Jan. 13, 1970 Z. HAYDU 3,488,851

ULTRASONIC DEVICES

Filed April 18, 1968

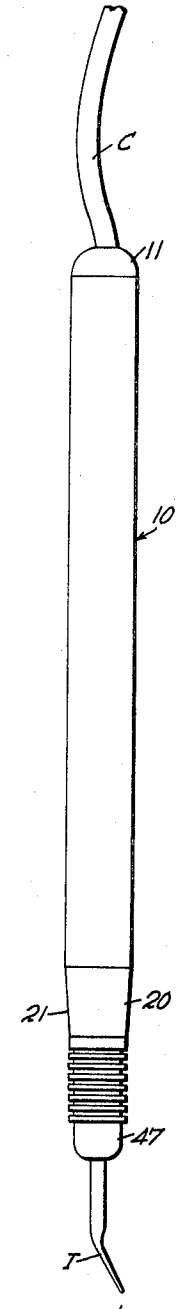


Fig. 1

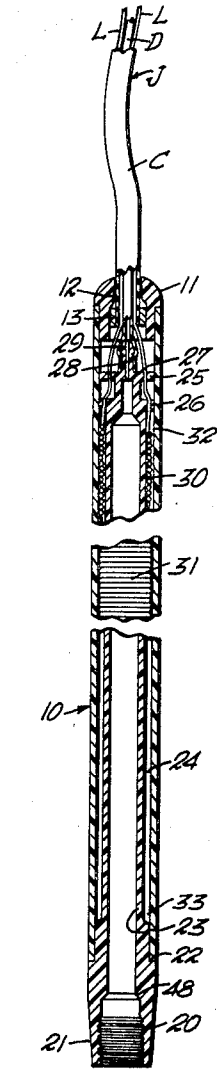


Fig. 2

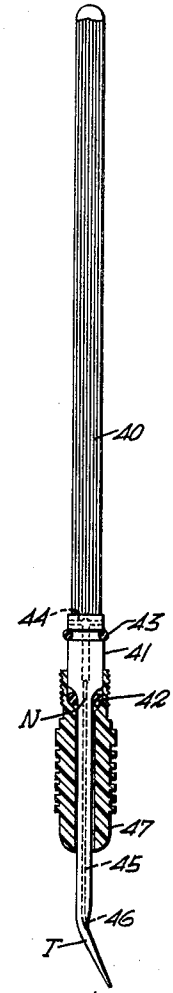


Fig. 3

INVENTOR.
ZOLTAN HAYDU

BY

ATTORNEY.

United States Patent Office 3,488,851 Patented Jan. 13, 1970

3,488,851

ULTRASONIC DEVICES

Zoltan Haydu, 810 Tyler St., Hollywood, Fla. 33020

Filed Apr. 18, 1968, Ser. No. 722,454
Int. Cl. A61c 1/06, 3/03; H01v 7/00
U.S. Cl. 32—58 1 Claim

ABSTRACT OF THE DISCLOSURE

An ultrasonic device of the handtool type comprising a magnetostrictive stack, a horn functioning as an impedance transformer with means for cooling the magnetostrictive stack and discharging the coolant under pressure at the work area through the horn, the stack-horn-tool assembly being contained within two telescoping enclosures with proximal and distal caps.

This invention relates to ultrasonic devices.

The embodiment described in the within specification and disclosed in the annexed drawing is a dental device useful for various types of dental treatment or surgery. Basically such devices as they have been heretofore designed comprise a power source and a handpiece containing a magnetostrictive stack to provide ultrasonic energy for a tool usable for removing tartar and stains from a dental patient's teeth and for other dental procedures, such as packing amalgam in cavities, curettage, dental surgery and the like. The numerous different types of operation to be performed require the utilization of differing tool configurations. One of the expedients which is generally employed for the interchange of tools in the handpiece is to provide tools having threaded connections to the stack. In this arrangement, the insertion of the tool into the stack requires the use of a wrench, or its equivalent, and, as the tool and stack are vibrating longitudinally at a very rapid rate, efficacious threading presents difficulties.

An alternative design comprises the employment of an integrated stack-tool assembly, removable as an entirety from the handpiece, with a frictional engagement between the enclosure for the stack and the exterior of the handpiece.

Additionally, the rapid impact of the tool on the tooth surface or other medium upon which work is being performed, generates heat within the dental patient's mouth which must be dissipated, and it is conventional to transmit a coolant to the work surface. This is usually done by a conduit, exterior to the stack, terminating in the region of the working part of the tool. However, in some arrangement, the generation of heat within the stack causes a heat rise in the fluid to the extent that if all of the fluid is passed to the patient's mouth the quantum of heat is uncomfortable. Thus arrangements are added to bypass a portion of the fluid from the patient's mouth and discharge it separately. A certain quantity of fluid is desirable for reasons other than its cooling effect, as the impinging of the fluid on the work surface results in cavitation within the fluid and the implosion of very small bubbles, which facilitate the work.

I have found it desirable to connect the tool permanently to the magnetostrictive stack, and in this invention have disclosed means for rapidly connecting and disconnecting the tool and stack from the holder therefor to eliminate the problem created by the threaded connections between the tool and stack without incurring the disadvantages following the employment of the press-fit between the stack enclosure and the casing of the handpiece.

Further, I have found that the efficacy of the fluid in its performance in the operation is increased by so arranging

the duct work that the output for the fluid is at the base of the working surface of the tool, whatever configuration it may have for the particular operation to be performed.

Another object of the invention is to provide a tool of the type described having a minimum of components, with resultant simplicity of manufacture and assembly and, naturally reduction in cost to the user, in which the components are so arranged so that the tool is properly balanced and of such a weight that it can be used continuously by the operator without fatigue. These and other objects of the invention will be more particularly hereinafter described.

In the drawings,

FIG. 1 is a side elevational view of the device, with a cord for attachment to the power supply and fluid source, not shown;

FIG. 2 is a view in section through the center-line of the handle portion of the device, broken into three different sections and part showing the solenoid in section part in plan, and part with the solenoid removed;

FIG. 3 is a plan view of the stack with attached horn, or, as it is sometimes referred to, acoustical matching transformer, and one of the forms of tools usable therewith;

Referring now to FIG. 2, the device comprises a flexible cable, C, having a jacket, J, which contains a pair of electrical lines, L, and a duct for the input of fluid, D. The lines are connected to a power source not shown, and the duct to a fluid source under pressure, likewise not shown. The tool comprises a casing indicated generally at **10**, FIG. 1, having at its proximal end a proximal cap **11**, with a central opening **12**, FIG. 2, for the lines L and duct D, and at its opposite end, a tubular enclosure **20**. The casing **10** is shown in section in FIG. 2, and has smooth internal surfaces at both its proximal and distal ends for press-fits with the proximal cap **11** and the tubular enclosure **20**. The tubular enclosure **20** has an internal threading at its distal end for connection with a distal cap **47**, having a central opening through which the tool T protrudes.

Within the casing and surrounding the tubular enclosure **20** is a solenoid, shown at **30** in section and at **31** in side elevation in FIG. 2. It should be understood that the winding of the solenoid is continuous throughout the space **24** between the casing **10** and the tubular enclosure **20**, from the point **33** near the base to the point **32** at the distal end of the casing. Thus the solenoid surrounds the entire length of the magnetostrictive stack **40** shown in the elevation in FIG. 3.

Referring further to FIG. 2, it will be noted that the proximal cap **11**, has an internal axial opening **12**, tapered with the smallest portion of the opening at the outer point of the cap with the taper enlarging the opening as it proceeds inwardly. Further provided is a ferrule **13**, to clamp the jacket, J, of the cable, the lines L and the duct D, being fed through the internal opening of the ferrule **13**, for connection with the solenoid and cooling space, hereinafter to be described.

The tubular enclosure **20**, has an external taper at **21**, a stepped portion **22**, and an internal tubular portion **23**, spaced from the walls of the casing **10**, to provide a space **24**. At the portion of the tubular enclosure **20** nearest the proximal cap **11**, are a pair of flanges, **25**, **26**, for engagement with the wall of the casing **10**, and a base **27**, having a coaxial channel **28**, terminating in a nipple **29**, for engagement with the duct, D. The flanges, **25**, **26**, are provided with openings for the electrical lines L, so that they can be electrically connected to the solenoid **30**.

Referring specifically now to FIG. 3, the stack is formed of a series of sheets of a magnetostrictive material consisting of laminations in physical contact with one another

except for oxide coatings, acquired when they are annealed, which electrically insulate the laminations from one another, thus decreasing the eddy current losses. The magnetostrictive stack is brazed at the end nearest the base and affixed by brazing to a horn or acoustical impedance matching transformer **41** of a stepped type, the acoustical performance of which is well understood, see for example, Belford, The Stepped Horn, Clevite Technical Paper TP–214, pages 814 through 822, and addendum, and similar literature.

The nodal region of the horn **41**, is approximately at the point designated N, FIG. 3, at which point I locate a first O-ring **42**, which not only serves as a seal to prevent the transmission of any escaping liquid beyond that point, but likewise as a nodal support for the horn.

The fluid operational aspects of the system are as follows. Fluid under pressure is transmitted into the region around the magnetostrictive stack **40** through the duct D, where it has a cooling effect. By reason of the circuitry described in co-pending application Ser. No. 722,485 filed Apr. 18, 1968, of John M. Eubanks, concurrently filed, when used conjointly with my invention, the heat rise in the magnetostrictive stack is less than in other prior art structures so that the quantum of fluid required for the dissipation of the heat is less. This permits the use of smaller duct work than would otherwise be the case and the provision of the duct work through the horn which will now be described.

At the base of the horn, I have an inlet **44**, shown in dotted lines, FIG. 3, which proceeds normal to the axis of the horn where it intercepts at right angles an axially centered duct, likewise shown in dotted lines at **45**, FIG. 3, throughout the length of the horn to the outlet **46**, at the inner face of the working surface of the tool T.

To provide an additional seal, I have included a second O-ring, **43**, at a point near the base of the horn and immediately beyond the inlet **44**, for the disposal of fluid circulating in the space between the tubular portion **23**, of the tubular enclosure **20**, and the magnetostrictive stack. This second O-ring, **43**, seats against the internal shoulder **48** in the tubular enclosure **20**, when the distal cap **47** is fully engaged with the internal threads of the tubular enclosure **20**.

I have found that by the arrangement described, the fluid is delivered to a point where its efficacy is at an optimum through the cavitation processes in implementing the work being done by the tool. By reason of the exposure of the fluid to the heated stack, it is gently warm so that it subjects the mouth of the dental patient to a pleasant reaction.

It will be obvious, of course, to persons skilled in the art that numerous variants of the arrangements I have hereby described are possible.

Having fully described my invention, I claim:

1. An ultrasonic dental device comprising in combination,

a magnetostrictive stack joined to an acoustical horn of the stepped type,

said horn functioning as an impedance transformer, with the low impedance section of the horn terminating in a tool,

a fluid input near the junction between the high impedance section of the horn and the magnetostrictive stack, leading to a conduit extending through the horn and terminating in an outlet in proximity to the tool,

a groove in the high impedance section of said horn beyond said input in which a second O-ring is seated,

a tubular enclosure for the stack and horn, having a proximal and a distal end, and having in its proximal end a fluid inlet originating from a nipple into an internal cavity in which the stack is located, and having near its distal end a shoulder, beyond the stack and beyond the fluid input in the base of the horn, against which the second O-ring is seated,

a first O-ring located near the node of the horn,

said tubular enclosure being internally threaded at its distal end, and

an externally threaded distal cap, said external threads being adapted to engage the internal threads at the distal end of the tubular enclosure,

said distal cap having an internal bore of small diameter surrounding the low impedance section of the horn, a second bore of larger diameter sized to encompass the high impedance section of the horn, and a bevelled shoulder between said large and small bores adapted to seat the first O-ring near the node in the horn, when the distal cap is fully engaged with the tubular enclosure,

said tubular enclosure having an external shoulder near its distal end forming a cylindrical portion having a diameter less than the diameter of the distal end, and a flange at its proximal end of the same diameter as the cylindrical portion near the distal end of the tubular enclosure, the space therebetween being adapted to form a cavity in the region of the magnetostrictive stack to receive and contain a solenoid,

a solenoid in said cavity, encircling said stack,

a casing of tubular configuration having a proximal and a distal end, the inner diameter of the casing at its proximal end having a press-fit with the flange at the proximal end of the tubular enclosure, and a similar press-fit at the cylindrical portion near the distal end of the tubular enclosure, the outer diameter of said casing being the same as the outer diameter near the shoulder at the distal end of the tubular enclosure,

openings for electrical lines through the flange at the proximal end of the tubular enclosure, and,

electrical lines connected with a source of electrical energy therethrough and connected with the solenoid,

a proximal cap with a central opening having an outer diameter of the same dimension as the outer diameter of the casing and the distal end of the tubular enclosure, and adapted to be press-fitted within the proximal end of the casing,

said central opening in said proximal cap providing clearance for the pair of electrical lines to the solenoid and for a fluid conduit to the nipple at the proximal end of the tubular enclosure, said fluid conduit being connected to a source of fluid under pressure.

References Cited

UNITED STATES PATENTS

2,990,616	7/1961	Balamuth et al.	32—26
3,075,288	1/1963	Balamuth et al.	32—58
3,368,280	2/1968	Friedman et al.	32—58

ROBERT PESHOCK, Primary Examiner

U.S. Cl. X.R.

310—26