of gas the valve 68 allows to flow through the assembly 34.

Other embodiments are contemplated. For example, one or more of the tools 12 and/or the foot switch 40 may be wirelessly coupled with the control circuitry, and thus the cables 42 and 16 would not be required, unless the cable 16 provides liquid, vacuum and/or gas to one or more of the tools. For another example, the system 10 may also include power circuitry to provide power to one or more of the tools from the plurality of tools 12 when the tool is connected with the system 10. Furthermore, the cable 16 may transmit power from the power circuitry to the tool connected to the system 10. For yet another example, the one or more of the tools 12 may include one or more batteries for power; and the system 10 may include battery-charging circuitry to recharge the one or more batteries of a tool, and a docking station to locate one or more of the tools while the tools' batteries recharge.

Still referring to FIG. 1, in operation, a dentist or other medical technician first determines which tools he/she will need for performing the dental/medical procedure. In one embodiment, the dentist or other medical technician then connects to the control circuitry of the system 10 the tool that he/she will use first during the procedure. Then, he/she operates one or more switches 38a – 38o to provide the control circuitry data for modifying a performance characteristic of the connected

tool. Then, he/she uses the tool and may again operate the switches 38a – 38o or operate the foot switch 40 to provide the control circuitry more data for modifying a performance characteristic of the tool. Then, when the dentist or other medical technician wants to use another tool, he/she disconnects the tool and connects the desired tool. Then he/she operates the switches 38a – 38o to provide the control circuitry data for modifying a performance characteristic of the tool now connected.

FIG. 2 is a plan view of the display 44 and switches 38a – 38o included in the system 10 of FIG. 1. The switches 38a – 38o may be any desired type of switch. For example, one or more of the switches 38a – 38o may be buttons that a dentist or other medical technician pushes to input data. Or, one or more of the switches may be a knob that a dentist or other medical technician rotates to input data. If a knob is included in the switches 38a – 38o, the knob may be pushed as well as rotated to input data.

In one embodiment, each switch 38a – 38o is a button and programmable so that the data input to the control circuitry when a button is pushed depends on the operational state of the control circuitry — that is the one or more performance characteristics of a specific tool to be modified by the control circuitry. In addition, the data presented by the display 44 depends on the operational state of the control circuitry and includes information that is presented in labels 72a – 72g to indicate the function of each switch 38a – 38o in a specific operational state. The operational state may be determined by the tool connected to the control circuitry, or by the dentist or other medical technician, for example during preparation for a dental/medical procedure. Thus, the number of switches 38a – 38o used to input data to the control circuitry may be minimized, and the system 10 may be easier to use.

For example, a dentist or other medical technician can push the switch 38o to turn the system 10 on and off. Once the system 10 is on, he/she can push the switch 38n to change the operational state of the system, which is presented in label 72a. Alternatively, the dentist or other medical technician can connect the tool he/she wants to use for a dental/medical procedure, and the system will automatically change its operational state to correspond with the tool connected.

In one embodiment, when the system 10 is in the motor-assembly operational state, the label 72a includes the text "motor assembly" and the remaining labels 72b – 72g indicate the function of the one or more adjacent switches 38a – 38n. The switches 38a – 38d may be associated with preset values for a performance

characteristic or a combination of performance characteristics of the motor assembly 18 (FIG. 1), and label 72g includes the text "preset values". For example, pushing the switch 36a may instruct the control circuitry to modify the torque of the tool accessory 46 (FIG. 1) to a specific value, or the torque and rotational speed of the tool accessory 46 to specific values. The switches 38e and 38f may be pushed by a dentist or other medical technician to increase and decrease, respectively, the value of the hand-piece's output ratio — the ratio by which the hand-piece changes the output of the motor 48 (FIG. 1) — that the control circuitry should know to accurately modify a performance characteristic of the motor assembly 18. And, the label 72f includes the text "hand-piece ratio". The switches 38g and 38h may be pushed to increase and decrease, respectively, the rotational speed of the tool accessory 46, and the label 72e includes the text "speed". The switches 38i and 38j may be pushed to increase and decrease, respectively, the torque of the tool accessory 46, and the label 72d includes the text "torque". The switches 38k and 38l may be pushed to increase and decrease the amount of liquid the irrigator 32 dispenses if the irrigator 32 is a component of the motor assembly 18, and the label 72c includes the text "flow rate". The switch 38n may be pushed to reverse the direction — clockwise or counterclockwise — that the tool accessory rotates, and the label 72b includes the text "direction".

Still referring to FIG. 2, in one embodiment, when the system 10 is in the scaler operational state, the label 72a includes the text "scaler". The switches 38a – 38d may be associated with preset values for a performance characteristic or a combination of performance characteristics of the scaler 24 (FIG. 1), and the label 72g includes the text "preset values". The switches 38e and 38f may be pushed to increase and decrease, respectively, the frequency that the tool accessory 56 (FIG. 1) oscillates, and the label 72f includes the text " frequency". The switches 38g and 38h may be pushed to increase and decrease, respectively, the amplitude — stroke — of the tool accessory's oscillation. If the scaler 24 includes the pneumatic assembly 34 as a component, then the switches 38i and 38j may be pushed to increase and decrease, respectively, the amount of gas the valve of the pneumatic assembly allows to pass, and the label 72d includes the text "gas flowrate". Furthermore, the switches 38k and 38l may be pushed to increase and decrease, respectively, the pressure generated by the pump of the pneumatic assembly 34.

Still referring to FIG. 2, in one embodiment, when the system 10 is in the condenser operational state, the label 72a includes the text "condenser". The

switches 38e and 38f may be pushed to increase and decrease, respectively, the amount of heat the heating element of the condenser 28 (FIG. 1) generates, and the label 72f includes the text "temperature".

Still referring to FIG. 2, in one embodiment, when the system 10 is in the apical-foramen-locator operational state, the label 72a includes the text "apical-foramen locator". The switches 38e and 38f may be pushed to scroll through a list of data tables each corresponding to a type of tooth geometry and containing data that correlates impedance to proximity of a tool accessory's tip. And the label 72f includes the text "impedance map". The switch 38m may be pushed to select the desired impedance map to be used by the apical-foramen locator 20 (FIG. 1), and the label 72b includes the text "select".

Still referring to FIG. 2, in one embodiment, when the system 10 is in the obturator operational state, the label 72a includes the text "obturator". The switches 38f and 38e may be pushed to increase and decrease, respectively, pressure in the cartridge 60 (FIG. 1) when the cartridge is inserted into the body 58 (FIG. 1) of the obturator 26 (FIG. 1). And the label 72f includes the text "cartridge pressure". The switches 38h and 38g may be pushed to increase and decrease, respectively, the amount of heat the heater of the obturator 26 generates, and the label 72e includes the text "temperature".

Still referring to FIG. 2, in one embodiment, when the system 10 is in the curing-light operational state, the label 72a includes the text "curing light". The switch 38m may be pushed by a dentist to turn the curing light on and off, and the label 72b includes the text "On/Off".

Still referring to FIG. 2, in one embodiment, when the system 10 is in the irrigator operational state, the label 72a includes the text "irrigator". The switches 38e and 38f may be pushed to increase and decrease, respectively, the amount of liquid the valve of the irrigator 32 (FIG. 1) allows to flow, and the label 72f includes the text "flow rate". The switches 38g and 38h may be pushed to increase and decrease, respectively, the pressure of the liquid that is generated by the pump of the irrigator 32, and the label 72e includes the text "pressure".

Still referring to FIG. 2, in one embodiment, when the system 10 is in the pneumatic-assembly operational state, the label 72a includes the text "pneumatic assembly". The switches 38e and 38f may be pushed to increase and decrease, respectively, the amount of gas the valve of the pneumatic assembly 34 (FIG. 1) allows to flow, and the label 72f includes the text "flow rate". The switches 38g and

38h may be pushed to increase and decrease the gas pressure that is generated by the pump of the pneumatic assembly 34, and the label 72e includes the text "pressure".

FIG. 3 is a cross-sectional view of a cable 16 included in the system 10 of FIG. 1. The cable 16 connects the control circuitry of the system 10 to one of the tools 12 (FIG. 1) and transmits data from the control circuitry to the tool. If the tools 12 include an irrigator 32 (FIG. 1) and/or a pneumatic assembly 34 (FIG. 1), or if other tools in the group of tools 12 incorporate an irrigator and/or pneumatic assembly as a component, then the cable 16 may include conduits 74a and 74b to transmit gas and liquid to and from the tool. By incorporating the conduits 74a and 74b into the cable 16, the number of cables located in an operational area may be reduced, and thus clutter may be reduced.

For example, in one embodiment, the cable 16 includes a conduit 74a for transmitting a liquid to the valve 64 (FIG. 1) of the irrigator 32, a conduit 74b for transmitting a gas from the valve 68 (FIG. 1) of the pneumatic assembly 34, and a cable 76 to transmit data. The conduits 74a and 74b may be made of any desirable material, for example conventional plastic, that can withstand the pressure of the liquid and the gas that they transmit and allow flexibility to permit the dentist or other medical technician to easily move the connected tool while he/she uses the tool.

What is claimed is:

1. A system for performing dental/medical procedures, the system comprising:

a housing; and

control circuitry disposed within the housing and operable to modify a performance characteristic of each of the following tools:

a motor assembly including a motor operable to power at least one of the following tool accessories: a file and a drill bit,

an apical-foramen locator operable to determine the proximity of a tooth's apical foramen relative to a tip of a tool accessory disposed inside the tooth.

2. The system of claim 1 further comprising a cable operable to connect the control circuitry to a tool and to transmit at least one of the following:

power to the tool,

liquid to the tool so that the tool can dispense the liquid, and

gas away from the tool to generate a vacuum in the tool.

3. The system of claim 1 wherein the motor of the motor assembly is electrically powered.

4. The system of claim 1 wherein the motor assembly includes a hand-piece operable to connect the motor to a tool accessory and to change the rotational speed of the tool accessory relative to the motor's output.

5. The system of claim 1 wherein the apical foramen locator determines the proximity of a tooth's apical foramen relative to a tip of a tool accessory by comparing an impedance to a signal transmitted between the tip of a tool accessory and a lead coupled to the patient to an impedance in an impedance map generated from reference teeth.

6. The system of claim 5 wherein the apical foramen locator demodulates the signal transmitted between the tip of a tool accessory and a lead coupled to the patient to determine the impedance to the signal.

7. The system of claim 1 further comprising a foot switch operable to input data to the control circuitry.

8. The system of claim 1 further comprising a display coupled with the control circuitry and operable to display data.

9. The system of claim 1 further comprising input devices operable to provide data to the control circuitry, wherein the data the devices provide depends on the tool whose performance characteristic is to be modified by the control circuitry.

10. A system for performing dental/medical procedures, the system comprising:

a housing; and

control circuitry disposed within the housing and operable to modify a performance characteristic of each of the following tools:

a motor assembly including a motor operable to power at least one of the following tool accessories: a file and a drill bit,

an apical-foramen locator operable to determine the proximity of a tooth's apical foramen relative to a tip of a tool accessory disposed inside the tooth, and

an obturator that is operable to inject material into a tooth.

11. The system of claim 10 wherein the obturator is operable to inject gutta percha into a tooth to fill and seal the tooth.

12. The system of claim 10 wherein the obturator is operable to inject gutta percha from a disposable cartridge.

13. A system for performing dental/medical procedures, the system comprising:

a housing; and

control circuitry disposed within the housing and operable to modify a performance characteristic of each of the following tools:

a motor assembly including a motor operable to power at least one of the following tool accessories: a file and a drill bit,

an apical-foramen locator operable to determine the proximity of a tooth's apical foramen relative to a tip of a tool accessory disposed inside the tooth,

an obturator that is operable to inject material into a tooth, and

a condenser that is operable to heat the material injected into a tooth and pack the material into the tooth.

14. The system of claim 24 wherein the condenser includes a heating element operable to generate heat when electricity flows through the element, and a Hall sensor to sense the electrical current flowing through the heating element to determine the temperature of the heating element.

15. A system for performing dental/medical procedures, the system comprising:

a housing; and

control circuitry disposed within the housing and operable to modify a performance characteristic of each of the following tools:

a motor assembly including a motor operable to power at least one of the following tool accessories: a file and a drill bit,

a scaler operable to clean a tooth with an oscillating tool accessory,

an apical-foramen locator operable to determine the proximity of a tooth's apical foramen relative to a tip of a tool accessory disposed inside the tooth,

an obturator operable to inject material into a tooth,

a condenser operable to heat the material injected into a tooth and pack the material into the tooth,

a curing light operable to cure materials for restoring a tooth,

an irrigator operable to dispense a liquid toward a tool accessory, and

a pneumatic assembly operable to generate a vacuum in a tool accessory.

16. The system of claim 15 wherein the scaler's tool accessory oscillates at a frequency that is greater than the frequency of sound.

17. The system of claim 1 wherein the pneumatic assembly is operable to generate pressurized gas for powering a pneumatic motor assembly.

18. A method for performing a dental/medical procedure, the method comprising:

removing pulp from a tooth by rotating a file with a motor of a motor assembly that is connected to a system that includes control circuitry for modifying a performance characteristic of the motor assembly; and

locating the proximity of the tooth's apical foramen relative to a tip of the file with an apical-foramen locator of the system.

19. The method of claim 18 further comprising dispensing liquid toward the file with an irrigator connected to the system, wherein the control circuitry is operable to modify a performance characteristic of the irrigator.

20. A method for performing a dental/medical procedure, the method comprising:

removing pulp from a tooth by rotating a file with a motor of a motor assembly that is connected to a system that includes control circuitry for modifying a performance characteristic of the motor assembly;

injecting material into a tooth with an obturator connected to the system, wherein the control circuitry is operable to modify a performance characteristic of the obturator;

heating the material with a condenser connected to the system to soften the material, wherein the control circuitry is operable to modify a performance characteristic of the condenser; and

packing the material into the tooth with the condenser.

21. A method for performing a dental/medical procedure, the method comprising:

removing debris from a tooth by oscillating a tool accessory with a scaler that is connected to the system that includes control circuitry for modifying a performance characteristic of the scaler; and

removing saliva generated by the patient during the procedure by vacuuming the saliva with a pneumatic assembly connected to the system, wherein the control circuitry is operable to modify a performance characteristic of the pneumatic assembly.

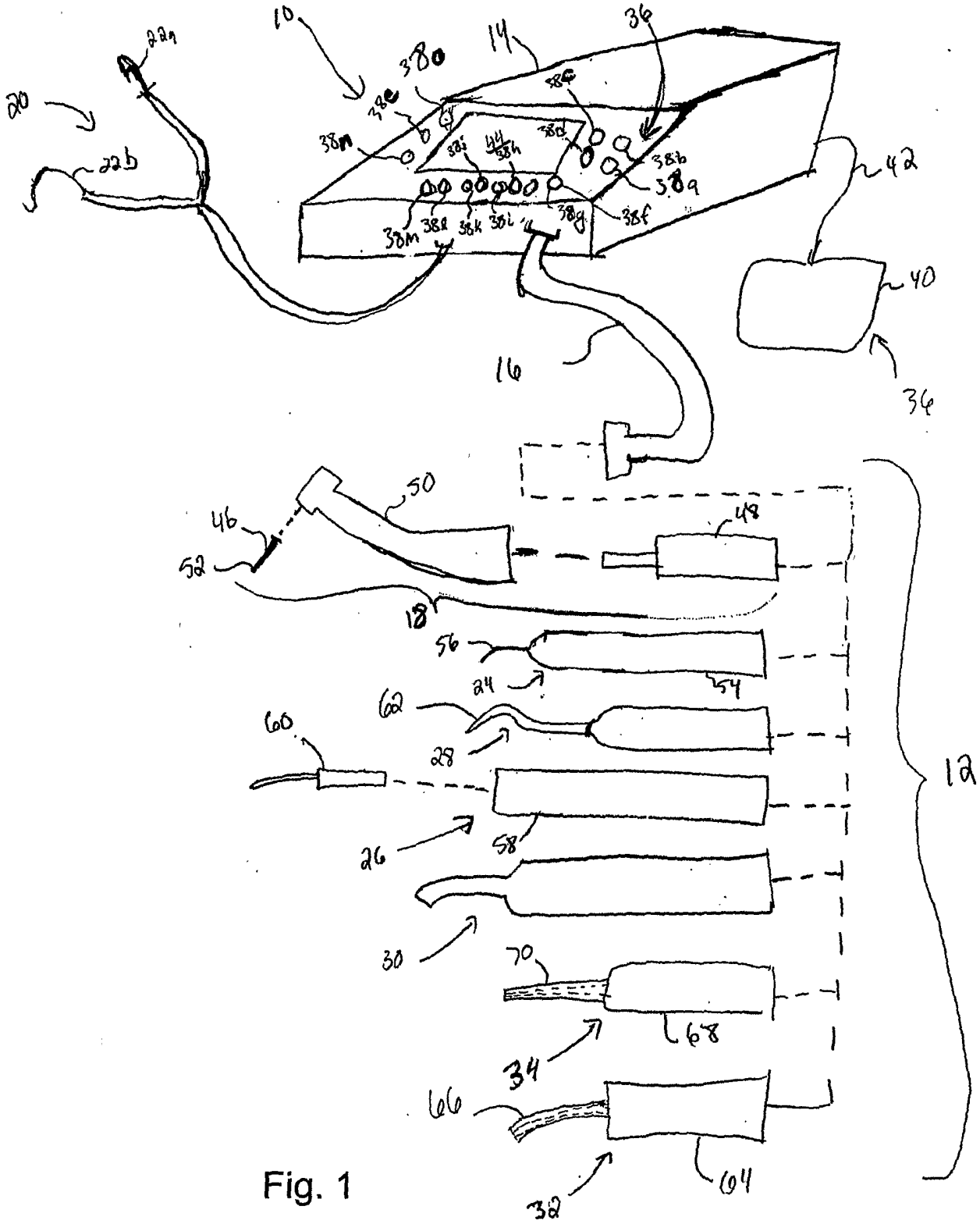
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Fig. 1

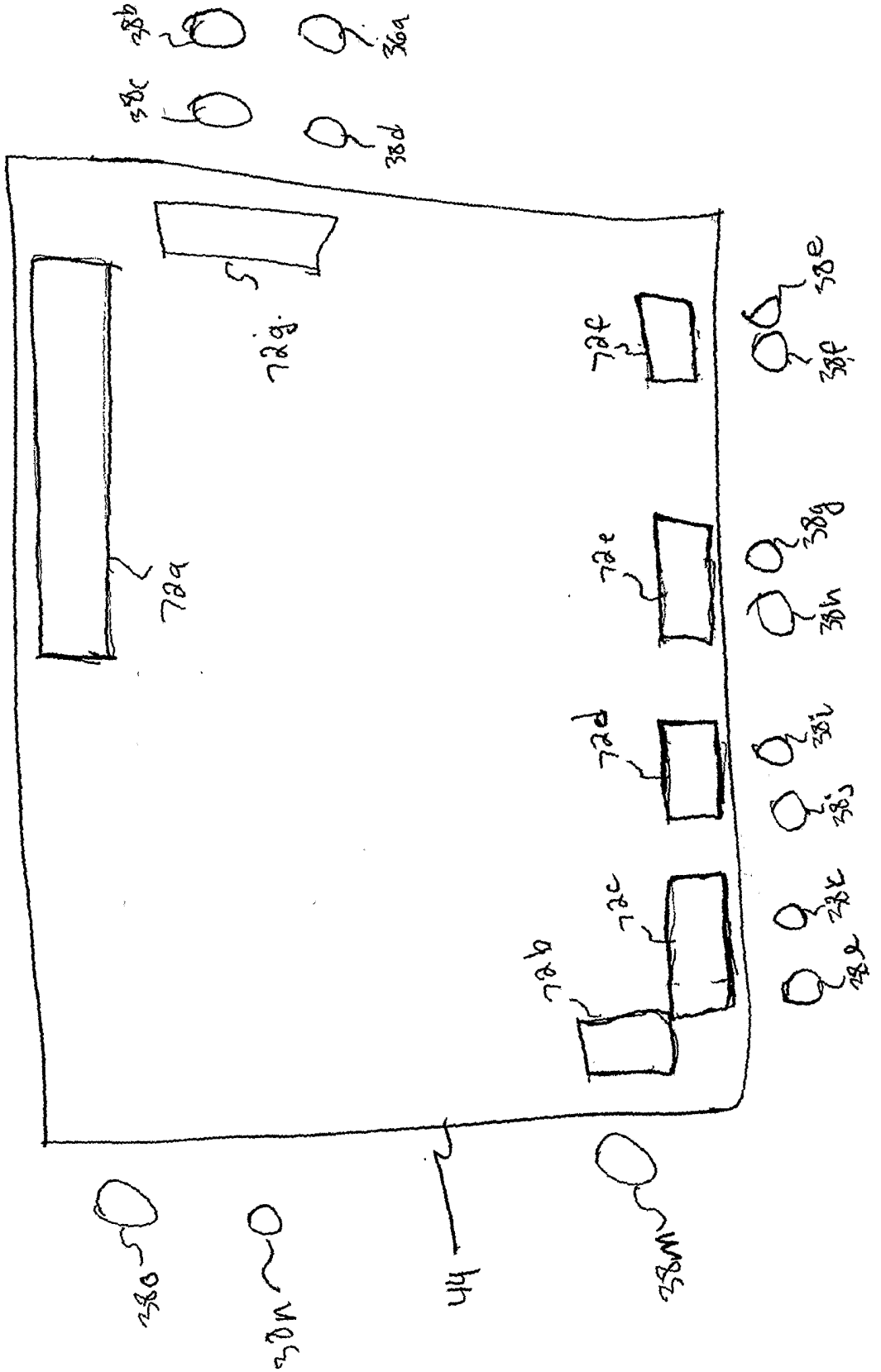
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Fig. 2

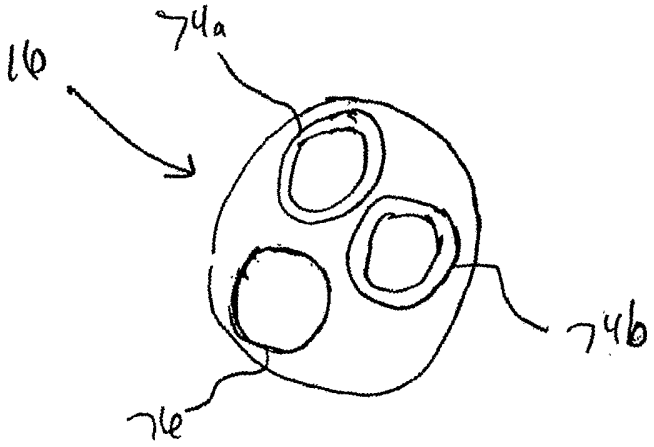

Fig. 3

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US2004/016089

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 A61C1/00 A61C19/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 A61C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	US 5 902 105 A (UEJIMA YOSHIO ET AL) 11 May 1999 (1999-05-11) the whole document	1,3-13, 15-17 2
Y A	US 4 080 737 A (FLEER ERNST OTTO) 28 March 1978 (1978-03-28) the whole document	2 15-17
A	US 3 792 530 A (SMITH D) 19 February 1974 (1974-02-19) column 18, line 41 - column 21, line 26; figure 36	10-13,15
A	US 4 501 558 A (MALIGA JOACHIM H) 26 February 1985 (1985-02-26) column 2, line 40 - line 41	16

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
21 September 2004	29/09/2004

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Vanrunxt, J

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2004/016089

Box II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. [X] Claims Nos.: 18-21
because they relate to subject matter not required to be searched by this Authority, namely:

Rule 39.1(iv) PCT - Method for treatment of the human or animal body by surgery

2. [ ] Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. [ ] Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. [ ] As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. [ ] As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. [ ] As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. [ ] No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

[ ] The additional search fees were accompanied by the applicant's protest.

[ ] No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

information on patent family members

International Application No
PCT/US2004/016089

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