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ELECTRICAL CONTROL DEVICE

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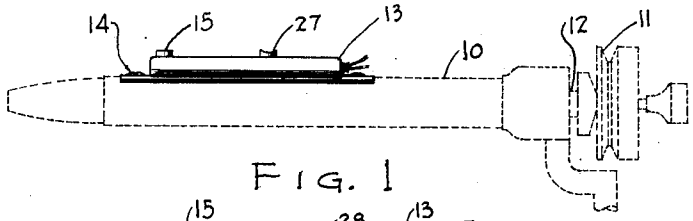


FIG. 1

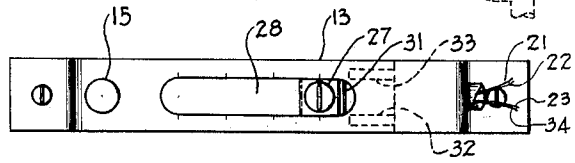


FIG. 2

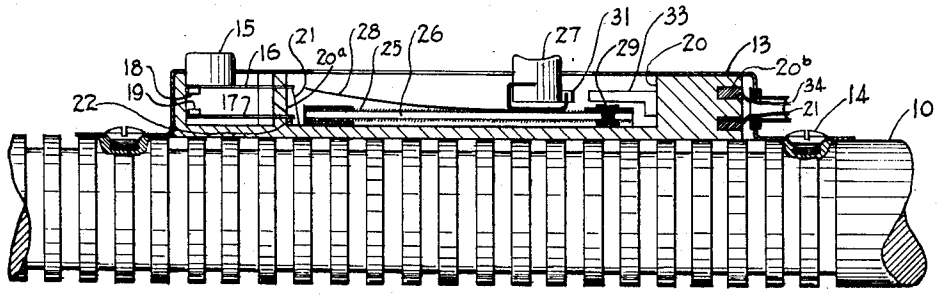


FIG. 3

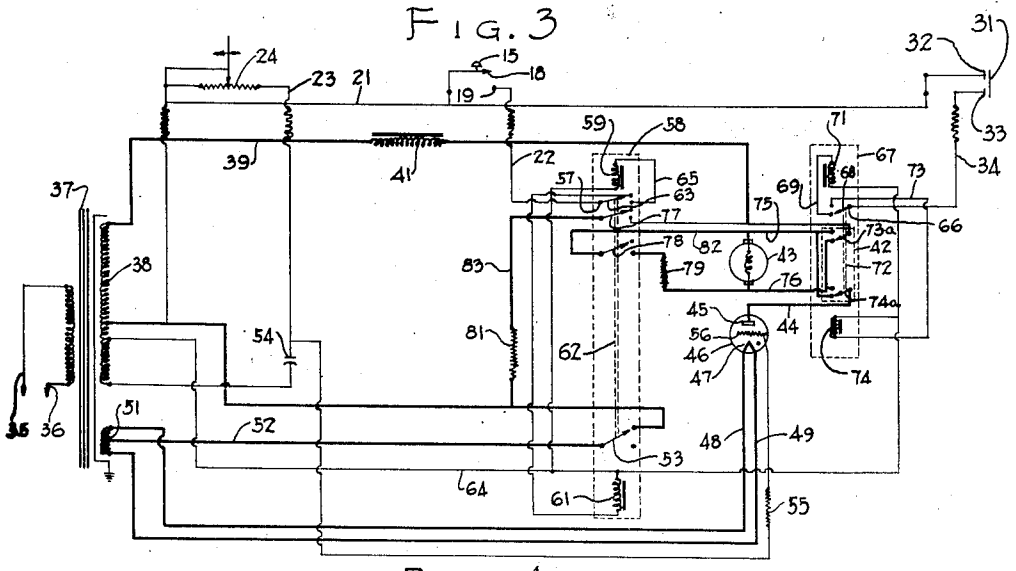


FIG. 4

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ELECTRICAL CONTROL DEVICE

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This invention relates to electric motor speed control, especially to controls for a motor used to drive a spindle of a dental hand piece.

Dental hand pieces, as made heretofore, are driven by small electrical motors which drive some type of a flexible belt that connects to and drives a pulley carried by the spindle of the dental hand piece. The speed of the electric motor is controlled and varied, as desired, by the operator through a control box positioned on the floor adjacent the dental chair. The control box usually had a pedal on it operable by foot for putting resistance in or taking it out of the motors' circuit to control the speed of drive of the hand piece. Furthermore, the control could be used to stop, or reverse the motor when desired.

If the dentist is considerate of his patient's welfare, as they substantially all are, the dentist must stand on one leg and keep the foot of the other leg constantly engaged with the speed controller. This tensed operating condition is due to the fact that it may be necessary to shut off or change the speed of the drill spindle rapidly should the drill slip or come loose in any way, or should the drill conditions change. It especially is necessary to shut off the spindle rapidly when an abrasive disc is being used on the spindle as such discs sometimes work free of the spindle. Hence, it is obvious that the spindle should be stopped rapidly to prevent a rapidly rotating disc from being thrown off the drill spindle into the patient's mouth. In all events, the foot controller causes bad operating conditions for dentists since they cannot even stand with their weight evenly divided on two feet and still operate the controller, since frequent drill speed changes are usually required.

A further disadvantage of the foot control for a dental drill spindle is that the control is remote from the scene of drilling. Thus, every time the dentist wants to locate the speed controller, should he not have his foot in engagement with such control, the dentist must withdraw the drill and mirror or any other implement in the patient's mouth at that time and take a step or two backwards, or to the side and look around in order to locate the controller. Then, too, the control is bulky, does not fit neatly in a dental office, and, in general, is not as easily operable as a dentist's drill control should be.

Efforts have been made to eliminate the foot control for the drive of a dental hand piece, and switches have been provided on the hand piece itself to connect to a remote motor control for varying the flexible drive of the hand piece

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spindle. Such controls have been relatively bulky and have not been satisfactory for that reason and because they have transmitted relatively high voltages and heavy currents which necessitate use of relatively large, heavy conductors leading to the hand piece. This obviously interferes with the required flexibility of the hand piece and some attempts also have been made to mount an electric motor in a trunnion member so that it would be directly connected to the shaft of a dental hand piece, but such constructions likewise have not provided the required lightness, flexibility and ease of control of the hand piece that is required.

The general object of this invention is to overcome the foregoing, and other objections to and disadvantages of prior types of dental hand piece spindle controls, and to provide a control for the drive of a dental hand piece spindle, which control is characterized by its availability to the hand piece operator and its ready and easy functionability.

Another object of the invention is to provide a motor controller having a minimum of wires connected thereto and a minimum of current flowing therethrough.

A further object of the invention is to provide a remote control for an electric motor, which control has only a fraction of the motor current flowing therethrough, and which completely controls the operation of the motor.

Another object of the invention is to provide a very compact control for a small electric motor, which control has relatively low currents and voltages in relation to those of the motor circuit.

A further object of the invention is to provide an inexpensive, uncomplicated, improved control for the motor associated with a dental hand piece, which control can be operated by means on a hand tool without impairing the ready maneuverability thereof.

Another object of the invention is to permit a dentist to change, readily, the speed of operation of a hand piece spindle, to reverse the spindle, or to stop it.

The foregoing and other objects and advantages of the invention will be made apparent as the specification proceeds.

Attention now is directed to the accompanying drawings, wherein:

Fig. 1 is an elevation of a dental hand piece assembly embodying the principles of my invention;

Fig. 2 is an enlarged top plan of the switch of Fig. 1;

Fig. 3 is a further enlarged vertical section of the switch of Fig. 2, showing it mounted on a dental hand piece; and

Fig. 4 is a circuit diagram of the invention.

Reference now is made to the details shown on the accompanying drawing, wherein a dental hand piece 10 is shown which has a pulley 11 engaged with a spindle 12 journalled in the housing formed by the hand piece. Suitable flexible means (not shown) connect to and drive the pulley 11. A primary feature of the invention is that a small controller box 13 is carried by the hand piece 10 and is removably secured thereto, as by screws 14. The controller box 13 has a push button 15 extending therefrom and it bears against and is suitably secured to the upper of two resiliently mounted contact arms 16 and 17 positioned by and extending from a bracket 20a secured to an insulator, or base member 20 within the box 13. Contacts 18 and 19 may be secured to the adjacent surfaces of the arms 16 and 17, respectively, while conductors 21 and 22 connect to the contact arms 16 and 17, respectively, so that a circuit is completed therethrough when the push button 15 is pressed in substantially flush with the outer surface of the controller box. This circuit is used to start and stop the motor that drives the spindle 12, as explained more fully hereinafter.

A second circuit is controlled by the controller box 13 so that a conductor 23 leads to the controller box 13 with the conductor 23 connecting to the one end of a suitable variable resistor 24, which may have a resistance of approximately .1 megohm. The resistor 24, in this instance, is shown as comprising an insulated wire 25 that is coiled around a non-conductive core 26, one coil thick, along the length thereof. The assembly then has a slider 27 engaged with the upper side of a metal strip 28 for sliding movement therealong. The insulation on the wire of coil 25 is removed on the top side of the coil 25 so that metal strip 28 may make electrical contact with coil 25 immediately beneath the slider 27. The metal strip 28, which extends the length of the core 26, is secured to one end of the non-conductive core 26 by a conductive pin 29. The conductor 23 connects to the end of the pin 29 and one end of the wire 25 also is suitably secured thereto while the opposite end of the wire 25 connects to the conductor 21. Thus, the slider 27 can be slid along the metal strip 28 to press against, or contact the uninsulated portions of the wire 25 to short out a part of such resistor through the strip 28. The conductors 21 and 23, leading from the variable resistance, are connected to the motor circuit, as explained hereinafter, to control the speed of the drive of the spindle 12.

To effect reversal of drive of the motor driving the spindle 12, the contactor 27 carries a spring contact bar 31 on its end adjacent the pin 29 and it is adapted to bear on spaced contact fingers 32 and 33 when the contactor 27 is moved to its extreme position remote from the start-stop button 15. The common conductor 21 also connects to the contact finger 32 while a conductor 34 connects to the contact finger 33 and such conductors 21 and 34 are connected to a suitable means for effecting reversal of the motor driving the spindle 12, as explained more fully hereinafter.

Referring now to Fig. 4, power is supplied for driving the spindle 12 by suitable power supply leads 35 and 36 that connect to the primary of a transformer 37. One coil 38 of the secondary of the transformer 37 has a lead 39 extending therefrom which connects through a series field 41 and reversible switch 42 to an electric motor 43. The motor 43 usually is of the universal type and has only a fractional horsepower output. A lead 44 connects the other side of the motor 43 to the plate, or anode 45 of an electronic tube 46 that may be of the type known as Thyratrons. A filament 47 of the tube 46 connects by leads 48 and 49 to a small secondary coil 51 of the transformer 37 and the filament 47 serves as a cathode for transmittal of motor current therethrough. A lead 52 connects the mid-point of the coil 51 to the lower section of the coil 38 so that the motor circuit is thereby completed. A switch 53 may be provided in the lead 52 to open and close the motor circuit and thereby start or stop the motor 43, which is the motor driving the pulley 11 through flexible connecting means (not shown).

The conductor 21, that extends to the controller box 13, connects to the conductor 52 while the other lead 23 of the variable resistance 24 connects to one plate of a small condenser 54 of about .25 microfarad capacity. The other plate of condenser 54 then connects to the lower end of the coil 38 of the transformer 37, thereby completing the primary phase-shifting circuit. The junction of the lead 23 with condenser 54 connects to one end of the resistor 55, the other end of which connects to the grid 56 of tube 46, thus connecting the phase-shifted voltage from the primary phase-shifting circuit to the control element in the motor current-controlling tube 46, by means of resistance 55 whose primary function is to limit grid-filament current to so low a value that damage cannot occur to the grid itself. The phase of any alternating voltage impressed on the control grid 56 due to the current in the circuit of the coil 38, conductors 21, 23 and 52, and the condenser 54 may be varied by changing the setting of the variable resistor 24. Thus, the motor current flowing through the Thyratron tube 46 can be controlled, since the tube will conduct only portions of alternate half cycles of the alternating current impressed on it and the phase of the grid voltage can be adjusted to control the time of starting conduction within each half cycle, the end of the conducting periods always occurring at approximately the end of the half cycle. Control of the motor current effects the desired control of the speed of the motor 43.

An important feature of the invention is the control of the motor 43 without the use of high voltages or heavy currents, which would necessitate use of heavy conductors, so that light, flexible controls can be provided in the hand controller which still would be effective in controlling the motor circuit. To this end, the conductor 22 from the start and stop switch contact 17 leads to a contact 57 of a two position relay 58 of a conventional design and having two operative coils 59 and 61. The relay 58 is held in a given position by suitable devices, such as springs (not shown). The relay 58 controls a rod or solenoid 62 which connects to the switch 53 and to a switch 63 that may be associated with the relay. Hence, moving the button 15 to close the contacts 16 and 17 energizes the coil 61 which is connected to a lead 64 that in turn connects to the lower portion of the secondary coil 38. Such movement of the solenoid 62 opens the switch 53 and closes the switch 63 on a conductor 65 which connects through the relay coil 59 to the lead 64 whereby again clos-

ing the contacts 18 and 19 momentarily will energize the coil 59 and close the switch 53 thereby resetting the relay 58 in its run position. Thus, the relay 58, which will operate on a low voltage such as 4 volts, can be used to start or stop the motor 43 which might have, for example, 220 volts impressed on it.

Dentists frequently reverse the direction of rotation of their drill spindles and another salient feature of the invention is that the lead 34 from the reversing switch connector 31 of the controller box connects to a contact 66 of a reversing relay 67. The contact 66 has a switch 68 associated with it and the switch 68 is adapted to connect to a lead 69 that connects through a relay operating coil 71 to the lead 64. The switch 68 is controlled by a solenoid 72, or other means that is positioned by the relay 67, and in its reverse position connects to a lead 73 that connects through a coil 74 to the lead 64. Hence, in either of its positions, the relay 67 has an operative coil ready to function the relay upon closing the contact 31 on the contact fingers 32 and 33 with the relay being retained in a given position by any conventional means. The solenoid 72 is secured to movable switches 73*a* and 74*a* in the reverse switch 42 which switches effect the reversal of flow of current through the motor 43 through bifurcated end leads 75 and 76. Again the motor control is effected from the controller box 13 with only a low voltage, say 4 volts, being impressed on the reversal means of the control. It should be observed that reversal of the motor only can occur when the contact 27 is at its extreme position with all of the resistance in the controller box circuit which condition causes the motor 43 to run at its slowest speed.

As a further feature, the start and stop relay 58 may also set up some dynamic braking action in the motor 43 to stop it rapidly. Thus, switches 77 and 78 may be secured to the solenoid 62 and they close circuits through suitable resistances 79 and 81. The resistance 79 is connected in shunt with the motor 43 by a lead 82 whereas the resistance 81 and switch 77 are located in a conductor 83 that extends between the lead 52 and the junction of the series field 41 and the reversing switch 73*a* to keep current flowing in the field 41 to aid in effecting dynamic braking of the motor.

While the controller box 13 is shown, for convenience, as being secured to a dental hand piece, it will be understood that the controller box 13 may be mounted on other dental hand tools, such as a mouth lamp, without losing the benefits of the invention.

Naturally, the resistance 24, condenser 54 and other variable devices and voltages of the circuit of the invention are chosen so as to give the desired operation under the probable operating conditions in a small motor circuit. The controller or switch box 13 is of minimum size, being about 1½'' long, ⅜'' wide and ¼'' high in one instance, and is of maximum flexibility due to the small number and size of the conductors leading to it. However, it provides a complete controller box for a controller slave unit, including a dental motor. The controller box can be removed from the hand piece 10, if desired, when the hand piece is to be sterilized but its construction is such that it can stand sterilization conditions.

To simplify changes of the hand piece, and its sterilization, it might be desirable to have the conductors connecting to the hand piece con-

troller to be grouped into one connector plug (not shown) that would easily be engaged with, or disengaged from the controller box 13.

In some instances, it may be desirable to use a shunt motor in place of the series motor shown but it will be apparent that the principles of our invention apply equally well to any type of small D. C. or universal motor. The shunt field, with a small resistance and rectifier in series with it, could be connected across the upper part of the coil 38 and the resistance 81 and its associated circuit could be omitted, when a shunt motor is used.

In the controller box 13, portions of the wires extending through the box are not shown and they may be embedded in the base member 20 or be otherwise conventionally led through the box to contact blocks 20*b* provided at the connection end of the box.

From the foregoing, it will be seen that a compact, easily operated motor control is provided for use in controlling small dental motors. This control is adapted for positioning for ready use by a dentist and overcomes the difficulties attendant use of previous types of controls so that the objects of the invention are achieved.

While in accord with the patent statutes we have specifically illustrated and described one embodiment of our invention, it should be understood that the invention is not limited thereto or thereby but that the scope of the invention is defined in the appended claims.

We claim:

1. A control member for an electric motor comprising a base; a pair of resilient contact arms mounted in spaced horizontal relation on said base but adapted to be moved to temporarily contacting relation; a switch button carried on the upper surface of the upper of said contact arms for moving such arm down against the other of said arms; an elongated resistor unit carried by said base, said unit including a flat insulator core element, an insulated wire wound around the core element and having the insulation removed longitudinally at the center of the upper flat side, a contactor slidably engaged with the core element and bearing on the uninsulated parts of the wire, and a flat metal strip associated with the core element intermediate it and the contactor for shorting out part of the resistor; a pair of contact fingers carried by said base at one end of said resistor unit; a spring contact carried by the contactor of said resistance unit and adapted to close a contact through said contact fingers when the contactor is at its extremity of movement with none of the wire of said resistance unit shorted out of its circuit; and conductors connecting to said contact arms, said contact fingers, and said resistance unit, one of said conductors being a common connection to the three elements of the control member.

2. A control member for an electric motor comprising a base; a pair of resilient contact arms mounted in spaced horizontal relation on said base but adapted to be moved to contacting relations; a switch button carried on one of said contact arms for moving it against the other of said arms; an elongated variable resistor unit carried by said base and having a movable element; a pair of contact fingers carried by said base at one end of said resistor unit; a contact element carried by the movable element of said resistance unit and adapted to contact said contact fingers and close a circuit therethrough when the element is at its extremity of move-

ment with none of said resistance unit shorted out of its circuit; and conductors connecting to said contact arms, said contact fingers, and said resistance unit, one of said conductors being a common connection to the three elements of the control member.

3. A rheostat and reversing switch comprising a frame, an elongated resistor unit carried by said frame and having a slider thereon, a resilient contact strip secured to said slider and extending from one portion thereof, said contact strip being separate from the circuit of said resistor unit, and a pair of spaced contacts carried by said frame and protruding therefrom adjacent said resistor unit, said contact strip contacting said contacts and closing a circuit between said contacts when said slider is at a predetermined position on said resistance unit.

4. A rheostat and reversing switch comprising a frame, an elongated resistor unit carried by said frame and having a slider thereon, a contactor secured to said slider and extending substantially axially from one portion thereof, and a pair of spaced contacts carried by said frame

adjacent one end of said resistor unit, said contactor being adapted to strike said contacts and close a circuit between said contacts when said slider is at a predetermined position on said resistance unit.

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