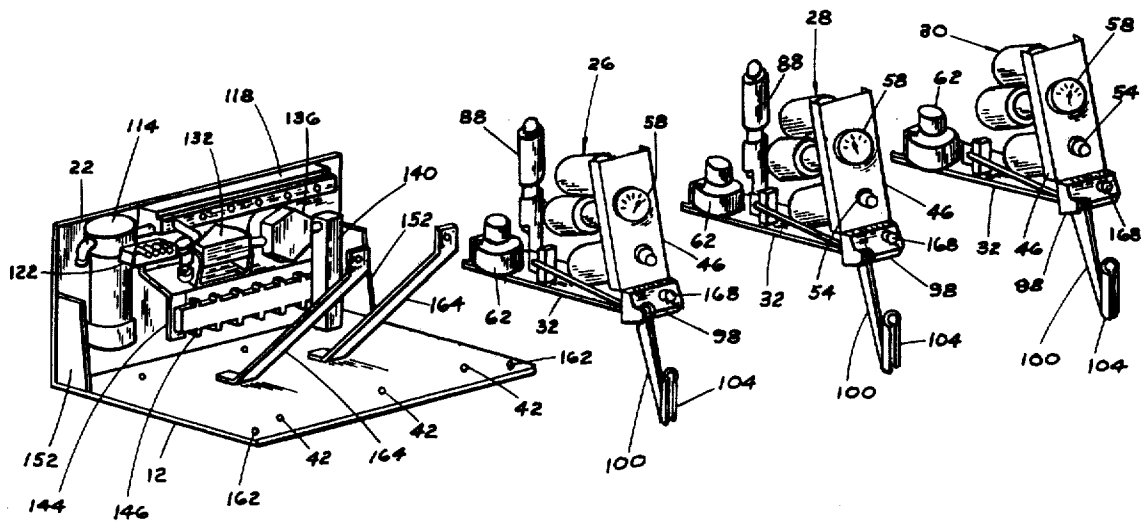


[54] CONTROL UNIT FOR DENTAL EQUIPMENT
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[22] Filed: Apr. 4, 1969
[21] Appl. No.: 822,806
[52] U.S. Cl. 32/22
[51] Int. Cl. A61c 7/00
[58] Field of Search 32/22

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[57] ABSTRACT
A dental control unit for one or more dental instruments requiring air and/or water to operate the same and including a cabinet containing a plurality of control modules interchangeable with each other and comprising a sub-frame connectable to the base of said cabinet and having similar front panels jointly forming the front face of said housing. Control means for the supply of air and/or water to the dental instruments are mounted in each module. A foot control unit having a bleed-type control valve operates to vary the air pressure to at least certain modules to vary the speed of dental handpieces controlled thereby.
12 Claims, 14 Drawing Figures



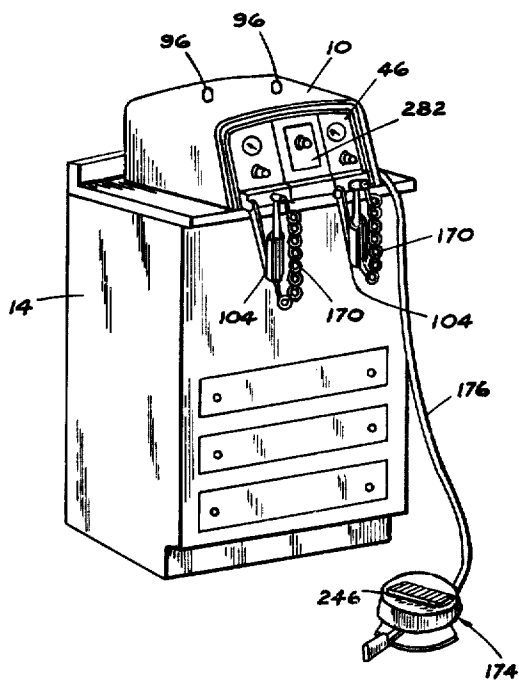


FIG. 1

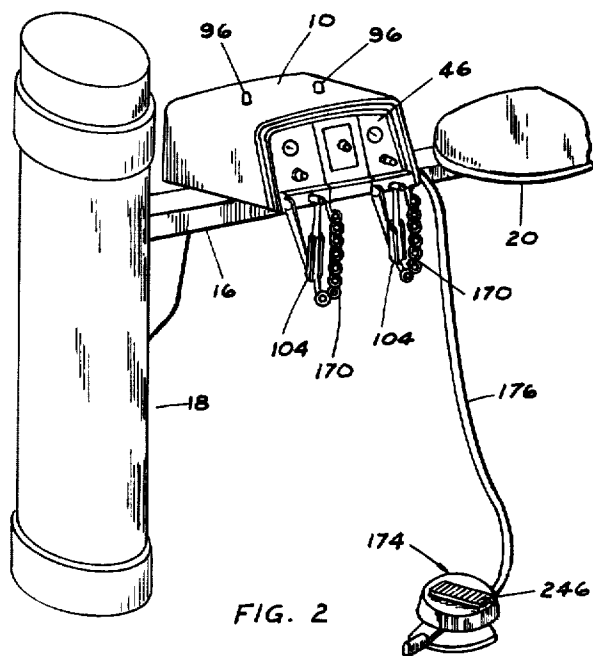


FIG. 2

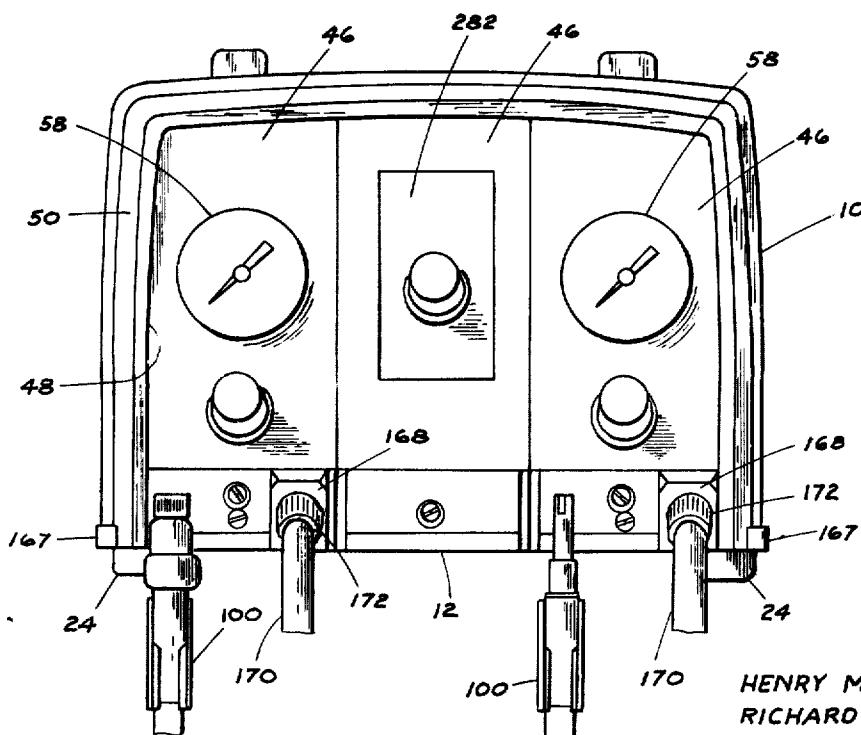
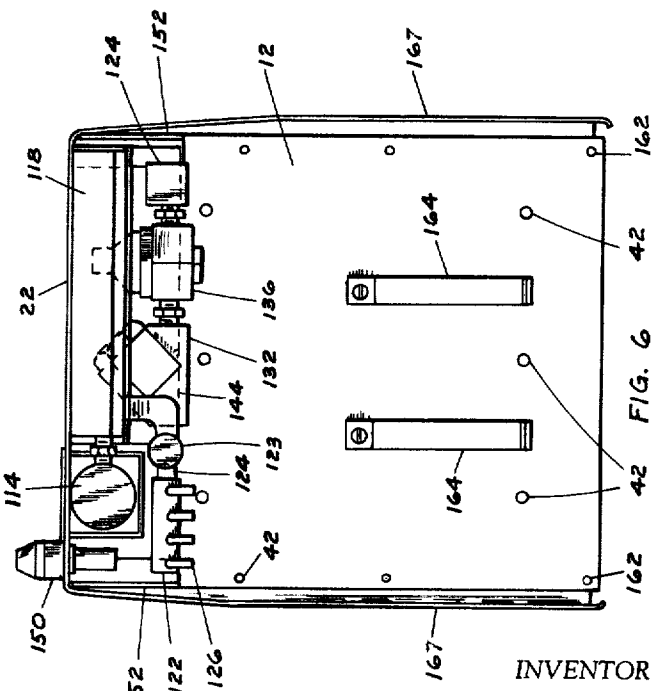
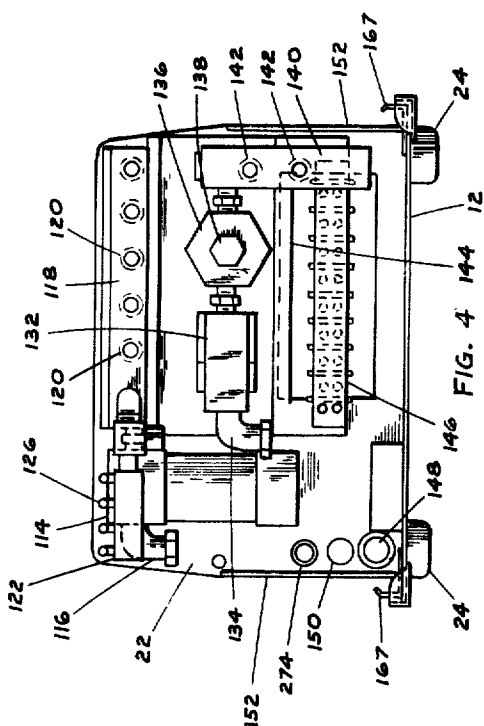
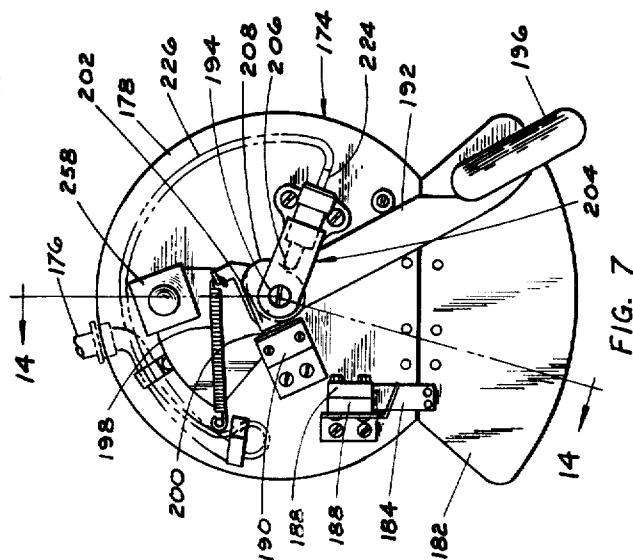
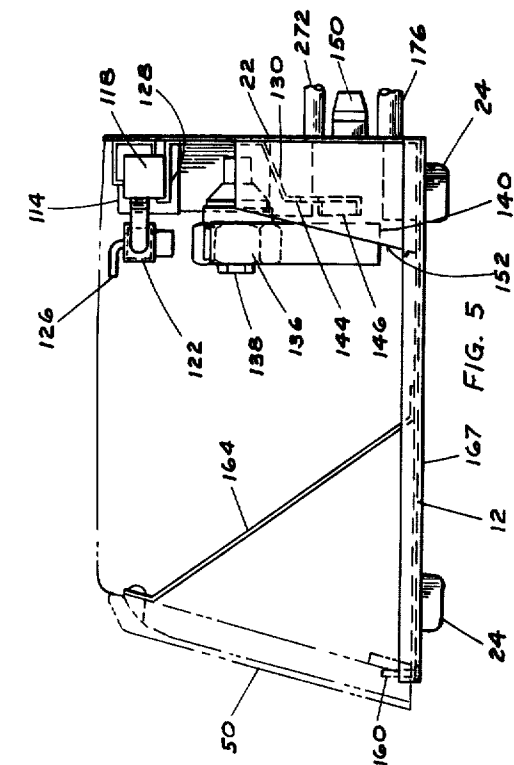


FIG. 3

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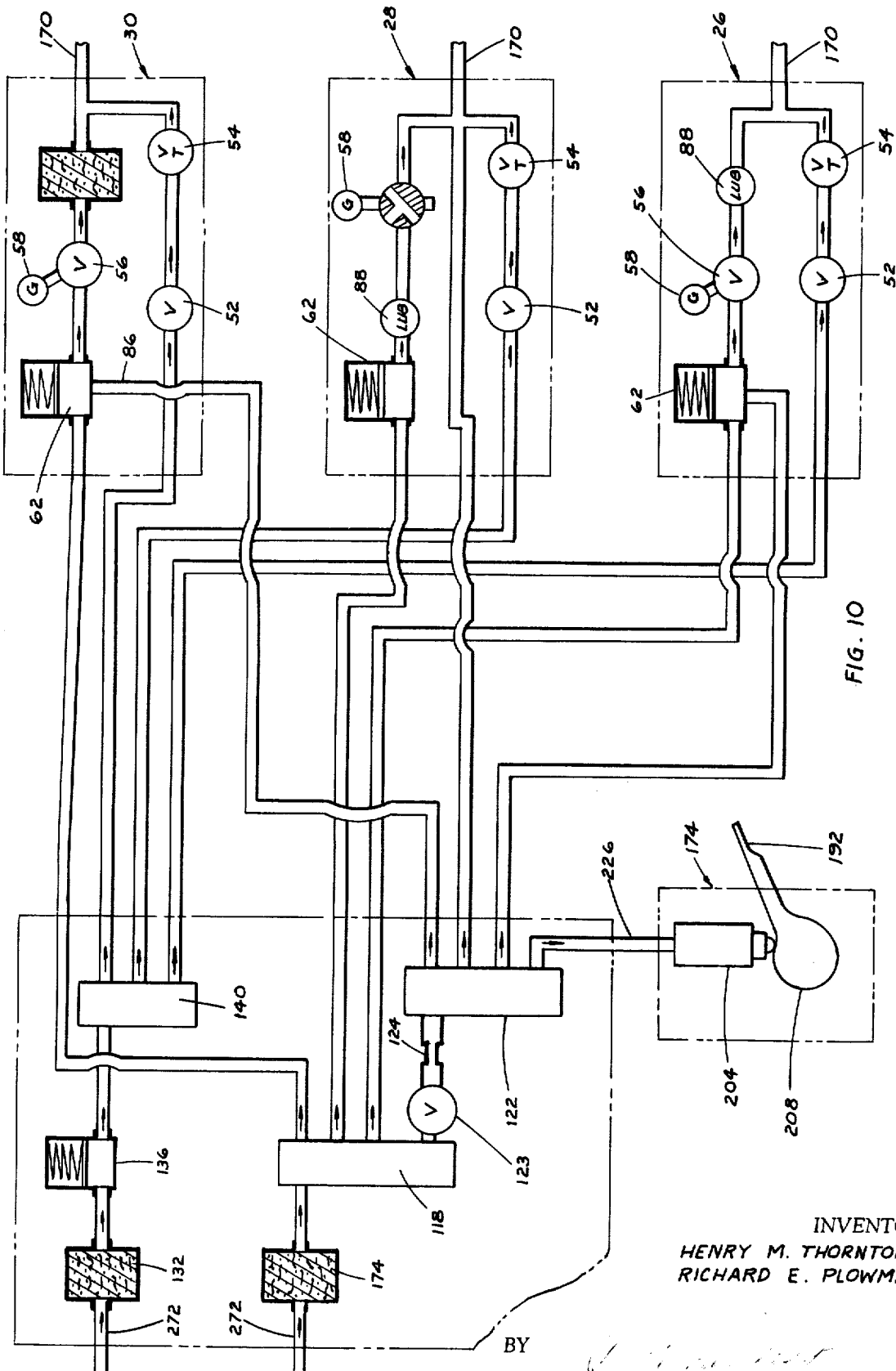
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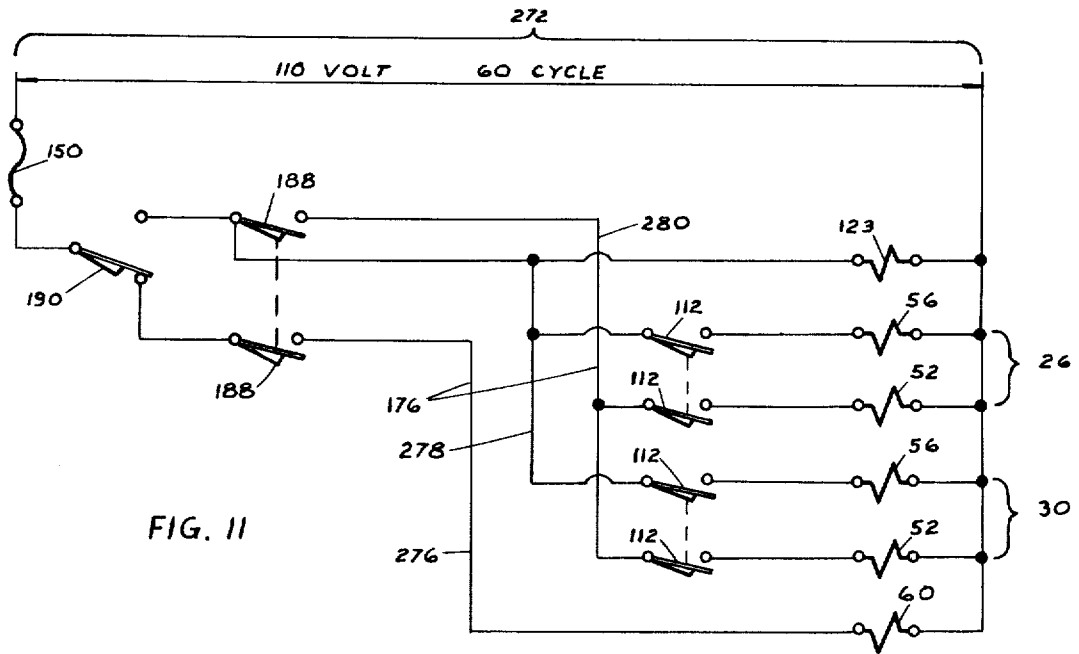


FIG. 11

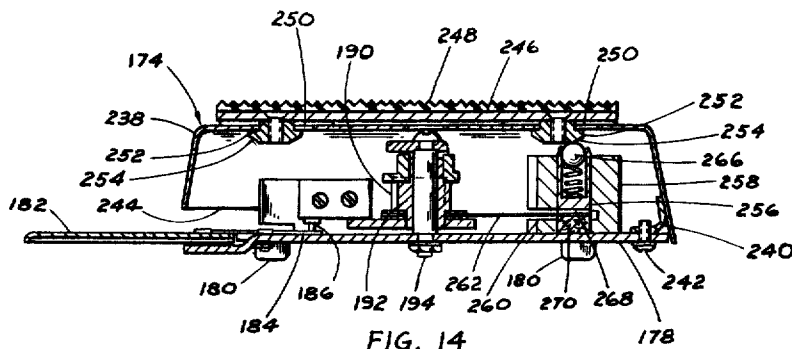


FIG. 14

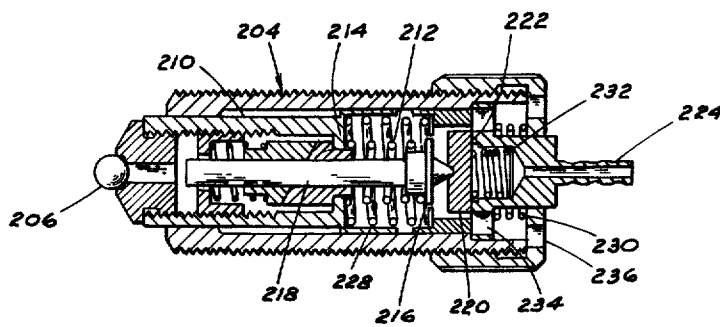


FIG. 13

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CONTROL UNIT FOR DENTAL EQUIPMENT

BACKGROUND OF THE INVENTION

This invention pertains to a dental control unit and, more particularly, to a control unit for purposes of delivering dental utilities, such as air, water, or otherwise, to various types of dental instruments and especially dental handpieces of the type driven by air under various pressures.

During very recent years, modern dental practice has been very substantially revolutionized by the introduction of a vast increase in speeds over those of conventional motor or belt-driven handpieces, such increase in speeds being more than tenfold, due principally to the introduction of dental handpieces employing air-driven turbines of very small size which are mounted in the heads of the handpieces, these being supplied by air under pressure to drive the turbines at desired speeds. Certain handpieces of this type now are available capable of obtaining speeds of the order of 400,000 rpm or higher.

Most of the high speed air-turbine type handpieces depend primarily upon speed, rather than torque, for achieving desired cutting and drilling functions. There are however, certain dental operations which require less speed and higher torque and, under such circumstances, different air pressures and volumes are required for this latter type of handpiece, as distinguished from those operating at much higher speeds with relatively low torque.

In addition, there are available at present, at least somewhat in experimental stage, dental handpieces employing air bearings instead of conventional antifriction bearings which are the principal type employed at present in air-turbine type handpieces. In general, the air pressures to support air bearings in dental handpieces are normally required to drive said handpieces.

Certain of the handpieces referred to, and especially those employing antifriction bearings, require lubrication which, in many handpieces of this type, is supplied in the form of an air mist entrained in the driving air for transmission to the anti-friction bearings of the handpieces. Variations in rates and intensities of lubrication exist between different handpieces. Also, in regard to many dental operations, both cooling and flushing water sprays or mists are desired, where it is necessary to furnish water at desired pressures and in appropriate volumes to discharge means on the head of the handpiece. The water requirements of the different types of handpieces presently available vary with respect to each other.

In order to control the operation of the various types and kinds of handpieces referred to above and furnish them with the required air pressures, water, and lubrication, it has been customary for each manufacturer to supply control means which include various types of pressure-regulating and control valves for the air and water, and also air filters and devices capable of developing oil mist for entrainment in the stream of driving air. Such control units are arranged primarily for the specific needs of the individual dental handpiece for which they are constructed. Accordingly, if a dentist desires to have several different types of handpieces of the class referred to above in his operatory or laboratory, it is necessary, at least in general, to have a corresponding control unit for each different type of handpiece, mounted appropriately and thereby resulting in

a very substantial amount of additional equipment which must not only be accommodated physically, but also adds to the capital investment.

SUMMARY OF THE INVENTION

Recognizing that all of the major types of presently available air-turbine type handpieces commonly require the principal dental utilities such as air under suitable pressure, and water, as well as some of them requiring lubrication, it is the principal object of the present invention to provide a dental control unit capable of accommodating substantially any type of air-turbine operated dental handpiece, even those having widely different air pressure requirements and differing lubrication needs and water pressure and volume requirements, through the employment of a plurality of control modules preferably of similar overall size and capable of being interchanged with each other or substituted for other modules, as desired, in accordance with the needs of such handpieces to be controlled respectively by said modules, each of said modules compactly containing the particular type of control means required by the dental handpiece specifically to be controlled thereby, whereby a compact arrangement of modules is afforded, within a unitary housing to provide individual control means for a plurality of different dental handpieces or similar dental instruments having widely different utility requirements within reasonable limits.

Another very important object of the present invention is to provide on each module within the unitary housing a front panel unit preferably either identical in size with the panel units on the other modules or multiples thereof in width, whereby the total number of modules to be accommodated in the housing, when mounted operatively in side-by-side relationship, will have the front panels thereof disposed in contiguous side-by-side relationship and, thereby comprise a composite front panel for the housing which has means thereon by which all instruments associated with the unit may be controlled.

Still another object of the invention is to provide a dental control unit enclosed compactly within a preferably unitary housing having a base frame arranged to be mounted suitably on stationary means and being connected thereto, if desired, and a plurality of sub-frames connectable to said base frame respectively supporting various control means for the individual types of dental instruments to be controlled thereby, adjustable means also being provided for detachably connecting the sub-frames to the frame of the housing and each of said modules also including appropriate means to support a dental instrument thereon, the operation of the instrument being accomplished by the appropriate dental utility which is connected to the control means for delivery thereby.

A further object of the invention is to provide, directly in the housing, filter means and manifold means respectively connectable to sources of air under pressure and water at city pressure and further including means by which said manifold means may be connected selectively to all of the utility supply and control means of the individual control units requiring the same for use by the dental instruments attached selectively thereto.

Still another object of the invention is to provide valves capable of being controlled remotely and serving

as the utility control means on the respective modules, additional conditioning valves or switches also preferably being connected in the circuits of the valves and operable by the instrument support means, whereby the valves can not be operated until an instrument has been removed from its support.

A still further object of the invention is to provide on the various modules adjustable water volume valves operable by knobs on the front panel of each module whereby the same is accessible for ready adjustment to control the water flow to the dental instrument at any given time in accordance with such setting.

Still other general objects are to obviate obsolescence, facilitate repair, and permit wide design flexibility especially in the individual modules.

Details of the foregoing objects and of the invention, as well as other objects thereof, are set forth in the following specification and illustrated in the accompanying drawings comprising a part thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an exemplary perspective view of a modular dental control unit embodying the principles of the present invention and being of the type arranged to be mounted on a suitable stationary support, such as a dental cabinet.

FIG. 2 is another exemplary perspective view showing a modular dental control unit embodying the principles of the present invention and supported on a conventional tray arm of a dental unit.

FIG. 3 is an exemplary front elevation of the modular dental control unit shown in FIGS. 1 and 2.

FIG. 4 is a front elevational view of the main frame or chassis of the modular dental control unit embodying the principles of the present invention and having the housing removed therefrom, said chassis having no modules mounted thereon.

FIG. 5 is a side elevation of the chassis shown in FIG. 4.

FIG. 6 is a plan view of the chassis shown in FIGS. 4 and 5.

FIG. 7 is a plan view of an exemplary foot-operated switch unit associated with the modular dental control unit to actuate the modules thereof.

FIG. 8 is a perspective exploded view showing the housing, chassis, and a plurality of exemplary modules to be supported by said chassis and embodying the principles of the present invention.

FIG. 9 is a side elevation of a typical exemplary module of the type illustrated in FIG. 8.

FIG. 10 is a schematic diagram of exemplary air and water supply conduits and control means in accordance with the principles of the invention.

FIG. 11 is a schematic circuit diagram of the principal electrical supply and control system for the modular dental control unit comprising the invention.

FIG. 12 is a sectional view of a typical air control valve of the type used in the individual modules.

FIG. 13 is a longitudinal sectional view of the air control valve included in the foot-operated switch unit shown in FIG. 7.

FIG. 14 is an enlarged vertical sectional view of the foot control unit per se.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

HOUSING — GENERAL

The modular dental control unit comprising the present invention is illustrated in its overall arrangement in FIGS. 1-3. The unit comprises a housing 10 which has been esthetically designed for ready connection to and separation from a base 12 which may be supported conveniently upon an appropriate cabinet 14 or other suitable support in a dental operator or, if preferred, it may be connected to a conventional horizontal arm 16 of a dental stand 18, said arm, for example, being of the type which supports the normal tray 20 of the dental stand 18. Appropriate brackets, not shown, may be used to clamp the base 12 to the arm 16. In general, the unit is intended to be positioned stationarily in the operator. Hence, it also may be suitably supported upon an independent pedestal or the like, of appropriate height and design, as desired.

Base 12 of the control unit may be made from any suitable material, such as sheet metal. Said base preferably has a rear wall 22 extending upwardly from the rear edge of base 12, formed from the same material as said base, and integral therewith if desired. For purposes of mounting the unit upon the upper surface of a cabinet, such as shown in FIG. 1, for example, the base preferably has a plurality of spaced cushion means, such as rubber buttons or knobs 24 fastened to the corners of the base.

The base 12 is of sufficient width to accommodate a plurality of the dental control modules 26, 28 and 30, which are illustrated in exemplary manner in FIGS. 8 and 9. While three such modules are illustrated in FIG. 8, it is to be understood that said number is not to be regarded as restrictive since the primary objective of the invention envisions a plurality of such modules without restriction to the exact number illustrated.

MODULES

Each of the modules has a sub-frame 32, which is best illustrated in side elevation in FIG. 9, and preferably is made from a strip of metal of suitable width and thickness to form a relatively rigid support for a plurality of individual control elements, details of which are described hereinafter. This permits the assembly of such elements, comprising each module, to be connected to and removed from the base 12 as a unit. Each of the sub-frames 32 comprises a bottom strip 34 and a front strip 36, which preferably is integral with the forward end of the bottom strip 34 and, for convenience particularly, may be formed simply by bending a single strip of metallic material, or the equivalent, into the configuration shown in FIG. 9. The front strip, incidentally, has an intermediate offset portion 38 for purposes to be described. The sub-frames 32 are readily and quickly detachably connected to the base 12 by a plurality of screws 40, shown in exemplary manner in FIG. 9, which are projected upwardly through suitable screw holes 42 in base 12 for threaded engagement with bosses 44 formed on the bottom strip 34 of each sub-frame, as best shown in FIG. 9. Holes 42 preferably are larger in diameter than screws 40 to permit limited adjustable positioning of the modules relative to base 12.

Fastened to the front strip 36 of each module, by any appropriate means, is a front panel 46, which is sub-

stantially coextensive in length with the front strip and the width of such panel is adequate to extend transversely in front of the various components of the module to which it is connected so as to subtend the same. Thus, when the assembled group of modules which are to be connected to the base plate 12 have been positioned thereon in operative relationship with respect to each other and the various supply means carried by the rear wall 22, to be described in detail hereinafter, all of the front face panels of the various modules will be in transverse juxtaposition. Such arrangement comprises a composite front face panel for the entire control unit enclosed within the housing 10, as can be fully appreciated from FIGS. 1-3, and especially the latter. Further, the housing 10 has a front opening 48 surrounded by an appropriate decorative bezel 50, the portion of said bezel extending across the upper part of the housing 10 preferably overlying the upper edges of the front face panels 46 of each module, whereby all of said face panels may be similar and yet an attractive, somewhat arcuate configuration of the upper portion of said bezel may be provided, as shown in FIG. 3.

It is contemplated that the modular dental control unit comprising the present invention shall serve to deliver dental utilities, such as air under pressure and water at suitable pressures, to a range of different types and kinds of dental instruments, such as handpieces or drills. There are available on the market at present quite a wide range of different types of dental handpieces, as well as other similar instruments requiring the control of the delivery of air and water thereto for desired use of such handpieces. Most of these instruments have different pressure requirements, especially in regard to the air to be delivered thereto. Also, the ability to regulate the volume and pressure of water delivered to instruments such as a dental handpiece is a necessary feature.

Most of the high speed dental handpieces used at present, particularly those having speeds in the range of 200,000 rpm or upwards, are driven by air-turbines of a miniature type contained within the head of the handpiece. There also are available lower speed air-driven power units to which a number of different types of dental handpiece heads selectively may be connected quickly in driving relationship with the drive shaft of the power unit for purposes of driving the shaft or rotor carried by the handpiece heads and containing a chuck or other gripping means by which burs and other forms of dental tools, such as grinding wheels, etc., may be connected to such shaft or rotor.

Accordingly, it is at least one of the principal objectives of the present invention to provide basic supply and control means for dental utilities, such as air and water under adequate pressure within desired ranges, and at required volumes, for delivery to a range of different types and kinds of dental instruments such as handpieces and the like which have various consumption rates and operative pressures. Means to furnish adequate lubrication, as required, are provided. Regardless of such variations in the requirements of these different types and kinds of dental handpieces and other similar dental instruments, the fundamental supply and control means provided by the present control unit are adequate to operate, with complete satisfaction, most, if not all, of the presently used dental instruments such as air-turbine type handpieces, power units, and the like.

In view of the varying requirements of such different kinds and types of dental instruments and handpieces in particular, and the fact that they have various consumption and pressure requirements different from each other with respect to both air and water, variations in the fundamental control means of the various modules are required for the individual dental instruments referred to. Especially for purposes of minimizing inventory requirements, and providing maximum installation ease and efficiency, all of the individual modules readily and quickly are attachable to and detachably from the base 12 and are all enclosed within the housing 10, whereby the individual desires of any dentist readily are satisfied with respect to providing not only a range of dental instruments to be supplied and controlled by the modular control unit comprising the present invention, but the specific location of each in said unit.

The typical module illustrated in FIG. 9 includes a number of compactly arranged control valves which are actuated by suitable power means supplied from appropriate sources. Valves operable by fluid means, such as pneumatic or hydraulic, or solenoid type valves are contemplated by this invention. The various valves, regardless of their operating means, are for purposes of controlling the delivery of air and water to the dental instrument connected to any particular module. Said valves are directly connected to and supported by the front strip 36 of the sub-frame 32 of each module and said valves are as follows. Although solenoid-operated valves are shown specifically in the drawings and described hereinafter, the invention is not to be restricted to such type of valves.

Lowermost on the strip 36 is a water valve 52 having an adjustable knob 54 by which the discharge of water through the valve may be readily regulated by a dentist or his assistant, as desired, by adjusting the valve knob 54. It will be understood that when the valve is opened by the solenoid which is illustrated as being connected thereto, the valve will be opened for discharge to the full extent determined by the adjustment produced in the valve by the knob 54. Suitable inlet and delivery connection ports and couplings are provided on the valve in accordance with conventional practice, these being connected to suitable, preferably flexible conduits, described in further detail hereinafter.

Supported by the offset portion 38 of front strip 36 is a three-way control valve 56, the solenoid coil specifically illustrated as being connected thereto also is connected in the electric circuit as described hereinafter and the body of the valve also is provided with appropriate air inlet and outlet connection parts and couplings to which flexible conduits or the like are connected. Projecting forwardly from the offset portion 38 is an air pressure gauge 58 which extends through a suitable opening in the front face panel 46 for ready observation of the pressure of air delivered by the valve when opened. Operation of the valve is achieved by the foot control assembly shown in FIG. 7 by means described hereinafter.

Incident to performing certain cutting and drilling operations, as well as other dental functions, it frequently is desirable to have a blast of air available from the handpiece to clear the particles from a newly prepared tooth cavity, for example, to dry a cavity, or otherwise. The present invention contemplates the provision of such a blast of air being available, preferably

from a suitable jet or nozzle in the handpiece adjacent the bur. Control of the supply of air under suitable pressure is performed by still another air control valve 60 but, preferably, the same is only a two-way valve. Said valve, when desired on a module, is connected to the upper end portion of the front strip 36 and the body of the valve is provided with appropriate air inlet and discharge connectors to which preferably flexible conduits are attached, in accordance with the air flow diagram shown in FIG. 10.

Each module also is provided with an air pressure regulator valve 62, which is supported by the rearward portion of the bottom strip 34 of each sub-frame 32. Valve 62 is for purposes of controlling the initial pressure of air to be delivered to a dental instrument when either of the air control valves 56 or 60 are opened. The valve 62 is of the adjustable type and details thereof are shown in FIG. 12. Referring to said figure, it will be seen that the valve has a flexible, impervious diaphragm 64 against which the pressure of a spring 66 is exerted, as controlled by an adjusting screw 68 threaded into the upper end of the valve body. The upper end of a valve-actuating rod 70 is connected centrally to diaphragm 64 and the lower end thereof engages a valve member 72 having a compressible sealing ring 74 thereon engageable with a valve seat 76.

Driving air is introduced through inlet port 78 and passes through opening 80, valve seat 76, when open, and opening 82 for the discharge of air into the air exhaust port 84. Assuming, solely for purposes of example, that the dental instrument which requires the highest pressure range of any of the instruments to be served by the control unit comprising the present invention is of the maximum range of about 60 p.s.i. Air in the supply line accordingly will have to carry air at a pressure of at least 60 p.s.i. and, preferably, somewhat greater to allow for losses. Such line pressure will be present in the air inlet port 78.

Certain types of air-turbine type handpieces operate at variable speeds, depending upon the air pressure delivered to the turbine. Accordingly, the speeds vary directly in proportion to the amount of air pressure. Hence, as the air pressure is increased, the speed increases. For handpieces or other dental instruments of such type, the spring 66 is adjusted by the screw 68 to operate against the diaphragm 64 at a pressure equal to the minimum air pressure required by a dental instrument of the type referred to.

The air pressure present in the air delivery line from exhaust port 84 to the dental instrument will determine whether the valve member 72 is seated against the seat 76 or spaced from it. If the dental instrument requires driving air, as determined by the setting of the foot control unit shown in FIG. 7 and described in detail hereinafter, the valve member 72 will be in an open position determined by the pressure of spring 66 and additional pressure afforded by a supply of control air, connected directly to the main air supply lines by means to be described. Such control air is applied against the upper face of diaphragm 64 by means of inlet tube 86, through which air is fed in a somewhat constricted but steady manner against the diaphragm 64. Accordingly, for example, if 30 p.s.i. air pressure is desired at a given time to operate an air-turbine dental handpiece, to produce a speed corresponding thereto, and assuming that the spring 66 is regulated to exert a pressure of 15 p.s.i. 15 p.s.i. additional pressure will have to be delivered by

the control air against the upper face of diaphragm 64 through inlet tube 86.

As the demand for driving air at required pressure is satisfied, the valve member 72 will be closed in accordance with the amount of air pressure directed against the lower face of diaphragm 64 and, correspondingly, the inlet of supply air through port 78 will be decreased proportionately or, under certain circumstances at least of a momentary nature, the valve may be entirely closed until the pressure of the driving air being delivered to the dental instrument decreases to such pressure that additional driving air must be drawn from the supply line.

Those modules which are to regulate air-turbine handpieces or other similar dental instruments requiring the introduction of an oil mist into the driving air, are provided with an oiling unit 88 of well-known commercial type adapted to atomize lightweight vegetable oil or the like which is supported by an appropriate bracket 90. Said bracket may be part of an additional bracket 92 which supports the pressure-regulator valve 62 upon the bottom strip 34 of the sub-frame. The oiling unit 88 has suitable air inlet and outlet coupling means to which flexible or rigid air lines may be connected. The unit 88 also is of the type which preferably has an oil reservoir 94 thereon and the upper portion of the unit also preferably has a transparent observation globe 96 which is air-tight and projects through appropriate openings in the top of the housing 10. Observation may be made through these globes of the delivery of oil from the reservoir 94 to the atomizing mechanism in the upper portion of the oiling unit 88. Air to be delivered to handpieces or other dental instruments of the type described for use in driving the same first passes through the oiling unit 88 for purposes of having a desired amount of oil mist entrained therein for delivery by the driving air to the bearings, for example, of said handpieces.

Connected to the forward lower portion of each sub-frame 32 is a bracket block 98 to which one end of an instrument-supporting arm 100 is pivotally connected by a pin 102, see FIG. 9. The lower portion of each arm 100 has a slotted sleeve 104 thereon which receives the handle portion of a dental instrument, such as an air-turbine type handpiece. The weight of the instrument is adequate to hold the sleeve 104 in a lowered position but, when the instrument is removed for use from the sleeve 104, the lower end of arm 100 is moved forwardly a limited distance about the pin 102 by means of a connecting rod 106 which is connected at one end to the inner end 108 of arm 100 and, at the other end, is pivotally connected to a flange 110 on the outer end of a leaf spring which commonly engages all of the rearwardly extending operating plungers of an exemplary stack of three electrical conditioning switches 112, which respectively are connected in the circuits to the solenoid for the valves 52, 56 and 60. If fluid actuated valves are used rather than the solenoid valves, suitable fluid conditioning valves should be used, in lieu of the electric conditioning switches 112.

Details of the electric circuitry to said solenoids are such that the conditioning switches 112 somewhat serve as control switches for the solenoids of the various valves, whereby, as long as a dental instrument remains supported in the sleeve 104 of any given module, the sleeve is depressed to its lowermost position and this results in all of the switches 112 being held open.

Hence, none of the solenoids of any of the valves of said module may be operated under such condition. However, upon the removal of a dental instrument from the sleeve 104, the pressure of the plungers of the switches 112 is adequate to move the leaf spring which supports flange 110 rearwardly, correspondingly moving the connecting rod 106, and thereby causing the lower end of the arm 100 to move forwardly a limited amount. All of the switches 112 then will be closed simultaneously and, in accordance with the requirement of air and water for the dental instrument connected to said module, as controlled by the foot control switch of FIG. 7, the various valves of the module may be operated to supply such air and water needs. The foregoing would apply also if fluid actuated valves were used in lieu of the electric switches 112.

UTILITY SUPPLY

Supply of air under pressure and water at desired pressure commonly to all of the modules and the dental instruments mounted thereon is provided by manifold arrangements connected to the base 12 and particularly to the rear wall 22 extending upwardly therefrom. By reference especially to FIGS. 4-6 and 8, the details of such manifold means will be seen, the same being as follows.

An air filter 114 of suitable capacity is mounted on wall 22 and has inlet connector means 116 for connection to either a rigid or flexible air supply line communicating with a source of air under pressure, such as a suitable compressor or pressure tank. If desired, a master pressure-regulator valve, not shown, may be included in the supply line. Extending along the upper portion of wall 22 is an elongated air manifold 118, which is connected directly to the air filter 114 and receives air therefrom in filtered condition, said air being designated as driving air for the various dental instruments contemplated to be operated from the various modules of the unit. The manifold 118 is provided with a plurality of tapped ports 120 arranged to receive conduit connecting members otherwise connected to the air inlet means of the various air control valves of the module. Any unused connecting members may be plugged. It will be understood that the air present in manifold 118 is at so-called line pressure and, for rendering the control unit capable of operating substantially all of the presently available types of air-actuated dental instruments now commonly employed in dental operatories, for example, such pressure preferably should not be substantially less than about 65 pounds. It also would be better if the pressure was somewhat greater than this to insure of providing at least 60 p.s.i. pressure regardless of variations in line pressure from time to time.

Particularly for purposes of delivering constricted volumes of air at line pressure to the inlet tube 86 of the various pressure-regulator valves 62 of the modules 26, 28 and 30, a so-called control air manifold 122 is connected to the driving air manifold 118 by suitable means including an auxiliary air control valve 123, preferably solenoid actuated and for purposes to be described, and constricted passage means 124 there-through to permit only limited flow of air, at line pressure, into the manifold 122. The manifold 122 has a series of ports of small diameter in which complementary connecting tubes 126 are press-fitted or otherwise secured for purposes of having one end of a small diame-

ter, flexible air conduit, not shown, connected thereto simply by frictionally expanding one end over one of the tubes 126. Those tubes which are not required for use may be suitably plugged. The other ends of such small diameter conduits are similarly fitted over the outer ends of the inlet tubes 86 of the pressure-regulator valves 62 on the various modules.

For convenience, the driving air manifold 118 may be supported by a suitable metallic bracket 128, shown in FIG. 5, which is directly affixed to the rear wall 22 of base 12, said bracket extending downwardly and having an extension 130 which directly supports certain elements of the water delivery and control means comprising a filter or strainer 132 having a connecting coupling 134 thereon for connection to the delivery end of a suitable flexible water conduit or the like, and the other end of the conduit being connectable to a source of water at city pressure, for example.

Closely arranged relative to the strainer 132 is a water pressure regulator valve 136 having an adjusting screw 138 thereon by which the valve may be regulated to deliver water at a desired predetermined maximum pressure, regardless of how much higher the line pressure may be. The delivery end of the regulating valve 136 is connected directly to an inlet port in water manifold 140, which is provided with a plurality of tapped discharge ports 142 that may either be plugged or receive connecting couplings to which flexible conduits may be connected at one end for connection at the opposite ends respectively to the water control valves 52 of the various modules.

A terminal flange 144 extends downwardly from the bracket extension 130 for purposes of receiving an insulated electrical terminal strip 146 to which appropriate leads from the solenoids of the switches of the various modules may be connected in order that current may be established between the same and certain leads from a preferably compound electrical cable, illustrated in diagrammatic form in FIG. 11, which enters the interior of the unit 10 through an appropriate opening 148, see FIG. 4, in the rear wall 22. Leads from the various conditioning switches 112 also are interconnected into the electric circuit through the medium of the terminal strip 146 and, similarly, the flexible electric leads are conductors from the foot control switch member shown in FIG. 7, to be described hereinafter, also are connected into the circuit by means of the terminal strip 146. For safety purposes, a fuse receptacle 150 is connected in the circuit and mounted on the rear wall 22 with access in the interior thereof normally being covered by a screw threaded cap rearwardly of wall 22, as shown in FIG. 6 and the wiring diagram of FIG. 11.

HOUSING DETAILS

It is evident that the rear wall 22 of base 12 supports a substantial amount of apparatus and to brace the wall relative to base 12, any appropriate means, such as suitably shaped side flanges 152 respectively connected to the side edges of base 12 and rear wall 22, may be used to provide suitable means to render the rear wall 22 rigid relative to base 12.

The housing or cover 10 may be made from any suitable sheet material, such as being molded or formed from relatively rigid synthetic resin, stamped from suitable sheet metal, cast from appropriate metal, or otherwise. The housing preferably has a peripheral forward

flange 154, which defines the front opening 48 and a rear peripheral flange 156. When the housing 10 is connected to the base 12 and rear wall 22, said flange 156 overlaps the side and top edges of said rear wall and, by means of a single screw inserted through the screw hole 158 in flange 156, the rear portion of the housing 10 is securely but detachably connected to the base 12 and the modules connected thereto for enclosing all of the mechanism of the modules and the various manifolds and the like supported by the rear wall 22.

The forward portion of housing 10 is secured in operative position upon base 12 by means of the bezel 50 which preferably comprises a casting complementary to the outline of the front opening 48 of the housing and overlying the forward flange 154 thereof. The bezel 50 is U-shaped and the terminal ends of the legs thereof have tapped holes 160 therein to receive screws extending upward through screw holes 162 in the forward corners of base 12. Appropriate angularly extending braces 164 are connected at one end to base 12 and at the upper forward ends thereof, said braces are connected by suitable screws to tapped bosses 164 formed on the rear face of the upper portion of bezel 50, as shown in FIGS. 5 and 8. Correspondingly, the upper portion of the forward flange 154 of housing 10 has notches 166 therein which receive the bosses 164 incident to connecting the housing 10 to the base 12.

From FIG. 5, it will be seen that the bezel 50 extends upwardly and rearwardly and the side portions of forward flange 154 of housing 10 slopes similarly, whereby when the housing 10 is disposed in covering relationship to the base 12 and rear wall 22, and the forward flange 154 fits snugly behind the bezel 50, such sloping arrangement of the bezel and sides of forward flange 154 will prevent any appreciable upward movement of the housing 10 relative to the base 12. Accordingly, only a single screw extending through hole 158 in rear peripheral flange 156 of housing 10 is all that is required to maintain the housing 10 in operative, covering manner with respect to base 12 and all of the mechanism supported thereby and also supported by the rear wall 22.

Particularly for esthetic purposes as well as protecting the lower terminal edges of the sides of housing 10, the opposite sides of base 12 are provided with elongated channel-forming strips 168, best shown in FIGS. 4-6, and the lower terminal edges of the sides of housing 10 are received within the channels formed thereby.

Each of the bracket blocks 98 at the lower portion of each module is provided with a connection socket 168 to which one end of a so-called handpiece hose 170 is connected, the opposite end thereof being connected to the handpiece or other dental instrument to be serviced thereby. Said hose is of a compound nature and includes, at least for use with most types of dental handpieces and similar instruments, two conduits, one of which conducts air to the dental instrument, and the other conducts water thereto, as outlined in diagrammatic form in FIG. 10. If chip-blowing air is required, another air conduit is included. The connection socket 168 has appropriate terminal nozzles automatically engageable with the correspondingly arranged flexible air and water conduits in the hose 170 when one end of the latter is connected to said socket 168, such as by a threaded clamping collar 172, see FIG. 3. Such terminals in the connection socket 168 communicate with

the delivery conduits extending from the various valves 52, 56 and 60 of each module, in accordance with the diagrammatic conduit layout of FIG. 10.

FOOT CONTROL UNIT

Delivery of air and water to the various dental instruments is controlled by the variable speed foot control unit 174, details of which are illustrated in FIG. 7. Said unit is connected to the control modules within housing 10 by means of another compound flexible conduit 176 which carries a plurality of electrical conductors and a small capacity flexible air conduit. The electrical conductors are connected to suitable terminals on terminal strip 146 and the air conduit is connected to one of the connecting tubes 126 of control air manifold 122, in accordance with the diagrammatic layout of FIG. 10. The electrical system, including the electrical conductors of compound flexible conduit 176, is shown in the electrical diagram of FIG. 11 and details of both of the diagrammatic layouts of FIGS. 10 and 11 are described hereinafter.

Referring to FIGS. 7 and 14, the latter being a sectional view on line 14-14 of FIG. 7, it will be seen that the variable speed foot control unit 174 comprises a base plate 178 supported adjacent a floor by buttons 180. Flexibly connected to one edge of the base plate 178 for limited pivotal movement is a plate-like foot treadle 182 to which one end of a leaf spring actuator 184 is connected, the opposite end thereof being arranged to engage simultaneously the switch-actuator plungers 186 of the electric double unit switch 188 which is supported by base plate 178. The units of switch 188 are connected in the circuit of each module, one unit being directly in the circuits of the solenoid-actuated valves 52 of the various modules, when this type of valve is used, for controlling the supply of water to any handpiece or other dental instrument selected for operation by the dentist or his attendant, the electric circuit of which has been conditioned by closing the switches 112, and the other unit of double switch 188 being directly in the circuits of the solenoid-actuated air control valves 60 of the modules.

Another electric switch 190, see FIG. 7, also is supported by the base plate 178 and a foot-actuated lever 192 is pivotally supported by the base plate 178 for movement about a fixed vertical pivot post 194. The outer end of the lever 192 has a vertical terminal leaf member 196 which overlies the foot treadle 182 and readily is engageable by the toe of the operator. Normally, a spring 198 maintains the lever 192 in the inoperative or "home" position thereof shown in FIG. 7.

The switch 190 preferably is of a relatively sensitive nature, one suitable example of the same being a micro-switch having an operating plunger 200 projecting from the side thereof nearest the lever 192 and engageable by a corner 202 of the pivoted end of lever 192. Hence, when the operator moves the lever 192 clockwise, by engaging the member 196 with his toe, the first portion of said movement will move the corner 202 of lever 192 away from the switch-actuating plunger 200 and thereby release said plunger and permit the switch to close, it being of the type that normally is open when the plunger 200 is depressed.

The switch 190 is within and controls the circuits to all of the solenoids of the air control valves 56 of the various control modules 26, 28 and 30 and also the solenoid of auxiliary air control valve 123 of FIGS. 6 and

10. The solenoids of said air control valves will be energized when lever 192 is moved clockwise, as indicated above, after the conditioning switch 122 of any particular unit has been closed incident to the dental instrument of said module being removed from said arm for use. Thus, immediately upon the several switches referred to being closed, any selected dental instrument will have air delivered to it at a pressure initially controlled by the setting of the regulator valve 62 of that particular module to which the dental instrument is connected.

In the event the dental instrument is of the type, such as a handpiece driven by an air-turbine or the like, the speed of which is variable in accordance with the pressure, and consequently the volume of the air delivered to it, air pressure in excess of that controlled by the pressure regulator valve 62 of the particular module is furnished by means of a variable valve 204. The position of said valve in the foot control unit 174 is shown in FIG. 7, and details of the valve are shown in FIG. 13. The valve has a projecting end 206 which is engaged by a cam 208 fixed to the inner end of lever 192, the cam being of such shape that, as the lever 192 is moved clockwise as viewed in FIG. 7, the plunger 206 is depressed progressively to move inward the sleeve 210 comprising part of said plunger for reaction against loading spring 212 which extends between the inner end 214 of plunger 206 and a flange 216 on the inner end of thrust member 218, the inner end of which engages circular valve member 220 which is movable limited distances toward and from valve seat 222.

The interior of valve seat 222 communicates with an air-inlet extension 224 which is connected by a flexible tube 226, see FIG. 7, to auxiliary control valve 123, see FIG. 10, and one of the connecting tubes 126, see FIG. 6, on control air manifold 122. Movement of lever 192 also closes switch 190, see FIGS. 7 and 14. When this has occurred at the initiation of movement of lever 192 to complete the circuit through auxiliary air supply valve 123 shown in FIGS. 10 and 11, the valve member 220 will be subjected to air which is exerted against it from air inlet extension 224, at line pressure, but in limited supply due to the constricted passage member 124 shown in FIG. 10.

Valve member 220 is shown in FIG. 13 in closed position, wherein it is seated against its valve seat 222. This only occurs when auxiliary air control valve 123 is closed. When in this position, air will not flow into the valve from air inlet extension 224. However, at the initiation of movement of lever 192, the valve member 220 is spaced from seat 222 due to auxiliary air pressure entering through inlet 224. Positioning of plunger sleeve 210 and plunger 218 in the initial position thereof is assured by return spring 228 and any sticking of the valve member 220 with respect to the seat 222 is prevented by another spring 232 of low compression rating which extends between the inner face of valve member 220 and seat 222 within air-inlet extension member 224. Various interconnected members of valve 204 adjacent inlet extension 224 are provided with passages 234 and 236 to permit the exhausting of air past valve seat 222 to atmosphere for purposes to be described.

Referring to the description of pressure-regulator valve 62 illustrated in FIG. 12, as set forth hereinabove, it will be seen that such valves are used on the modules which are selected for supporting and servicing dental

instruments and especially dental handpieces of the type which require a variable air pressure over and above a predetermined initial pressure which is furnished by adjusting the screw 68 of valve 62 to produce the desired pressure upon spring 66 which is exerted against diaphragm 64. Such pressure is transmitted to valve member 72 which controls the flow of air, under pressure, to the dental instrument from the driving air manifold 118. For example, to increase the speed of the dental instrument, such as an air turbine therein, above that which is caused by the pressure for which the valve 62 initially is set, pressure upon diaphragm 64 may be increased by delivering a restricted amount of air, at line pressure, through inlet tube 86 of valve 62. As described, the inlet tube 86 of the several valves 62 is connected to one of the tubes 126 leading from the control air manifold 122 shown best in FIGS. 4-6.

It will be understood that air, at line pressure, will always be available in control air manifold 122 for constant delivery to the inlet tubes 86 of all of the pressure regulator valves 62 which are connected to the various connecting tubes 126 of manifold 122 upon auxiliary valve 123 being opened when lever 192 closes switch 190. Normally, however, one of the connecting tubes 126 is connected to the air inlet extension 224 of variable valve 204, shown in detail in FIG. 13, which is carried by the foot control unit 174. When the projecting end 206 of the operating plunger of valve 204 is in its fullest extended position, shown in FIGS. 7 and 13, only minimum pressure is exerted upon valve member 220 by the loading spring 212. Thus, compressed air, at line pressure, constantly is available from the air inlet extension 224 and, as a result, such pressure is exerted against valve member 220, thereby removing it from valve seat 222. Such movement usually is only slight, being sufficient to permit limited amounts of such air, at line pressure, to escape constantly through the exhaust passages 234 and 236 but only after valve 123 has been opened.

From the foregoing, it will be seen that the principal function of variable valve 204 is to restrict the escape of air, at line pressure, from the control air manifold 122, to atmosphere, and otherwise cause it to be applied usefully against the diaphragm 64 of the pressure-regulator valve 62 of a selected module so as to increase the pressure of the spring 66 against diaphragm 64 by introducing such applied line pressure through inlet tube 86 into the valve. As a result, air at higher pressures than normally would be permitted to flow through valves 62 by the initial setting of the springs 66 thereof, is permitted to flow through the inlet port 78 to the exhaust port 84 of the valve 62 being operated at the time, for delivery of driving air at such increased pressure to the dental instrument connected to port 84 of the valve by means of handpiece hose 170. Such driving air is furnished by manifold 118.

By restricting the escape of air from manifold 122 through the movement of the projecting end of plunger 206 of valve 204, as actuated by cam 208 on the inner end of foot lever 192, the delivery of air at increased pressures through the pressure-regulator valve 62 will be effected until the dental tool reaches the speed desired by the operator, at which time he will no longer move the foot lever 192 and the speed of said dental tool will be maintained substantially constant by holding the foot lever 192 at such adjusted position. Such desired pressure is maintained by the pressure of the

spring 66 and the additional air pressure applied through inlet tube 86 of valve 62 against diaphragm 64. If there is any tendency for the pressure of the air passing through the valve 62 to increase, such increase in pressure will move the valve member 72 in closing direction at least momentarily against the valve seat 76 until the desired pressure is restored, when valve member 72 will again open. Such adjustable movement of the valve member 72 may occur a number of times during operation of any particular dental instrument. Under such circumstances it readily can be seen that the valves 62 are truly pressure-regulator valves.

Referring to FIG. 13, the preferred operation is that the entire range of movement of valve member 220 relative to its seat 222 is small. When the valve unit 204 is functioning, there will always be at least limited escape of air through ports 234 and 236. To a limited extent, the valve member 220 is capable of at least slight floating action resulting from equalizing forces exerted by loading spring 212 and the combined forces of incoming air and spring 232 which operate in opposition to spring 212. All the while, additional air pressure is being applied against diaphragm 64 of regulator valve 62, for the purposes described above. In certain modules, depending upon the type of instrument being controlled, such additional air pressure will be delivered directly to the instrument to vary the speed thereof.

In the valve unit 204 there is also a safety relief feature in the form of a spring 230 which extends between valve seat 222 and the cap threaded onto the discharge end of the outer housing of valve 204. This permits valve seat member 222 to move outwardly a limited amount, if required to do so, such as when sleeve 210 is moved an abnormal distance inwardly so as to substantially close valve member 220 against seat 222 while air is still entering the valve through inlet 224 so that pressure therefrom would continue to increase up to full line pressure if the relief afforded by spring 230 were not provided.

Under circumstances where either very precise movement of the foot lever 192, or locking of the same in an adjusted position, are desired, the same is accomplished by the use of brake means, details of which are best shown in FIG. 14. As will be seen also in FIGS. 1 and 2, the foot control unit 174 includes an inverted dish-like cover 238 provided with a The forward portion of the cover 238 of brackets 240, which are engaged by screws 242 to detachably secure the cover 238 to the base plate 178 of foot control unit 174. The forward portion of the cover 38 is provided with a cut-out portion 244 through which the pivoted lever 192 extends, the same overlying the foot treadle 182, as best shown in FIG. 7.

Slidably supported exteriorly of the top of cover 238 is a brake slide 246, which is of appreciable length so as to be conveniently operable by the toe of a dentist without having to gauge precisely where to contact the slide. Preferably, the slide is covered with a friction pad 248, formed from molded rubber or the like. The cover 238 is provided with a pair of slots 250 extending substantially within a common diametrically arranged line across the top of cover 238 for purposes of receiving the shanks of headed metallic buttons 252, the rims of which extend over the inner surfaces of the top of cover 238 at opposite sides of the slots 250 for purposes of permitting horizontal movement of the slide 246, but prevent separation thereof from cover 238. The but-

tons 252 are secured to the slide 246 by any suitable means, such as screws 254.

In addition to serving to retain the brake slide 246 in operative position upon the cover 238 and to guide the same in its movement relative to the cover, it will be seen that the lower portion 254 of the periphery of the buttons 252 is substantially conical and one of said buttons serves as a cam surface to engage the upper end of a brake plunger 256, which is mounted for limited vertical movement within an appropriate complementary bore formed in stationary block 258. Said block is fixed to the base plate 178 and is provided near the lower end thereof with a horizontal slot 260 which movably receives the peripheral extremity of a segmental brake plate 262 fixed to and movable with the inner end of foot lever 192 as it is actuated about the axis of pivot post 194.

The upper portion of brake plunger 256 preferably is hollow to contain a compression spring 264 for purposes of urging upwardly a ball bearing 266 or the like, the latter being directly engaged by the button 252 when the brake slide 246 is moved toward the right, as viewed in FIG. 14, by the toe of the operator. The upper edge of the walls of plunger 256 are crimped slightly inwardly to prevent escape of ball bearing 266 from the upper end of plunger 256 when the ball bearing is not engaged by button 252. The lower end of plunger 256 acts directly against a friction disc 268, which engages the upper surface of brake plate 262, while the lower end of block 258 directly below and coaxial with disc 268 preferably also contains a friction plug 270, the upper surface of which engages the lower surface of brake plate 262.

From the foregoing, it will be seen that when pressure is placed upon ball bearing 266 by movement of the right-hand button 252 toward the right, as viewed in FIG. 14, corresponding pressure urges plunger 256 and upper friction disc 268 against brake plate 262 and also urges the lower surface of the brake plate against the stationary friction plug 270 to provide adequate braking of the foot lever 192 so as either to hold it releasably fixed in any adjusted position desired by the operator, or to permit further movement thereof, if desired. Further movement, under the circumstances, requires greater force than normally is necessary for purposes of simply moving the lever against the action of return spring 198.

It will be seen that the central portion of the lower surface of at least the right-hand button 252 preferably is flat, whereby when the brake slide 246 is moved toward the right, as indicated above, to the full extent permitted by the slots 250, for example, such flat surface will be placed directly over ball bearing 266 and thereby will serve to maintain the brake plate 262 in frictional engagement between the friction members 268 and 270 until the brake slide 246 is again moved to the left to release such pressure upon the plunger 256. The friction disc 268 and friction plug 270 preferably are formed from similar material of an appropriate wear-resisting nature, certain types of synthetic resins, such as phenolics, being highly suited for this purpose.

OPERATION OF THE CONTROL UNIT

A flexible, compound "cord" 272, including an assembly of several conduit tubes and electric conductors, see FIG. 5, extend through an opening 274 in the rear wall 22 of the housing 10 for purposes of bringing

to the various supply and control elements within the housing air under pressure from a suitable source, water at municipal pressure or otherwise, and electric current which, under normal circumstances, is 60 cycle, 110 volt current. Air is directed to the filter 114 and from there is distributed by manifold 118 to the various air conduits interconnecting said manifold with the control valves 56 of the various modules. Some of the air is also delivered to the control air manifold 122 and various small-capacity tubes distribute this air at line pressure to the various pressure valves 62 of the modules, as well as to valve 204 in the foot control unit 174. Water from the compound conduit assembly 272 is delivered to the strainer or filter 132 for passage through the pressure regulator valve 136 and is distributed to those modules requiring the same by means of water manifold 140. Preferably flexible tubes connect said manifold with the water control valves 52 of the various modules, the amount of water delivered by said valves being controlled by the adjustable knob 54 on the various modules.

The several electric switches and the variable valve 204 of the foot control units 174 are connected by another compound conduit and conductor assembly or "cord" 176, which enters the housing through the opening 148 in the rear wall 22 of the housing for connection to appropriate terminals on the insulated strip 146, as well as the flexible air conduit of the assembly 176 being connected to one of the connecting tubes 126 on manifold 122.

Assuming that one of the dental instruments to be used is a handpiece of the air-turbine type, upon removing the same from the supporting arm 100 of the control module to which it is connected, the conditioning switches 112 of that module are closed by reason of the weight of the instrument being removed from the arm 100. This partially preconditions the electric circuit to which said module is interconnected. To initiate the delivery of air under pressure to the turbine of said instrument, it also is necessary to move the foot lever 192 of the control unit 174 at least a slight amount, sufficient to remove the corner 202 of said lever from engagement with the plunger 200 of switch 190, whereupon the circuits to the solenoid of the air control valve 56 are completed simultaneously and said valve and valve 123 are opened. Air will commence to "bleed" from valve 204 at a limited rate when valve 123 is opened and continues to do so until it is closed. Driving air will then be delivered to the dental instrument at the maximum pressure determined by the initial setting of the pressure regulator valve 62 and any increase in regulating pressure.

The turbine of the selected dental instrument will be operated at a speed in proportion to said pressure. If greater speed is desired, the operator then moves the foot lever 192 clockwise, as viewed in FIG. 7, an additional amount necessary to produce the desired speed. This increase in speed is produced by such movement of lever 192 causing the cam 208 to depress the plunger 206 of variable bleed-type valve 204 and thereby increase the pressure at which the air, at line pressure, is capable of unseating the valve member 220 from seat 222 so that said air can escape to atmosphere through passages 234 and 236. As a result, a restricted amount of air at line pressure flows from manifold 122 to the inlet tube 86 of the pressure regulator valve 62 of the module to effect an increase in pressure against the dia-

phragm 64 of said valve over that afforded by spring 66, see FIG. 12, thereby increasing the pressure of air to be delivered to a dental instrument from line supply.

As described hereinabove, the speed of certain air-turbine actuated dental handpieces is proportional either to the volume or the pressure of air delivered thereto, air volume and pressure being closely related. Accordingly, rather than having to guess at the speed of the handpiece, for example, the operator is able to determine with reasonable accuracy the speed thereof by observing the pressure indicated on the gauge 58 of each module. More or less speed is attainable simply by varying the position of the foot lever 192 of control unit 174, either with or without the brake apparatus being applied.

The foregoing will cause driving air to flow through the inlet and exhaust ports of valve 62 at a higher pressure than that for which the valve initially is set, thereby permitting the dental instrument to operate at a proportionally increased speed. This speed is maintained by operation of the valve 204, and especially the adjusted pressure exerted therein upon the valve member 220 will respect to its seat 222. As additional air at line pressure is applied against the upper surface of diaphragm 62, any which is not required to maintain the desired speed, is dissipated to atmosphere past valve seat 222 rather than being applied against the diaphragm 64 of valve 62.

In the event the operator of the dental instrument desires water to be supplied to the same, it is only necessary to depress the foot treadle 182 to actuate switch 188 and thereby close the circuit to the solenoid of the water control valve 52 of that particular module, such actuation of the valve permitting the delivery of water at pressure regulated by the valve 136 to the dental instrument from manifold 140 after the water first has been filtered by the strainer unit 132.

If the dental instrument referred to is of the type which requires the lubrication of the bearings of the turbine by means of an oil mist entrained in the driving air, for example, the module is provided with an oiling unit 88 for purposes of generating such oil mist and the functioning thereof is readily discernible visually by noting the observation globe 96 which projects through the cover of the housing 10 as shown in FIGS. 1 and 2. The oiling unit 88 is preferably of a commercial type capable of functioning by air pressure incident to the driving air flowing therethrough for purposes of entraining oil mist therein prior to delivering said air to the dental instrument to lubricate the bearings thereof.

UTILITY CIRCUITS

To readily understand the circuitry pertaining to the fluid discharge conduits, including those for both air and water, from the source to the ultimate point of consumption thereof in the various dental instruments, attention is directed to the diagrammatic layout shown in FIG. 10. In this figure, the various modules 26, 28 and 30 have been indicated in diagrammatic form, there being certain differences in detail in these modules for purposes of indicating the versatility of the control mechanism of the entire unit being adapted to the operation of dental instruments of different types. For example, the dental instrument to be utilized with exemplary module 30 may be of the type which requires no lubrication of the bearings, such as a dental handpiece employing air bearings. In slight contrast to this, the

dental instrument to be used with module 28, as indicated in said diagram, is one requiring no additional supply of air at line pressure to the pressure regulating valve 62, for example, as in the other modules illustrated in said figure. Lastly, an exemplary module 26 is illustrated as being of the type which requires lubrication, such as by an oiling unit 88.

The principal elements of the electrical system embodied in the various modules and the foot control unit 74 are illustrated diagrammatically in FIG. 11. In this figure, it will be seen that the switch 190, which is controlled by foot lever 192, is illustrated in so-called "home" position as when the lever is in the position shown in FIG. 7 of the drawings. Under such circumstances, when the foot treadle 182 is depressed, both units of the double switch 188 will be closed, whereby, especially with reference to FIG. 12, it will be seen that a circuit will be completed through the lower switch 188 illustrated in said figure. A circuit also will be established through the solenoid-actuated air control valve 60 which, with reference to FIGS. 8 and 9, will be seen mounted on the upper portion of the front strip 36 of each sub-frame which supports the elements of the modules. Valve 60 controls the discharge of what is known in the dental profession as a chip-blowing jet of air.

Dental handpieces which employ the foregoing arrangement include a small tube or other suitable conductor having an outlet adjacent the rotatable bur of the handpiece, the air jet delivered thereby being for purposes of blowing chips from a prepared cavity or for drying the surface. Such a chip-blowing jet actually can take the place of the conventional air syringe normally employed by a dentist for such purposes, when desired, and enables the dentist to quickly clear a cavity or dry the same by blowing any accumulated water therefrom incident to drilling or cutting the cavity in the tooth. This can occur while the handpiece is held substantially in operative position within the oral cavity and without requiring the dentist, as otherwise would be necessary, to release the handpiece, grasp the conventional air syringe, and then return to the handpiece after he has replaced the conventional air syringe in its accommodating socket.

Any of the modules may quickly be provided with the additional air control valve 60 and be connected in the air circuit of the module very simply by the use of short pieces of tubing connectable to the manifold 118 and, under such circumstances, the handpiece hose 170 will include among the plurality of passages contained therein a separate passage for air employed as a chip-blowing jet, to which valve 60 also is connected.

It is only when the foot lever 192 is in the "home" position that the treadle 182 may be depressed for purposes of discharging chip-blowing jets of air, in accordance with the arrangement specifically described above. Said "home" position is that which is illustrated with respect to switch 190 in FIG. 11. When in such position, and both of the switches 188 are closed, which will occur simultaneously incident to depressing the treadle 182, only the lower switch 188 in the circuit of FIG. 12, which is in the electric line 276 to the solenoid of the chip-blowing air control valve 60, is effective to complete the circuit to said solenoid of any particular module. Such circuit also will have been pre-conditioned by the closing of switches 112 of that module and thus the valve 60 will be actuated to discharge

chip-blowing air from the dental instrument being operated by the selected module. When such chip-blowing air is desired, it thus simply is necessary to depress the foot treadle 182 while the foot lever 192 is in said "home" position.

Upon moving the foot lever 192 from said "home" position, such as illustrated in FIG. 12, the movable switch member of switch 90 will be moved to the opposite contact directly below the outer end thereof, as illustrated in FIG. 12, thus severing engagement with the upper contact engaged when in the "home" position. Such shifting of the movable switch member will occur instantaneously and immediately disrupt the circuit to the solenoid coil for the chip-blowing air control valve 60 of any given module and immediately establish circuit with the line 278, which delivers current to the solenoids of the driving air control valves 56 of the various modules, depending upon which has been pre-conditioned through the closing of the switches 112 incident to removing the dental instrument from the supporting arm 100 of such selected module, and also closes the circuit to valve 123 for varying valve 204.

If the delivery of water to a particular dental instrument is desired after foot lever 192 has been moved from said "home" position so as to establish a circuit in the line 278, it will be seen from FIG. 12 also that upon the foot treadle 182 being depressed to close both of the switches 188, such closing of the upper switch 188, as viewed in FIG. 12, results in a circuit being established with electric line 280, which is connected to the solenoids of the water valves 52 of the various modules but water will flow only through that module which has been pre-conditioned by the switches 112 thereof being closed. Hence, it will be seen that while a selected dental instrument is being driven by air pressure resulting from the movement of foot lever 192 from "home" position toward its maximum position, so as to actuate valve 204 to produce the speed of the dental instrument desired, for example, water simultaneously may be delivered to such dental instrument simply by additionally depressing the treadle 182. While this occurs, and even though the lower switch 188, as illustrated in FIG. 12, is closed, power to electric line 276 in which said lower switch is connected, is interrupted by reason of the movable member of switch 190 being disengaged from the upper contact and placed into engagement with the lower contact, as viewed in FIG. 12.

It will be understood that the solenoid-actuated water valves 52 of the modules, when the solenoid thereof is actuated, operate only between completely closed and fully opened position, the latter being in accordance with the setting of knob 54 which regulates the passage of the valve when in fully opened position. Accordingly, the amount of flow of water through the valve, when opened, can be regulated even during operation of the particular dental instrument connected to said module simply by regulating the knob 54 for greater or lesser discharge through the valve. Said knobs are only accessible upon the front panels 46 of the module for instant actuation.

Although the housing 10 and the composite front panel thereof composed of a plurality of front face panels 46 on the individual modules is illustrated as embodying the total of three modules, it is to be understood that this number is not to be regarded as restrictive. Also, it is not necessary to use as many as three modules, if this number is not desired. For example, if

only one or two dental instruments are to be serviced by the control mechanism embodied in housing 10, the space or spaces not occupied by modules may be occupied by other means, such as the drawer 282 shown in FIG. 3, the face of which is movable with respect to front panel means of similar size and shape to one of the panels 46. Such a drawer might be arranged to contain an assembly of burs, for example, or other similar dental tools which conveniently may be contained within the housing 10 and be ready for connection to any of the dental instruments serviced by the modules of the housing.

From the foregoing, it will be seen that the present invention provides a modular-type dental control unit of highly versatile nature with respect to servicing a wide range of different types of dental instruments requiring such dental utilities as compressed air or similar gaseous fluids of different types and for different purposes, such as driving the movable members of the dental instrument or for blowing chips from prepared cavities and the like, as well as water, and other similar fluids. Control of the delivery of such dental utilities to the instruments is effected conveniently, by compact means, incident to removing the dental instrument per se from its supporting member to condition the control means of the particular module by which the instrument is supported as well as to initiate operation of the instrument, and also be other means which preferably are foot-controlled, to vary the speed of the instrument, render it selective for the discharge of chip-blowing air per se, or deliver water to the instrument in conjunction with operating it by air.

The various modules are connectable to common supply means, such as manifolds, filters, electrical connecting means when required, and the like, all conveniently arranged and capable of ready access. Adjustment of the various switch and valve actuating means is accomplished easily and conveniently to insure precise and highly efficient control of the actuation of all of the instruments supported and controlled by the various modules. Further, interchanging of the modules within the spaces provided therefor in the housing of the control unit likewise readily is effected with only a limited number of relatively simple tools.

We claim:

1. A dental control unit comprising in combination, a substantially horizontal plate-like base arranged to be supported stationarily, a housing detachably connectable to said base, a plurality of compact control modules positioned in side-by-side relation within said housing and operable respectively to control the operation of different dental instruments, each module comprising a sub-frame having a portion complementary to said base, means detachably connecting said complementary portions of said sub-frame of said modules to said base, dental utility supply control valves connected to said sub-frame of each module and supported thereby, supporting wall means connected to and supported by the rear portion of said base and extending upwardly therefrom, dental utility manifold means supported directly and compactly within said housing by said wall means, conduits connected between said control valves of said modules and manifold means, a bezel supported by the forward portion of said base and engaged by the forward portion of said housing, and front face panels respectively carried by said sub-frames of said modules and arranged in side-by-side relation to

each other relative to said bezel to comprise a composite planar front wall of said housing and said bezel overlying the edge portions of said composite arrangement of front face panels.

2. The control unit according to claim 1 further including braces extending upwardly and forwardly from said base to the upper portion of said bezel to brace the same relative to said base independently of said housing.

3. The control unit according to claim 1 in which said manifold means include manifolds connected respectively to sources of air and water and further including a pressure regulator valve connected to one end of said water manifold means and an air filter connected to one end of said air manifold means and operable commonly to regulate water pressure and filter the air delivered to the control means of all said modules.

4. The dental control unit according to claim 1 in which each module has a supporting member for a dental instrument supported by the forward portion thereof adjacent said front face panel, means on each supporting member to receive and support a dental instrument to be operated in response to the control valves carried by the module to which said dental instrument is connectable, primary control means commonly connected to all the supply control valves of all the modules of said control unit, and conditioning control means on each module connected in series with said primary control means and operable upon the removal of a dental instrument from the supporting member of the module to which said member is connected to cause delivery of at least one dental utility to said instrument through the supply control valve of its module after said primary control means also is actuated, said conditioning control means of said other modules preventing opening of said supply control valves thereof when said primary control means is actuated for a selected module.

5. The control unit according to claim 4 in which each module includes a bracket block on the forward portion thereof, said instrument supporting member of each module comprising a bracket arm supported by said bracket block for movement between operative and inoperative positions, the mounting of said arm being arranged to permit said arm to be responsive to the weight of a dental instrument and move said arm to said inoperative position thereof, connection means on said bracket block to receive one end of a conduit hose for connection thereto to deliver dental utilities to a handpiece when connected to the other end thereof, and utility conducting means extending between said connection means and said control valves for delivery of utilities to said connection means.

6. The dental control unit according to claim 4 in which said primary control means is foot actuated and comprises a pair of switches and separate actuating means in therefor, said supply control valves on all said modules being solenoid actuated and said pair of switches respectively being connected in series with the conditioning switches for the valves controlling the flow of air and water and in parallel with the solenoid coils of said supply control valves of said modules controlling the flow of air and water therefrom.

7. The dental control unit according to claim 6 in which said foot-actuated additional control means comprises pivoted lever means respectively interconnected to said pair of switches and movable in different

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directions to actuate said switches, whereby both switches may be operated simultaneously by a single foot of an operator.

8. A dental control unit comprising in combination, a housing, a plurality of control modules for dental instruments mounted within said housing in side-by-side relationship, each of said modules comprising a plurality of dental utility supply control valves actuated by remote control means and certain of said valves being interconnectable to a source of air under pressure, at least one of said modules including an air pressure regulator valve connected between the air supply control valve therein and said source of air; said regulator valve having means to pass air therethrough and arranged to control the maximum air pressure to be delivered therethrough to a dental instrument by said air supply control valve when opened and said regulator valve comprising a cooperable valve member and seat, spring means acting against said valve member to limit the closing of said valve, said regulator valve also having chamber means containing a diaphragm interconnected to said valve member, air supply means to deliver auxiliary air under pressure to one side of said diaphragm and operable to supplement the force exerted by said spring against said valve member and thereby increase the pressure required to close said valve and correspondingly vary the pressure of air to be delivered to a dental instrument; a normally closed auxiliary air control valve connected to said auxiliary air supply means to prevent flow of air said valve chamber, and means connected to said auxiliary air control valve and

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operable immediately upon the commencement of operation of a selected dental instrument to open said auxiliary valve and cause delivery of air to said auxiliary air supply means.

9. The control unit according to claim 8 in which said supply means for auxiliary air includes venting means operable to discharge auxiliary air in excess of that applied against said diaphragm, and said control unit further including an adjustable means for said discharge valve operable relative to said venting means to restrict discharge of said venting of air and thereby increase the pressure of air capable of being applied to the diaphragm of said regulator valve.

10. The control unit according to claim 9 in which said adjustable discharge valve includes a foot-operable actuating member.

11. The control unit according to claim 9 in which said air supply means includes a manifold having means to receive air under pressure from a source thereof and means commonly connecting said manifold to the chamber means of said regulator valves of at least certain of said modules, said venting means also being connected to said manifold and operable to vent the same to prevent auxiliary pressure being applied against the diaphragms of said regulator valves until said adjustable discharge valve is operated.

12. The control unit according to claim 11 in which said auxiliary air control valve is connected to the supply means for said manifold.

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