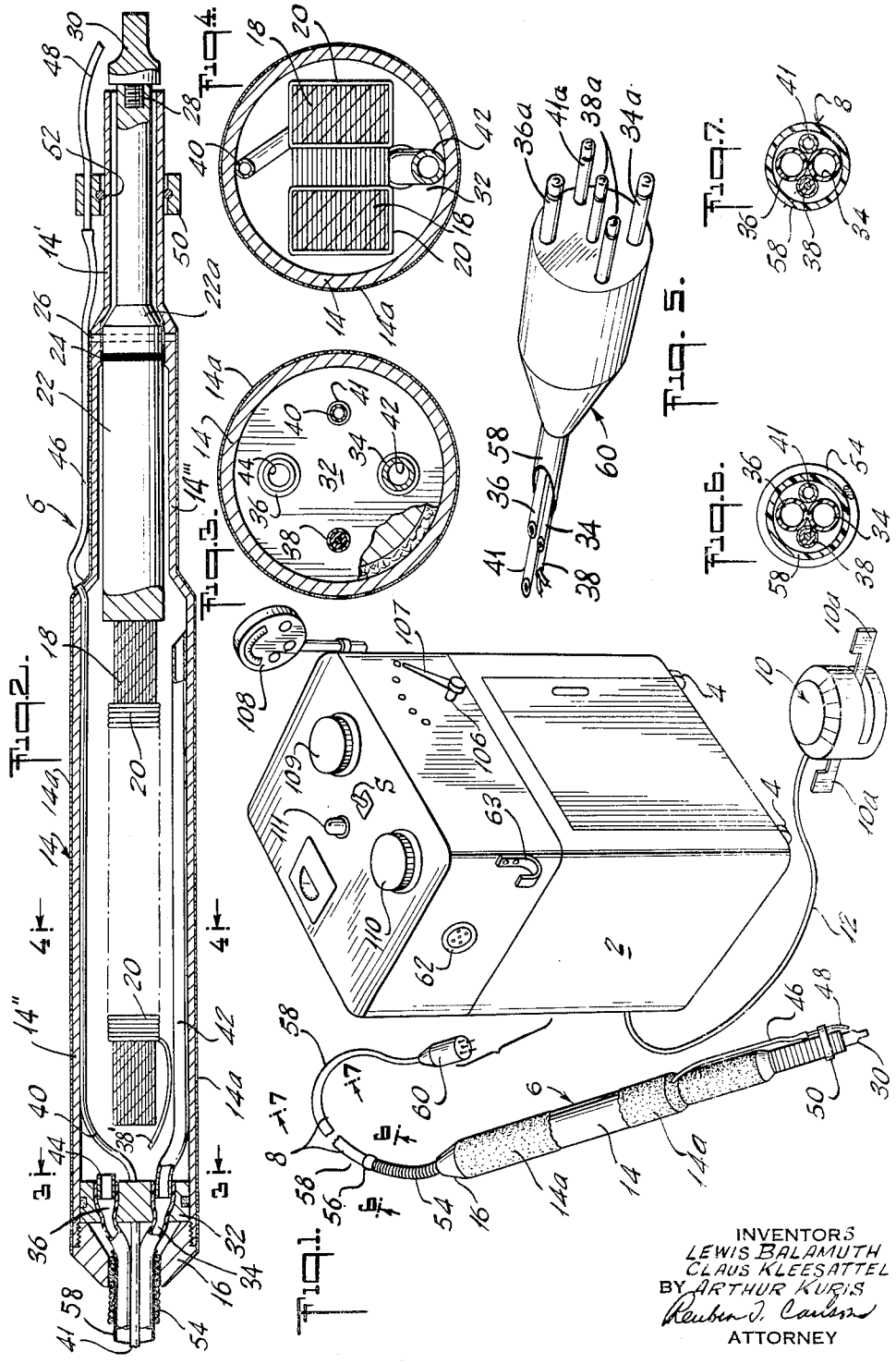
Oct. 26, 1965 L. BALAMUTH ETAL 3,213,537

SUPPLY AND CONTROL APPARATUS FOR VIBRATORY CUTTING DEVICE

Original Filed Dec. 24, 1954 4 Sheets-Sheet 1



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Original Filed Dec. 24, 1954 4 Sheets-Sheet 2

Fig. 8.

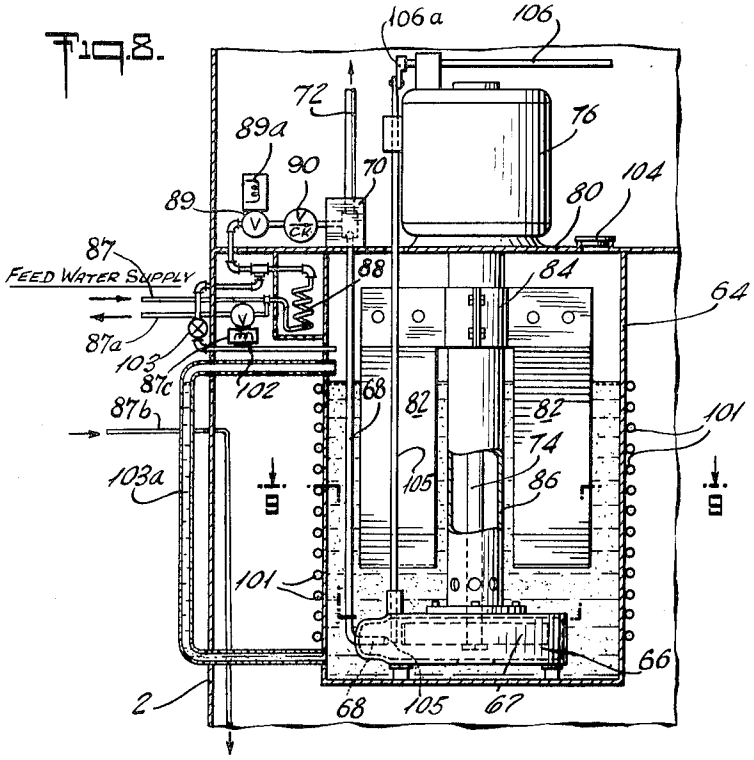


Fig. 9.

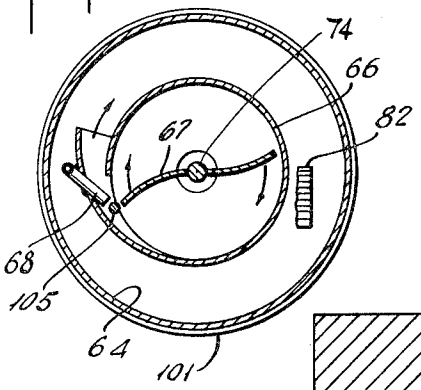


Fig. 10.

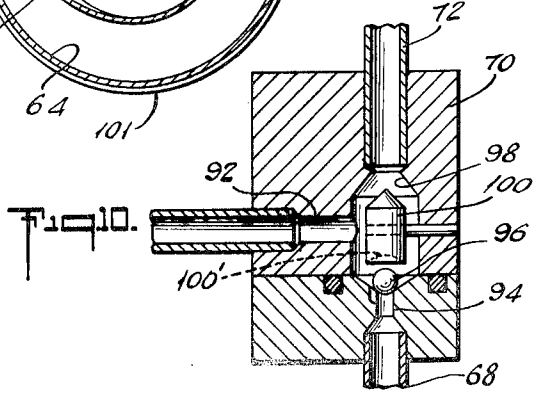
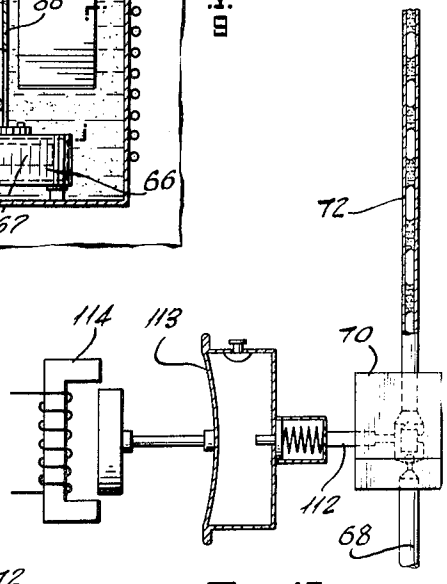


Fig. 12.



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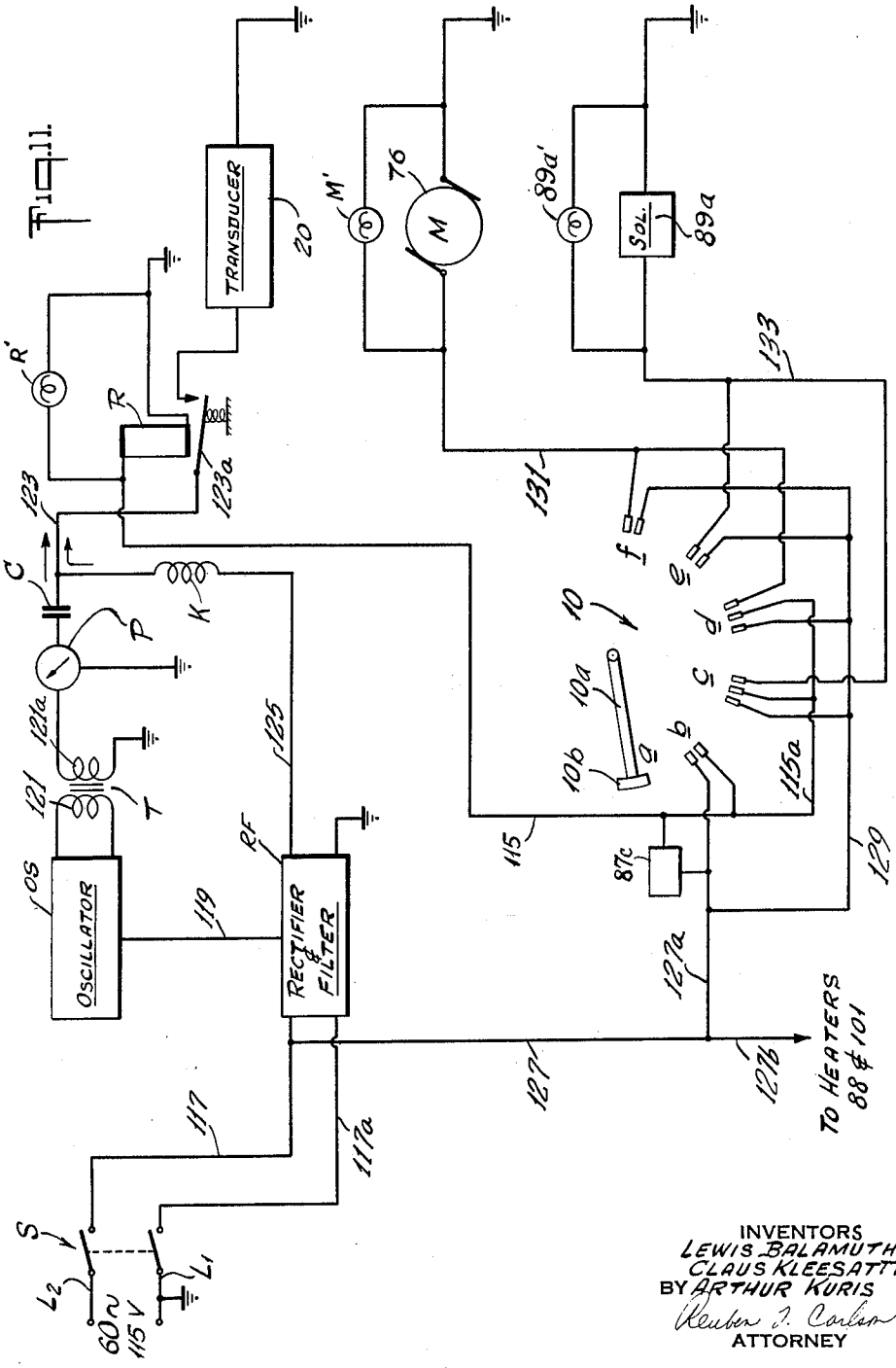
SUPPLY AND CONTROL APPARATUS FOR VIBRATORY CUTTING DEVICE

Original Filed Dec. 24, 1954 4 Sheets-Sheet 3

Fig. 11.



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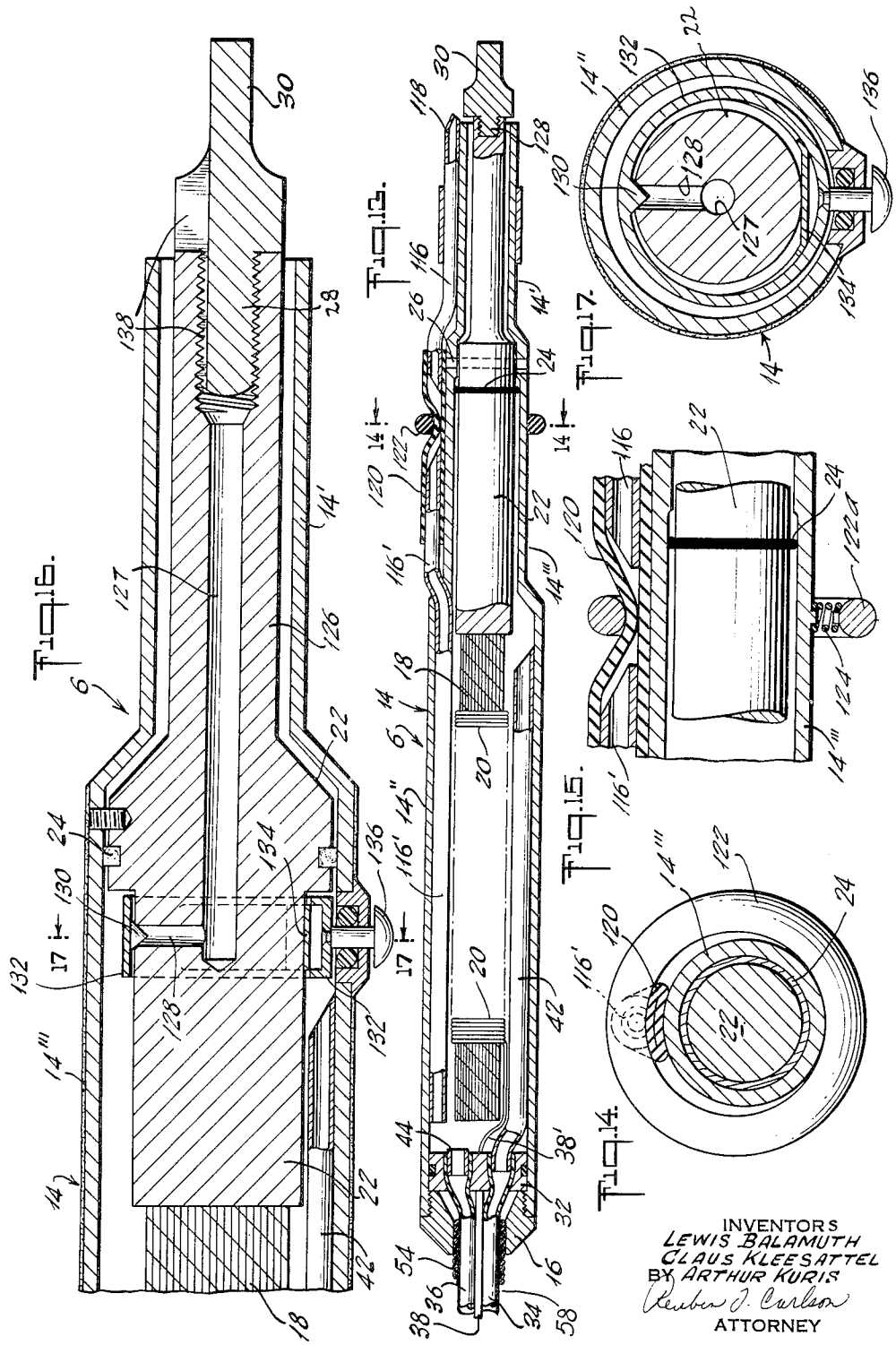

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3,213,537

SUPPLY AND CONTROL APPARATUS FOR VIBRATORY CUTTING DEVICE

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Original application Dec. 24, 1954, Ser. No. 477,530, now Patent No. 3,075,288, dated Jan. 29, 1963. Divided and this application Sept. 11, 1961, Ser. No. 137,321
15 Claims. (Cl. 32—28)

This application is a division of copending application Serial No. 477,530 filed December 24, 1954, which issued into Patent 3,075,288 on January 29, 1963.

This invention relates to acoustical apparatus for association with sonic and ultrasonic devices and instruments which may be designed to be held in the hand of the operator, and adapted to be used as a dental, surgical or other work implement.

The apparatus of this invention is particularly adapted for association with a hand supported instrument which may be substantially the size of a conventional drill, and to one end of which a small dental or other work tool of any desired configuration is attached. The instrument may comprise a tubular casing which houses a vibrator comprising a magnetostrictive transducer rigidly fixed to one end of a tool holder or acoustical impedance transformer and which provides a transmission line for transmitting vibration of high frequency and relatively small amplitude to a work tool fixed to the other end of the tool holder, and which projects from one end of the casing. Mounting means, such as a ring of compressible material located in the neighborhood of a node of longitudinal vibration of the tool holder, supports the vibrator within the casing. For maximum amplitude of vibration and maximum transmission of working energy to the work tool, the overall length of transducer, tool holder and tool is so correlated to the frequency of the electrical oscillations delivered to the transducer, that a loop of motion of the generated compressional waves will occur at or near the working end of the tool. In other words, the overall length of transducer, tool holder and tool are approximately equal to an integral number of one-half wavelengths of sound waves in the particular materials from which the transducer, tool holder and tool are made at the working frequency.

To cool the transducer when vibrating, a water inlet tube leads into one end of the casing through a removable plug, and extends into the casing for substantially the length of the transducer. A short tube or nipple extending through the plug provides the outlet for warmed cooling water. The compressible mounting ring serves to prevent uncontrolled leakage of cooling water to the tool end of the casing, and permits radial expansion and contraction of the transformer during vibration. The transducer comprises a laminated stack of magnetostrictive metal sheets about which is wound an electrical conductor provided with a water impervious insulating coating. The conductor winding, supplied with high frequency alternating current, establishes a high frequency alternating magnetic field which energizes the magnetostrictive transducer and causes the transducer to longitudinally vibrate at a frequency corresponding to the frequency of the surrounding magnetic field.

Production of a commercially practical apparatus for association with an ultrasonic instrument as above generally described, required the solution of many problems. For example, means must be provided for supplying cooling water to the transducer, for withdrawing warmed coolant from the instrument, for feeding a cutting liquid to the work area of the tool with operator control thereof, and for supplying high frequency electrical energy to the transducer; all without restriction of the manipulation of the hand piece instrument by the operator. In dental operations, an excess of abrasive liquid at the work area is not desirable for efficient operation of the work tool, nor for the patient's comfort. Freqent interruptions of cutting operations to replenish or eliminate the cutting liquid are also objectionable. Preferably, therefore, the cutting liquid should be delivered only during cutting and under the control of the operator, without interferring with the manipulation of the instrument. To avoid shock to the patient, the liquid supply to the cutting area should also be warm.

In accordance with this invention, apparatus is provided which includes a cabinet or housing containing the electrical parts of the system, the electric power supply lines, coupling means to a water supply and water discharge, and supply means for the cutting liquid. The cabinet and vibratory instrument are detachably interconnected by a flexible lightweight tubular sheath or conduit within which the electrical lines, coolant delivery and return tubing, and treating fluid tubing, are contained. The tubular sheath or conduit has a closure cap fixed to one end thereof which is designed to be detachably connected to one end of the tubular casing of the instrument. The electrical lines may comprise a concentric cable having an inner insulated conductor and an outer grounded metallic cover which extends from the high frequency generator contained in the cabinet through the flexible conduit and end closure cap. One end of the transducer winding is connected to the inner conductor cable and the other end of the transducer winding is grounded through the closure plug. The water coolant inlet and outlet tubes, as well as the electrical cable and the abrasive slurry supply tube, extend from the casing plug of the instrument through the flexible sheath or conduit to the cabinet, and thence to a water supply source, a return water discharge connection, an abrasive slurry supply source, and the high frequency generator, housed in the cabinet.

In the preferred embodiments of the invention, capillary tubing, extending from adjacent the tool end of the hand piece to a preheated supply of treating fluid, such as a slurry of water and abrasive, is provided for delivery of the cutting liquid to the work area. Operator controlled means, comprising a foot switch and solenoid valve controlled thereby, are provided for optionally delivering water or abrasive in water through the capillary tubing; the water serving not only for rinsing the patient's mouth, but also as insurance against clogging of the tubing by abrasive slurry during periods of non-use.

To illustrate specific embodiments of the apparatus of this invention, reference may be had to the accompanying drawings in which:

FIG. 1 is a perspective view of the apparatus of this invention, shown in association with a vibratory instrument, certain parts being shown on an exaggerated scale;

FIG. 2 is a longitudinal sectional view of one form of handpiece instrument, and with which the apparatus of this invention is adapted to be associated;

FIGS. 3 and 4 are transverse sectional views of the hand piece instrument on a larger scale, taken on the lines 3—3 and 4—4 respectively, of FIG. 2;

FIG. 5 is a perspective view of the receptacle plug shown in FIG. 1, but on a larger scale;

FIGS. 6 and 7 are sectional views of the flexible conduit and the capillary tubes and electrical cable extending therethrough, these views being taken on the lines 6—6 and 7—7 respectively, of FIG. 1;

FIG. 8 is a vertical sectional view, partly in elevation, and illustrating the cutting liquid supply and control means forming a part of the apparatus of this invention;

FIG. 9 is a horizontal sectional view taken on line 9—9 of FIG. 8;

FIG. 10 is a detailed sectional view through the T-junction manifold of the apparatus;

FIG. 11 is a schematic diagram illustrating the main components of the oscillator generator housed within the cabinet shown in FIG. 1, the circuit connections to the transducer energizing winding contained in the vibrator instrument shown in FIG. 2, and the circuits to and from the foot switch **10** shown in FIG. 1 which control the operation of the handpiece instrument and the flow of treating fluid and rinsing fluid to the working tip of the instrument;

FIG. 12 is a diagrammatic representation of an alternative arrangement for delivering cutting liquid;

FIG. 13 is a longitudinal sectional view of another form of hand piece instrument with which the apparatus of this invention is adapted to be associated;

FIG. 14 is an enlarged transverse sectional view taken on line **14**—**14** of FIG. 13;

FIG. 15 illustrates a modified means for finger controlling the flow of treating fluid to the work tool of the instrument;

FIG. 16 is a partial sectional view through a hand piece instrument of further modified form, and with which the apparatus of this invention may be associated; and

FIG. 17 is a transverse sectional view taken on line **17**—**17** of FIG. 16.

Similar reference characters refer to similar parts throughout the several views of the drawings and the specification.

In general, the apparatus of this invention embraces a housing or cabinet **2** as shown in FIG. 1, preferably mounted on casters **4**, a six position rotary foot switch **10** connected through a cable **12** to the cabinet **2**, and a flexible conduit **8** which interconnects the vibratory device or instrument **6** to the cabinet **2**. The cabinet **2** contains a coolant supply connection **87** to an outside supply source, a coolant supply connection **87***a* which supplies coolant to the casing of the handpiece instrument shown in FIG. 2, and a warmed coolant return connection **87***b* which conducts warmed coolant from the casing of the handpiece instrument for discard, as shown in FIG. 8. The cabinet **2** also contains a high frequency alternating current generator circuit as diagrammatically illustrated in the upper part of FIG. 11, for supplying energy to the transducer winding **20** of the handpiece instrument. The cabinet **2** also contains a cutting or cleaning liquid supply tank **64**, and associated pressure pump **66** as shown in FIG. 8, and a source of compressed air **112** as shown in FIG. 12. The apparatus thus embraces various conduit systems for supplying coolant to the vibratory device, for conducting warmed coolant from the vibratory device, for conducting treating liquid to the operative tool of the vibratory device, and an electric cable supplying energy to the vibratory device; all of which extend through the flexible conduit **8** in a manner to permit convenient hand manipulation of the vibratory device or instrument. Various electrical circuits, under the control of the operator, are also provided, as shown in FIG. 11, for controlling the supply of treating fluids and electrical energy to the vibratory device or instrument.

For a better understanding of the structural and functional attributes of the apparatus embraced by this invention, there is shown in FIGS. 1–4 inclusive and FIGS. 13–17 inclusive, typical forms of hand piece instruments with which the apparatus of this invention may be associated. The vibratory instrument **6**, as shown in FIGS. 2, 3, 4 and 5, comprises an outer casing **14** of cylindrical cross-section, having a section **14'** thereof at the end remote from the flexible coupling **8**, which is of relatively small diameter and is open ended. A section **14''** at the other end of the casing **14** is of larger cross-section. The two end sections **14'** and **14''** of different diameter are

connected by an intermediate section **14'''** of intermediate diameter, and which has a length approximately equal to that of the end section **14'** of least diameter. The outer surface of the casing may be covered with a layer **14***a* of vibration absorbing material, such as rubber, having closed air cells therein.

Within the casing section **14''** of larger diameter, is a magnetostrictive transducer comprising a laminated stack **18** of nickel or other magnetostrictive material and an energizing winding **20** therefor. One end of the stack is welded or soldered to an end of a tool holder **22** shaped to serve as an acoustical impedance transformer. The tool holder **22** extends through sections **14'''** and **14'** of the casing, and comprises two cylinders of different diameter interconnected by a short tapered section **22***a*. The over-all length of the tool holder or transformer **22** and tool **30** attached thereto, is substantially equal to one-half wavelength of standing waves set up therein at the operating frequency, and the junction of the sections of different diameters occurs substantially at the node of motion of such standing waves. It is at this nodal region that the transformer, with the transducer secured thereto, is mounted within the casing **14** of the hand piece. The mounting means comprises a ring **24** of compressible material, such as rubber, which seats in an annular recess in the holder and forms a yielding water tight coupling between the casing **14** and the parts contained therein. The compressible ring **24** does not appreciably dampen radial vibrations present at the nodal region of the transformer, and therefore does not subject the transformer to external stresses.

To avoid interference with the high frequency longitudinal vibrations set up in the tool holder and tool when the transducer is energized, the dimensions of the casing **14** and tool holder **22** are such as to provide clearance therebetween. To prevent relative rotation between the holder and casing, a transverse pin **26** is mounted in aligned transverse holes in the casing and tool holder adjacent the nodal region **22***a*. The tool holder **22** may be provided at its end with an axially threaded aperture for reception of a stud **28** carrying a short dental or other work tool **30**.

A plug **32**, held by friction within the larger end of the casing **14**, is provided with four apertures therethrough as shown in FIG. 3. These apertures are for accommodation of water inlet and outlet tubes **34** and **36**, respectively, for a coaxial electrical cable **38**, and a capillary tube **40**. The coaxial cable **38** comprises an outer metallic grounded cover which is conductively connected to the casing **14** through the plug **32**, and an inner conductor provided with an insulating and water impervious coating. The insulated inner conductor forms the winding **20** and is grounded at its end to the stack or to the casing. The coil **20** may be threaded through aligned slots in the stack **18**, as shown in FIG. 4. The diameter of the casing **14** is such, that there is only small play between the transducer **18** and tool holder **22**, and the inner wall of the casing **14**. Thus the transducer and tool holder are centered without having added any components which could hamper vibration. Extending along the inner wall of the casing **14** adjacent the transducer as shown in FIG. 2, is a water delivery line **42** which at one end is detachably connected within the plug **32** to the water inlet tube **34** and terminates at its other end adjacent the juncture of the stack with the transformer. A short water outlet tube or nipple **44** is carried in the plug **32** and is detachably connected therein to the outlet tube **36**.

The capillary tubing **49**, which connects within the plug **32** to the flexible capillary tube **41**, extends through the section **14''** of casing **14** containing the transducer and passes out through an opening in the casing **14** located substantially at the junction of the sections **14''** and **14'''** of intermediate and large diameters. Externally of the casing, tubing **40** is connected by plastic tubing **46** of nylon or the like to a short capillary tube **48**. The tube

48 is brazed to a steel ring 50 slidably supported by an O-ring 52 on the smaller section 14' of the casing. The steel tubing 48 and the ring 50 permit the operator, while holding the instrument in his hand, to adjust the angular and longitudinal disposition of the nozzle or tip of the tube 48 with reference to the tool end. It is through the tube 48, flexible capillary tubing 46, tubing 40 and flexible tubing 41 connected thereto within the plug 32, that cutting liquid is delivered to the work area under control of the foot switch 10.

In addition to the delivery of a preformed suspension of abrasive in water to the work tool 30, water or other treating fluid may be delivered to the work tool under finger control of the operator. For example, FIGS. 13 to 17 illustrate arrangements which may be used for delivering preheated water or other treating fluid to the work area under the finger control of the operator. In each of these arrangements, the water or treating fluid is first used as the coolant for the transducer. In the embodiment shown in FIGS. 13 and 14, a small metallic tube 116 is mounted on the outside of the casing 14 over the two sections 14' and 14''' of lesser diameter, and terminates in a nozzle 118, adjacent the tool 30. The second metallic tube 116' extends into the casing section 14'' and terminates adjacent the plug 32 within the chamber formed by the section 14'' of the casing 14 of larger diameter. A collapsible tube 120 connects the two tubes 116 and 116', and these tubes are cut off in planes of approximately 45° to the axis of the tube. An expansible ring 122 of rubber or the like encircles the casing 14, intermediate the adjacent ends of the tubes 116 and 116', and normally collapses the wall of the connecting tubing 120 as shown in FIG. 14. When the operator moves the ring 122 longitudinally along the casing 14 in either direction, the ring rides up the sloping end of one or the other of the parts of tubes 116 and 116', permitting the wall of the tube 120 to separate for delivery of treating fluid to the nozzle 118. Since the treating fluid, thus delivered through the tube 116 under control of the operator, is taken from the supply of treating fluid circulating about the transducer, it will be warmed by heat exchange with the transducer.

In FIG. 15 an alternative arrangement for finger controlling the passage of water or treating fluid through the collapsible tube 120 is shown. In this arrangement, a ring 122*a* of non-expansible material encompasses the casing 14 and tube 120. A compression spring 124 is interposed between the inner surface of the ring 122*a* and the casing at a position diametrically opposite to the collapsible tube 120. When the operator presses on the ring 122*a* to compress the spring 124, the water passage through the collapsible tube 120 will be opened.

In FIGS. 16 and 17 an internal feed of water to the work area is illustrated. In this construction, the tool holder 126 is provided with a longitudinal passage 127 which at its inner end intersects a radial passage 128 normally closed by a valve 130 carried on a collar 132. A leaf spring 134 biases the collar 132 into valve closing position. The operator, by pressure on a button 136 mounted on a pin extending through the casing wall, may move the collar 132 against the bias of the spring 134 to lift the valve 130 away from the passage 128 and thereby permit flow of water through the passages 128 and 127. To permit leakage of water from the passage 127 to the work area, the threaded studs of the tools and the tool bodies used in this embodiment of the invention, are provided with longitudinal slots 138 as shown in FIG. 16.

The flexible connection 8 of this invention, which extends between the housing or cabinet 2 and one end of the casing 14 of the vibratory instrument, includes a flexible sheath or conduit 58 having a closure cap 16 fixed to one end thereof as shown in FIGS. 1 and 2. The closure cap 16 has external threads designed for detachable connection to internal threads formed in the end of the larger section 14'' of the casing 14, and when fully applied, the inner face of the closure cap 16 is in abutting relation to the closure plug 32 of the instrument. A helical reinforcing spring 54, extending around a sectional length of the flexible conduit 58, is fixed within the axial opening of the closure cap 16, and provides reinforcement for the flexible conduit 58. The spiral spring 54 terminates in a collar 56 which is fixed to the tubular sheath 58.

A plug 60 is fixed to the other end of the flexible conduit 58, as shown in FIGS. 1 and 5, and presents five projecting plug-in terminals, which are designed for detachable connection to corresponding socket terminals of an outlet receptacle 62 mounted on a wall of the housing or cabinet 2. The tubular plug-in terminal 34*a* is connected to the coolant supply tube 34 which extends through the flexible conduit 58 and closure cap 16, and is designed to be detachably connected within the plug 32 as shown in FIG. 1 to the input end of the coolant supply tube 42 within the casing 14 of the instrument. Another tubular plug-in terminal 36*a* of the receptacle plug 60 is connected to the coolant return tube 36 which extends through the flexible conduit 58 and is designed for detachable connection to the coolant return tube or nipple 44 set in the closure plug 32 as shown in FIG. 1. A third tubular plug-in terminal 41*a* is connected to the treating fluid supply tube 41 which extends through the flexible conduit 58 and is designed to be detachably connected within the closure plug 32 to the treating fluid tube 40 extending into the casing 14 of the instrument. The receptacle plug 60 also presents a pair of electrical plug-in terminals 38*a* respectively connected to the inner conductor and to the grounding cover of the electric cable 38. The electric cable 38 extends through the flexible conduit 58 and closure cap 16 and is designed to be detachably connected within the closure plug 32 to the lead 38' of the energizing winding 20, as shown in FIG. 13.

As shown in FIG. 1, an outer wall of the cabinet 2 is provided with a receptacle 62 for reception of the plug 60, and may be provided with a cradle 63 for supporting the hand piece 6 when not in use. The receptacle 62 is provided with five socket terminals as shown in FIG. 1, respectively designed to receive the tubular plug-in terminals 34*a*, 36*a* and 41*a* and the electric terminal prongs 38*a* projecting from the receptacle plug 60. Within the cabinet 2, electrical and tubular socket terminals of the receptacle 62 are respectively connected to a high frequency generator or oscillation generator circuit and the electrical parts of the system as shown in FIG. 11, to a water or coolant supply piping 87*a*, drain piping 87*b*, and to piping 72 which is connected to a source of abrasive in water as shown in FIG. 8. It will be understood that the three tubular sockets of the receptacle 62 should each contain a suitable check valve adapted to be opened when the tubular plug-in terminals 34*a*, 36*a* and 41*a* are fully inserted therein, to thereby prevent fluid flow therefrom, except when the plug 60 and its terminals are properly inserted into the receptacle 62.

As shown in FIG. 8, there is a tank 64 within the cabinet 2 for a suspension of abrasive in water. Within the tank is a centrifugal pump 66 for circulating the cutting liquid contained within the tank to maintain the abrasive in suspension and for generating pressure for delivery of the suspension through a capillary tubing 68, which extends from the pump to a T-junction manifold 70. A treating fluid supply tube 72 connects the junction manifold 70 to a tubular socket terminal of the receptacle 62, and thence connectable to the tubular plug-in terminal 41*a* and tubing 41. A pump impeller 67 is mounted on the shaft 74 of an electric motor 76 carried on the cover 80 of the tank. Preferably, deflecting vanes 82 are supported within the tank by a collar 84 mounted on a tubular enclosure 86 for the shaft 74. The vanes or baffles 82 serve to deflect the circulated water toward the bottom of the tank and insure uniform mixing of the abrasive and water as it leaves the discharge port of pump 66. A supply line 87 for water under pressure is connected

through a preheater 88, preferably thermostat controlled, and through a valve 89 controlled by a solenoid 89*a*, and thence through a check valve 90 to a port 92 of the junction manifold 70. The cooling water for the instrument and supplied by tubing 34, may be obtained by a tap line 87*a* connected to the water supply line 87 and provided with a valve controlled by a solenoid 87*c*. A closure ball 96 rests by gravity on the port 94 within the junction manifold 70, as shown in FIG. 10. The capillary tubing 72 leading to the receptacle 62 communicates with a port 98 aligned with port 94 of the junction manifold 70. Interposed between ports 94 and 98 is a baffle 100 having a curved under surface 100' which is engaged by the ball 96 when cutting liquid is emitted from port 94. The port 94 is so formed as to permit some leakage of liquid downwardly through the capillary tubing 68 when the ball is seated.

When the solenoid valve 89 is open due to energization of the solenoid 89*a*, and the circuits to motor 76 are open, water will enter the junction manifold 70 through the port 92 and be forced upwardly through port 98, through the capillary tubing 72, 41, 40 and 46 and be emitted through the nozzle of the tube 48. Some water will leak around the ball 96 and into the capillary tubing 68 and tank 64, preventing clogging of the capillary tubing 68 by abrasive. When the valve 89 is closed, due to de-energization of the solenoid 89*a*, and when motor 76 is energized, the pump 66 forces the cutting liquid from the tank 64 up through the capillary 68, lifting the ball 96 and delivering cutting liquid through capillaries 72, 41, 40, 46 and to the nozzle of pipe 48. The check valve 90 prevents back-flow of abrasive liquid to the solenoid operated valve 89 in the event of low water pressure in line 87. The operator, by actuation of foot switch 10, as hereinafter described in connection with FIG. 11, controls the circuits of motor 76 and the solenoid 89*a* and can thereby control the delivery of water or cutting liquid through the nozzle pipe 48 as desired. By supplying water alone, after the dental operation has been performed, the operator flushes out the capillary tubing of the equipment and thereby insures that it will not be clogged when a further operation is to be made.

As the tank 64 is positioned in the lower part of the cabinet 2, neither water nor abrasive slurry will drip from the end of the tubing 48, when the supply thereof is shut off by the operator.

To insure that the temperature of the slurry will be such as to avoid shock to the patient, a heating coil 101, preferably thermostat controlled, is positioned around the tank 64. Preheated water for refilling the tank is obtained by provision of a branch pipe 102 connected to water line 87 between the preheater 88 and valve 89. A manually operated valve 103 in the branch line 102 and accessible from without the cabinet, permits refill of the tank at will. A conventional liquid level indicator 103*a* may be provided externally of the cabinet. A port 104 of the tank cover 80, provided with a suitable closure cap, serves for replenishment of abrasive.

In order that the flow rate at which the slurry is ejected from the nozzle of tubing 48 may be adjusted by the operator, a slidably mounted deflector rod 105 extends through the cover 80 and has its lower end positioned adjacent to the inlet to capillary 68 and its upper end is linked by a short crank arm section 106*a* to a horizontally disposed shaft 106. Shaft 106 is rotatably mounted in suitable bearings (not shown), extends through the front wall of the cabinet 2 and has fixed thereto a crank arm 107 (see FIG. 1) adapted to be manually rotated by the operator. When the arm 107 is rocked or rotated by the operator, the deflector rod 105 is raised or lowered to vary the position of the lower end thereof with respect to the inlet to capillary 68, thereby varying the inlet pressure of the slurry to the capillary system. As shown in FIG. 1, suitable indicia are carried on the cabinet wall under the path of movement of the arm 107 for visually indicating to the operator the outlet pressure of the slurry.

FIG. 12 illustrates an arrangement for delivery of abrasive and water, in the form of slurry globules which are separated by pockets of air, through the capillary tubing 72, 41, 40 and 46 for discharge through the nozzle pipe 48. In this embodiment of the invention, the T-junction manifold 70 is provided with an air inlet line 112 through which pulses of air are injected into the capillary 72 from a diaphragm pump 113 under the control of an electro-magnet 114. The winding of the electro-magnet 114 may be controlled over the same circuit as motor 76 and thus energized concurrently therewith, so that when slurry is delivered through the capillary tubing 68 to the slurry supply tubing 72, the slurry will be broken up into a series of globules separated by cushions or pockets of trapped air. Such a break-up of the cutting liquid prevents clogging of the capillary tubing 72, 41, 40, 46 and 48 during operation, and insures rapid and uniform flow of the slurry through the capillary system and nozzle pipe 48 of the instrument.

The electrical parts of the apparatus as well as connections controlled by the foot switch 10 are diagrammatically illustrated in FIG. 11. The oscillator generator circuit, sometimes referred to as the generator, and diagrammatically illustrated in the upper part of FIG. 11, is contained in the cabinet 2 shown in FIG. 1, and consists of a number of components connected in circuit with the exterior foot switch 10 and the exterior vibrator device or handpiece instrument shown in FIGS. 1 and 2. As shown in FIG. 11, the oscillator generator circuit contained within the cabinet 2 is supplied with normal alternating line current, such as A.C. 115 volt, 60 cycle, by power input lines L_1 and L_2, of which line L_1 is grounded. A manually operated switch S, which may be positioned outside the cabinet 2, connects lines L_1 and L_2 to the power input leads 117 and 117*a* which enter the rear of the cabinet and are connected to a cabinet contained rectifier and filter RF which generates high voltage direct current. Output line 119 from the rectifier and filter RF is connected to an oscillator system OS which generates alternating current of the desired high frequency. The output leads from the oscillator circuit OS are connected to the primary winding 121 of a transformer T, and whose secondary winding 121*a* may be connected to a power meter P and thence to a capacitor C. The capacitor C is connected as by line 123 to the arm 123*a* of a relay switch R. When the coil of the relay switch R is energized by manipulation of the exterior foot switch 10, the circuit between line 123 and the input line 38 of the transducer winding 20 is closed and thereby supplies the high frequency alternating current energy to the transducer winding 20. A direct current bias is applied to the high frequency alternating current which is supplied to the transducer winding 20, by line 125 extending from the rectifier and filter RF and connected by a choke K to the high frequency alternating current line 123, and which thereby imposes a direct current bias on the high frequency alternating current supplied to the transducer winding 20. Operation of the relay switch R is controlled by the foot switch 10 positioned exteriorly of the generator.

The foot switch 10 has six positions, indicated in FIG. 11 at *a, b, c, d, e* and *f* respectively, and includes a switch arm 10*a* which carries an arcuate contact member 10*b* adapted to span and connect fixed contacts at the respective positions. A fixed contact at each of positions *b, c, d, e* and *f* are connected by lines 129, 127*a*, 127 and 117 to the line L_2 through the switch S. A second contact at each of the positions *b, c* and *d* are connected by line 115*a* and by lead wire 115 to ground through the coil of relay R whose armature 123*a* over its front contact, controls the flow of biased high frequency alternating current from line 123 to the input lead 38 of

the transducer winding 20. Thus when the arcuate contact 10*b* bridges the fixed contacts at positions *b*, *c* or *d*, the relay R will be energized to close the circuit which supplies biased high frequency alternating current to the transducer winding 20, which energizes the transducer 18. When the circuit to the transducer winding 20 is closed, the solenoid controlled valve 87*c* is opened to permit flow of cooling water through the supply pipe 87*a* to the transducer containing chamber of the vibratory instrument, as shown in FIGS. 8 and 11. A third fixed contact at position *c* and a second contact at position *e* are connected by line 133 to ground through the winding of solenoid 89*a* to cause energization thereof at these positions of the rotary switch and which solenoid 89*a* controls the valve which controls the flow of rinsing water through line 72 to the working end of the handpiece instrument as shown in FIGS. 8 and 2. A third fixed contact at position *d* and a second fixed contact at position *f* are connected by line 131 to ground through the motor 76 so that this motor is energized when the contact arm 10*a* is in either position *d* or *f*, and which motor 76 drives the slurry pump 66 and forces the slurry mixture through line 72 which is thence supplied to the working end of the handpiece instrument, as shown in FIGS. 8 and 2. A current line 127*b* connected to line 127 supplies current to the preheaters 88 and 101 as indicated in FIG. 11 and shown in FIG. 8. At position *a* no circuits are completed by the contact 10*b*.

Thus, when the operator's foot moves the switch arm 10*a* from position *a* to position *b* the circuit for relay R is closed through contact 10*b* and the fixed contacts at position *b* to pick up its armature and close the circuit of the transducer winding 20 and open the solenoid controlled valve 87*c*. Longitudinal vibrations will thereby be set-up in the tool holder and tool and cooling water will flow to the cooling chamber of the instrument. If the operator desires water to be delivered through the capillary system to nozzle tube 43, he moves the switch arm 10*a* to position *c* in which position the circuit of relay R is maintained closed and the winding 20 energized, and the circuit of solenoid 89*a* is also closed through the third contact at that position. When the operator moves the switch arm to position *d* the solenoid 89*a* becomes de-energized and the motor 76 energized to cause delivery of the abrasive slurry through the capillary system. In this position *d* as in positions *b* and *c*, the transducer winding 20 is energized, and the solenoid 87*c* is also energized to supply cooling water to the chamber of the instrument. If the operator desires to deliver either water or abrasive slurry through the capillary system to nozzle pipe 48 without energizing the transducer winding, he may move the switch arm 10*a* to position *e* or *f* respectively. Preferably, as indicated in FIG. 11, a signal light R' is bridged across the relay R, another signal light M' is bridged across the motor 76, and a third signal light 89*a*' is bridged across the solenoid 89*a*. Thus, these lights will light whenever the associated elements are energized and serve to indicate to the operator the condition of the apparatus.

As shown in FIG. 11, there is preferably provided in conjunction with the circuit to the transducer winding 20, a power meter P connected in the output circuit of the transformer T which indicates the electric power delivered to the transducer. The power meter and signal lights may be conveniently assembled as a unit and connected through a cable to the electrical system within the cabinet 2. Such a unit is indicated in FIG. 1 by the reference numeral 108 and is provided with a suitable mounting bracket to permit the operator to clamp the unit in a convenient position for ready observation, as for example, on the arm of the dental chair. If desired, the foot switch 10, as in conventional dental foot switches may be provided with a return spring for insuring return of the arm 10*a* to off position (position *a*) when foot pressure against the switch arm 10*a* is released.

It will be understood that the particular circuit of FIG. 11 is illustrative only, as the present invention is not limited to any particular generator circuit for producing the high frequency alternating current delivered to the transducer winding 20. The generator circuit would ordinarily include means, such as the controller indicated diagrammatically at 109 in FIG. 1, for adjusting the power delivered to the amplifiers of the generator system; and means such as the controller indicated at 110, for tuning the oscillatory circuit of the generator system. An indicator lamp, such as that indicated at 111, would also be provided for indicating power on or off.

The operation of the apparatus and associated vibratory instrument as above described is as follows: In practice, the switch S is first thrown to supply power to the electric components of the system. When the operator is ready to perform a dental or other work operation, he can move the switch arm 10*a* from station *a* to station *b* at which position the transducer winding 20 will be energized to vibrate the work tool 30 and solenoid 87*c* will be energized to supply the instrument chamber with cooling water; or the operator can move the switch arm to station *c* where the transducer winding 20 will be energized to vibrate the work tool, the solenoid 87*c* will be energized to supply coolant to the instrument chamber, and the solenoid 89*a* will be energized to supply the nozzle pipe 48 of the instrument with warmed water or other treating fluid; or the operator can move the switch arm 10*a* to station *d* where the transducer winding 20 will be energized to vibrate the work tool 30, the solenoid 87*c* will be energized to supply coolant to the instrument chamber, and the motor M (motor 76 in FIG. 8) will be energized to drive a stream of slurry, or slurry globules separated by pockets of compressed air, through the nozzle pipe 48 of the instrument; or the operator can move the switch arm 10*a* to station *e* to thereby energize the solenoid 89*a* and drive warmed water or other treating fluid through the nozzle pipe 48 of the instrument, without energization of the transducer winding 20; or the operator can move the switch arm 10*a* to station *f* to thereby energize the motor and drive a stream of abrasive slurry, or slurry globules separated by pockets of compressed air, through the nozzle pipe of the instrument, without energization of the transducer winding 20. When the operator removes his foot from holding contact with the switch arm 10*a*, the switch arm returns to inoperative position *a*. By operating the foot switch 10 as above described, the operator can cause delivery of abrasive slurry or water to the work area, either with the tool vibrating or not, as desired. The operator thus needs only to manipulate the instrument in accordance with his skill, as no hand control of other parts of the apparatus during operations is necessitated. Flow of cutting liquid to the work area is immediately available whenever desired, no clogging of the capillary tubing while in use will occur, and the tubing 72, 41, 40, 46 and 48 can be rinsed out with water after the operation is completed.

The temperature of the cutting liquid when delivered to the mouth of the patient will be raised to a comfortable temperature by the heating coil 101 surrounding the slurry tank 64 as shown in FIG. 1. Also, water or other treating fluid supplied to the work area through the pipe nozzle 48 of the instrument, is preheated to a comfortable temperature by the preheater 88 as shown in FIG. 8. Where coolant water or treating fluid for the work area is tapped from the chamber of the instrument, as shown in FIG. 13, the fluid is warmed by heat exchange with the transducer stack 18 before it is delivered to the work area of the tool 30 through the adjacent nozzle 118 of tube 116. Thus the patient will be spared the shock of cold water injected into a cavity or other exposed area of the mouth.

The connection 8, comprising the flexible conduit 58

with closure cap **16** fixed to one end thereof, and containing the capillary tubes **34**, **36** and **41** and the electric cable **38** whose ends extend beyond the closure cap **16**, are initially applied to the instrument plug **32** as shown in FIGS. 2 and 13 when the plug **32** is removed from the instrument. The terminal end of capillary tube **34** is inserted into the tapered hole in the plug **32** and the end of coolant tube **42** is inserted into the end of the tube in a manner to expand the terminal end of the tube and lock it within the plug **32**. The terminal end of coolant return tube **36** is inserted in another tapered hole in the plug **32** and locked in position by the short tube or nipple **44** inserted therein. The terminal end of the slurry tube **41** and its extension **40** is inserted through a tightly fitted hole in the plug **32** and the extension **40** bent in the form shown in FIG. 2. The terminal end of the axial cable **38** is then connected within the plug **32** to the lead **38'** which forms the winding **20** of the transducer. When these connections are made, the coolant tube **42** extends into the instrument casing **14**, the slurry tube extension **40** extends into the casing **14** and its end projected through the casing for connection to the flexible tube **46**, and the plug **32** is then telescoped into snugly fitted relation within the outer end of the instrument casing **14**. The end closure cap **16** is then screwed into the threaded end of the casing **14** and into abutting relation against the end face of the plug **32**.

While the apparatus of this invention is designed and adapted for association with a vibratory device or instrument of any desired size, this apparatus is particularly designed for association with relatively small vibratory devices or instruments designed to be held in the hand of the operator, and conveniently hand manipulated without interference from supply lines which supply the electrical energy, the cutting liquids, the treating fluids, and the coolant to the instrument. Where the instrument is hand supported, an operating frequency in the ultrasonic range is preferably selected, since the hand piece instrument must be made of corresponding greater length where the lower frequency ranges are used. Where operating frequencies in the ultrasonic range are used, the instrument can be made small in length and diameter, and quiet operation assured.

Where the vibratory device or instrument is to be made of a size to be conveniently held in the hand and adapted to be conveniently hand manipulated by the operator, the coolant supply and return tubing, the energizing cable, the slurry supply tubing, and the treating fluid supply tubing, must be made correspondingly small in size. The apparatus of this invention makes provision for conducting the coolant under pressure to the instrument chamber and for conducting warmed coolant from the instrument chamber for discharge, and for conducting warm coolant or water from the instrument chamber to the work tool of the instrument under the finger control of the operator. In addition, this apparatus provides for the supply of warmed cutting liquid, or warmed water or other treating fluid, to the work tool of the instrument, under the selective control of the operator's foot. In addition, the apparatus provides for the injection of pockets of pressurized air to break up the abrasive slurry or cutting fluid supplied to the work tool into globules to thereby insure positive and uniform flow of the cutting fluid to the work tool and thus eliminate the possibility of clogging of the relatively small capillary tubes which conduct the cutting liquid.

It will be apparent from the above disclosure, that many changes can be made in the specific construction and components of the apparatus illustrated in the drawings, in accordance with the teachings of this invention, without departing from the spirit of this invention or the scope of the accompanying claims.

What is claimed is:

1. Apparatus designed for association with a vibratory device having a casing, a magnetostrictive transducer and an energizing coil extending into said casing, an amplitude increasing connecting body fixed to one end of said transducer, and a work element connected to the other end of said connecting body and extending exteriorly of said casing; said apparatus including, an oscillation generator circuit for converting normal line current into high frequency alternating current, a housing containing said oscillation generator circuit, a flexible conduit extending from said housing, a closure cap fixed to one end of said flexible conduit and adapted to be detachably connected to one end of the casing of the vibratory device, an electrical conductor extending from said oscillation generator circuit and through said flexible conduit and closure cap and adapted to be connected to the energizing coil of the vibratory device, and a fluid tube extending from said housing and through said flexible conduit and closure cap for supplying fluid to the interior of the casing of the vibratory device.

2. Apparatus designed for association with a vibratory device having a casing, a magnetostrictive transducer and an energizing coil extending into said casing, an amplitude increasing connecting body fixed to one end of said transducer, and a work element connected to the other end of said connecting body and extending exteriorly of said casing; said apparatus including, an oscillation generator circuit for converting normal line current into high frequency alternating current, a housing containing said oscillation generator circuit, a flexible conduit extending from said housing, a closure cap fixed to one end of said flexible conduit and connected to one end of the casing of the vibratory device, an electrical conductor extending from said oscillation generator circuit and through said flexible conduit and closure cap and adapted to be connected to the energizing coil of the vibratory device, a fluid supply tube extending from said housing and through said flexible conduit and closure cap for supplying fluid to the interior of the casing of the vibratory device, and a fluid return tube extending from said housing through said flexible conduit and closure cap for returning fluid from the interior of the casing to a fluid discharge.

3. Apparatus designed for association with a vibratory device having a casing, a magnetostrictive transducer and an energizing coil extending into said casing, an amplitude increasing connecting body fixed to one end of said transducer, and a work element connected to the other end of said connecting body and extending exteriorly of said casing; said apparatus including, an oscillation generator circuit for converting normal line current into high frequency alternating current, a housing containing said oscillation generator circuit, an outlet receptacle on a wall of said housing presenting electrical terminals and a fluid supply terminal connected to the current converting generator and a fluid supply in said housing, a receptacle plug having complementary electrical terminals and a complementary tubular terminal detachably connected to the electrical terminals and fluid supply terminal of said outlet receptacle, a flexible conduit fixed to and extending from said receptacle plug, a closure cap fixed to the other end of said flexible conduit and adapted to be detachably connected to one end of the casing of the vibratory device, an electrical conductor connected to the complementary electrical terminals of said receptacle plug and extending through said flexible conduit and closure cap and adapted to be connected to the energizing coil of the vibratory device, and a tube fixed to the complementary tubular terminal of said receptacle plug and extending through said flexible conduit and closure cap for supplying fluid to the interior of the casing of the vibratory device.

4. Apparatus designed for association with a vibratory device having a casing, a magnetostrictive transducer and an energizing coil extending into said casing, an amplitude increasing connecting body fixed to one end of said transducer, and a work element fixed to the other end of said connecting body and extending exteriorly of said casing; said apparatus including a housing, a fluid supply connec-

tion and a fluid discharge connection in said housing, an oscillation generator circuit in said housing operative to convert input current into high frequency alternating current, an outlet receptacle mounted on a wall of said housing, said outlet receptacle presenting electrical terminals connected to said current converting generator, a fluid supply terminal connected to said fluid supply connection and a fluid discharge terminal connected to said fluid discharge connection, a receptacle plug presenting complementary electrical terminals detachably connected to the electrical terminals of said outlet receptacle, and a pair of complementary fluid conducting terminals detachably connected to said fluid supply terminal and fluid discharge terminal of the outlet receptacle, a flexible conduit having one end thereof fixed to said receptacle plug and the other end thereof fixed to a closure cap which is adapted to be connected to one end of the casing of the vibratory device, a current conductor connected to the complementary electrical terminals of said receptacle plug and extending through said flexible conduit and closure cap and adapted to be connected to the energizing coil of the vibratory device, and a pair of fluid conducting tubes fixed to the complementary fluid conducting terminals of said receptacle plug and extending through said flexible conduit and closure cap for supplying fluid to and withdrawing fluid from the casing of the vibratory device.

5. Apparatus designed for association with a hand supported instrument for performing dental and surgical work which includes, a tubular casing containing an energizing coil, a magnetostrictive transducer in said casing and in energizing relation to said coil, an amplitude increasing connecting body fixed to one end of said transducer, an operative tool fixed to the other end of said connecting body and extending exteriorly of said casing, sealing means extending between said connecting body and casing defining a chamber in said casing, and a fluid passage extending from the casing chamber to the operative tool of the instrument; said apparatus including, a housing external to said instrument, a fluid supply source in said housing, an oscillation generator circuit in said housing operative to convert normally available electric current into a high frequency alternating current, a flexible conduit connected to said housing and having a closure cap fixed to an end thereof and adapted to be connected to one end of the casing of the instrument, an electrical conductor connected to said generator and extending through said flexible conduit and closure cap for connection to the energizing coil of the instrument, and a fluid supply tube connected to the fluid supply source in said housing and extending through said flexible conduit and closure cap for supplying fluid to the casing chamber and the fluid passage of the instrument.

6. Apparatus designed for association with a vibratory device having a casing, a magnetostrictive transducer and an energizing coil extending into said casing, an amplitude increasing connecting body fixed to one end of said transducer, and a work element fixed to the other end of said connecting body and extending exteriorly of said casing; said apparatus including, an oscillation generator circuit for converting normal line current into high frequency alternating current, a housing containing said oscillation generator circuit, a flexible conduit extending from said housing, a closure cap fixed to one end of said flexible conduit and adapted to be connected to one end of the casing of the vibratory device, an electrical conductor extending from said oscillation generator circuit and through said flexible conduit and closure cap and adapted to be connected to the energizing coil of the vibratory device, a fluid tube extending from said housing and through said flexible conduit and closure cap for supplying fluid to the interior of the casing of the vibratory device, an electrically operated valve in said housing for controlling the flow of fluid through said fluid tube, and a manually manipulated switch accessible exteriorly of said housing and electrically connected to said valve and generator circuit for simultaneously controlling the flow of liquid to the casing and the energization of the transducer of the vibratory device.

7. Apparatus designed for association with a hand supported instrument for performing dental and surgical work which includes, a tubular casing containing an energizing coil, a magnetostrictive transducer in said casing and in energizing relation to said coil, an amplitude increasing connecting body fixed to one end of said transducer, an operative tool fixed to the other end of said connecting body and extending exteriorly of said casing, sealing means extending between said connecting body and casing defining a chamber in said casing, and a fluid passage extending from the casing chamber to the operative tool of the instrument; said apparatus including, a housing external to said instrument, a fluid supply source in said housing, an oscillation generator circuit in said housing operative to convert normally available electric current into a high frequency alternating current, a flexible conduit connected to said housing and having a closure cap fixed to an end thereof and adapted to be connected to one end of the casing of the instrument, an electrical conductor connected to said generator and extending through said flexible conduit and closure cap for connection to the energizing coil of the instrument, a fluid supply tube connected to the fluid supply source in said housing and extending through said flexible conduit and closure cap for supplying fluid to the casing chamber and fluid passage of the instrument, manual means associated with said fluid passage for controlling the flow of fluid through said fluid passage to the operative tool of the instrument, and a manually manipulated switch accessible exteriorly of said housing and electrically connected to said generator for controlling the energization of said transducer.

8. Apparatus designed for association with a hand supported instrument for performing dental and surgical work which includes a tubular casing containing an energizing coil, a magnetostrictive transducer in said casing and in energizing relation to said coil, an amplitude increasing connecting body fixed to one end of said transducer, an operative tool fixed to the other end of said connecting body and extending exteriorly of said casing, sealing means extending between said connecting body and casing defining a chamber in said casing, and a fluid passage extending from the casing chamber to the operative tool of the instrument; said apparatus including, a housing external to said instrument, a fluid supply source in said housing, an oscillation generator circuit in said housing operative to convert normally available electric current into a high frequency alternating current, a flexible conduit connected to said housing and having a closure cap fixed to an end thereof and adapted to be connected to one end of the casing of the instrument, an electrical conductor connected to said generator and extending through said flexible conduit and closure cap for connection to the energizing coil of the instrument, a fluid supply tube connected to the fluid supply source in said housing and extending through said flexible conduit and closure cap for supplying fluid to the casing chamber and fluid passage of the instrument, an electrically operated valve in said housing for controlling the flow of fluid through said fluid supply tube, and a manually manipulated switch accessible exteriorly of said housing and electrically connected to said valve and generator circuit for controlling the flow of fluid through said fluid supply tube and to the casing chamber of the instrument and for controlling the energization of the transducer in the casing of the instrument.

9. Apparatus designed for association with a vibrator device which includes a tubular casing housing an energizing coil, a magnetostrictive transducer in said casing and in energizing relation to said coil, an amplitude increasing connecting body fixed to one end of said transducer, and a work element fixed to the other end of said connecting body and extending exteriorly of said casing;

said apparatus including a housing, a treating fluid supply connection in said housing, and an oscillation generator circuit in said housing operative to convert input current into high frequency alternating current, an outlet receptacle mounted on a wall of said housing, said outlet receptacle presenting electrical terminals connected to said current converting generator, and a treating fluid supply terminal connected to said treating fluid supply connection, a receptacle plug presenting complementary electrical terminals adapted to be detachably connected to the electrical terminals of said outlet receptacle, and a complementary treating fluid conducting terminal detachably connected to the treating fluid supply terminal of said outlet receptacle, a flexible conduit having one end thereof fixed to said receptacle plug and the other end thereof fixed to a closure cap adapted to be connected to one end of the casing of the vibratory device, a current conductor connected to the complementary electrical terminals of said receptacle plug and extending through said flexible conduit and closure cap for connection to the energizing coil of the vibratory device, and a treating fluid conducting tube fixed to the complementary treating fluid conducting terminal of said receptacle plug and extending through said flexible conduit and closure cap and adapted to terminate adjacent the work element of the vibratory device.

10. Apparatus designed for association with a vibrator device which includes a tubular casing housing an energizing coil, a magnetostrictive transducer in said casing and in energizing relation to said coil, an amplitude increasing connecting body fixed to one end of said transducer, and a work element fixed to the other end of said connecting body and extending exteriorly of said casing; said apparatus including a housing, a coolant supply connection and a treating fluid supply connection in said housing, an oscillation generator circuit in said housing operative to convert input current into high frequency alternating current, an outlet receptacle mounted on a wall of said housing, said outlet receptacle presenting electrical terminals connected to said current converting generator, a coolant supply terminal connected to said coolant supply connection, and a treating fluid supply terminal connected to said treating fluid supply connection, a receptacle plug presenting complementary electrical terminals detachably connected to the electrical terminals of said outlet receptacle, a complementary coolant conducting terminal detachably connected to said coolant supply terminal of said outlet receptacle, and a complementary treating fluid conducting terminal detachably connected to the treating fluid supply terminal of said outlet receptacle, a flexible conduit having one end thereof fixed to said receptacle plug and the other end thereof fixed to a closure cap adapted to be connected to one end of the casing of the vibratory device, a current conductor connected to the complementary electrical terminals of said receptacle plug and extending through said flexible conduit and closure cap and adapted to be connected to the energizing coil of the vibratory device, a coolant conducting tube fixed to the complementary coolant conducting terminal of said receptacle plug and extending through said flexible conduit and closure cap for supplying coolant to the casing of the vibratory device, and a treating fluid conducting tube fixed to the complementary treating fluid conducting terminal of said receptacle plug and extending through said flexible conduit and closure cap and adapted to terminate adjacent the work element of the vibratory device.

11. Apparatus designed for association with a vibratory device having a casing, a magnetostrictive transducer and an energizing coil extending into said casing, an amplitude increasing connecting body fixed to one end of said transducer, and a work element fixed to the other end of said connecting body and extending exteriorly of said casing; said apparatus including, an oscillation generator circuit for converting normal line current into high frequency alternating current, a housing containing said oscillation generator circuit, an outlet receptacle on a wall of said housing presenting electrical terminals connected to the current converting generator in said housing, a receptacle plug having complementary electrical terminals detachably connected to the electrical terminals of said outlet receptacle, a flexible conduit fixed to and extending from said receptacle plug, a closure cap fixed to the other end of said flexible conduit and adapted to be detachably connected to one end of the casing of the vibratory device, an electrical conductor connected to the complementary electrical terminals of said receptacle plug and extending through said flexible conduit and closure cap and adapted to be connected to the energizing coil of the vibratory device, and a manually manipulated switch accessible exteriorly of said housing and electrically connected to said generator circuit for controlling the energization of the transducer of the vibratory device.

12. Apparatus designed for association with a vibratory device having a casing, a magnetostrictive transducer and an energizing coil extending into said casing, an amplitude increasing connecting body fixed to one end of said transducer, and a work element fixed to the other end of said connecting body and extending exteriorly of said casing; said apparatus including; an oscillation generator circuit for converting normal line current into high frequency alternating current, a housing containing said oscillation generator circuit, a fluid supply in said housing, an outlet receptacle on a wall of said housing presenting electrical terminals and a fluid supply terminal connected to the current converting generator and a fluid supply in said housing, a receptacle plug having complementary electrical terminals and a complementary tubular terminal detachably connected to the electrical terminals and fluid supply terminal of said outlet receptacle, a flexible conduit fixed to and extending from said receptacle plug, a closure cap fixed to the other end of said flexible conduit and adapted to be connected to one end of the casing of the vibratory device, an electrical conductor connected to the complementary electrical terminals of said receptacle plug and extending through said flexible conduit and closure cap and adapted to be connected to the energizing coil of the vibratory device, a tube fixed to the complementary tubular terminal of said receptacle plug and extending through said flexible conduit and closure cap for supplying fluid to the interior of the casing of the vibratory device, an electrically operated valve in said housing for controlling the flow of fluid through said fluid tube, and a manually manipulated switch accessible exteriorly of said housing and electrically connected to said valve and generator circuit for simultaneously controlling the flow of liquid to the casing and the energization of the transducer of the vibratory device.

13. Apparatus designed for association with a vibrator device which includes a tubular casing housing an energizing coil, a magnetostrictive transducer in said casing and in energizing relation to said coil, an amplitude increasing connecting body fixed to one end of said transducer, and a work element fixed to the other end of said connecting body and extending exteriorly of said casing; said apparatus including a housing, a treating fluid supply connection in said housing and an oscillation generator circuit in said housing operative to convert input current into high frequency alternating current, an outlet receptacle mounted on a wall of said housing, said outlet receptacle presenting electrical terminals connected to said current converting generator, and a treating fluid supply terminal connected to said treating fluid supply connection, a receptacle plug presenting complementary electrical terminals detachably connected to the electrical terminals of said outlet receptacle, and a complementary treating fluid conducting terminal detachably connected to the treating fluid supply terminal of said outlet receptacle, a flexible conduit having one end thereof fixed to said receptacle plug and the other end thereof fixed to a closure cap

adapted to be connected to one end of the casing of the vibratory device, a current conductor connected to the complementary electrical terminals of said receptacle plug and extending through said flexible conduit and closure cap for connection to the energizing coil of the vibratory device, a treating fluid conducting tube fixed to the complementary treating fluid conducting terminal of said receptacle plug and extending through said flexible conduit and closure cap and adapted to terminate adjacent the work element of the vibratory device, an electrically operated valve in said housing for controlling the flow of fluid through said fluid conducting tube, and a manually manipulated switch accessible exteriorly of said housing and electrically connected to said valve and generator circuit for controlling the flow of fluid through said fluid conducting tube and to the work element of the vibratory device and for controlling the energization of the transducer in the casing of the vibrator device.

14. Apparatus designed for association with a hand supported instrument for performing dental and surgical work which includes a tubular casing containing an energizing coil, a magnetostrictive transducer in said casing and in energizing relation to said coil, an amplitude increasing connecting body fixed to one end of said transducer, an operative tool fixed to the other end of said connecting body and extending exteriorly of said casing, sealing means extending between said connecting body and casing defining a chamber in said casing, and a fluid passage extending from the casing chamber to the operative tool of the instrument; said apparatus including, a housing external to said instrument, a fluid supply source in said housing, an oscillation generator circuit in said housing operative to convert normally available electric current into a high frequency alternating current, an outlet receptacle mounted on a wall of said housing, said outlet receptacle presenting electrical terminals connected to said current converting generator, and a fluid terminal connected to said fluid supply source in said housing, a receptacle plug presenting complementary electrical terminals detachably connected to the electrical terminals of said outlet receptacle, and a complementary fluid terminal detachably connected to the fluid supply terminal of said outlet receptacle, a flexible conduit having one end thereof fixed to said receptacle plug and the other end thereof fixed to a closure cap adapted to be connected to one end of the casing of the vibratory device, a current conductor connected to the complementary electrical terminals of said receptacle plug and extending through said flexible conduit and closure cap for connection to the energization coil in the casing of the instrument, and a fluid conducting tube fixed to the complementary fluid terminal of said receptacle plug and extending through said flexible conduit and closure cap for supplying fluid to the casing chamber and fluid passage of the instrument.

15. Apparatus designed for association with a hand supported instrument for performing dental and surgical work which includes a tubular casing containing an energizing coil, a magnetostrictive transducer in said casing in energizing relation to said coil, an amplitude increasing connecting body fixed to one end of said transducer, an operative tool fixed to the other end of said connecting body and extending exteriorly of said casing, sealing means extending between said connecting body and casing defining a chamber in said casing, and a fluid passage extending from the casing chamber to the operative tool of the instrument; said apparatus including, a housing external to said instrument, a fluid supply source in said housing, an oscillation generator circuit in said housing operative to convert normally available electric current into a high frequency alternating current, an outlet receptacle on a wall of said housing presenting electrical terminals and a fluid supply terminal connected to the current converting generator and a fluid supply in said housing, a receptacle plug having complementary electrical terminals and a complementary tubular terminal detachably connected to the electrical terminals and fluid supply terminal of said outlet receptacle, a flexible conduit fixed to and extending from said receptacle plug, a closure cap fixed to the other end of said flexible conduit and adapted to be detachably connected to one end of the casing of the vibratory device, an electrical conductor connected to the complementary electrical terminals of said receptacle plug and extending through said flexible conduit and closure cap and adapted to be connected to the energizing coil of the vibratory device, a tube fixed to the complementary tubular terminal of said receptacle plug and extending through said flexible conduit and closure cap for supplying fluid to the casing chamber and the operative tool of the instrument, an electrically operated valve in said housing for controlling the flow of fluid through said fluid supply tube, and a manually manipulated switch accessible exteriorly of said housing and electrically connected to said valve and generator circuit for simultaneously controlling the flow of fluid through said fluid supply tube and to the casing chamber of the instrument and for controlling the energization of the transducer in the casing of the instrument.

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