INSERT FOR ULTRASONIC MEDICAL DEVICE

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ABSTRACT
An insert for ultrasonic medical apparatus includes a transducer for generating ultrasonic vibrations and a treatment instrument actively coupled to the transducer to apply the ultrasonic vibrations developed by the transducer to a patient undergoing treatment. The treatment instrument is a slender needle and is provided with a bore along its longitudinal axis. The bore provides a flow path for a fluid which flows through it, through a bulge in the flowpath at one end of the treatment instrument, and out through an orifice in the bulge. The bulge or enlargement induces cavitation in the fluid which reinforces the ultrasonic vibrations.

1 Claim, 2 Drawing Figures
BACKGROUND OF THE INVENTION

This invention relates to medical equipment for human or veterinary medicine using ultrasonics, and more particularly to a part of the equipment called an insert.

The use of medical equipment that produces ultrasonic vibrations for the treatment of various ills is well known. For example, U.S. Pat. Nos. 2,990,616 and 3,075,288 teach ultrasonic medical instruments used to treat stomach illnesses.

Ultrasonic medical instruments usually include an electric power source, a fluid source and a handle supporting an insert. The insert includes a transducer for generating ultrasonic vibrations actively coupled to a treatment instrument which applies the ultrasonic vibrations to an area of a patient undergoing treatment. A fluid current immerses the transducer and is then directed to the active zone of the treatment instrument; that is, the area of the treatment instrument at which the ultrasonic vibrations are applied to the patient. Most often a tube attached to the insert and provided with a swivelling tip at an end directs the fluid to the active zone of the treatment instrument.

Circulation of the fluid over the transducer and to the treatment instrument is necessary and desirable for a number of reasons. First, the fluid carries away heat from the transducer and from the active zone of the treatment instrument. This heat is generated by a transformation of some of the mechanical energy carried in the ultrasonic vibrations into thermal energy and would cause a considerable rise in temperature of the insert if it were not removed. By atomizing the fluid delivered to the active zone of the treatment instrument while the instrument is undergoing ultrasonic vibrations, cavitation is developed in the fluid. Vacuum bubbles within the atomized fluid burst and generate shock waves in the atomized fluid which reinforces the effect of the mechanical ultrasonic vibrations. Finally, for medical reasons one may wish to apply an active fluid to the area of treatment that will produce some desired result in a biological specimen undergoing treatment. For example, it is known to apply a hemostatic liquid in this manner.

In order to maximize cooling of the treatment insert vibration reinforcement due to cavitation, a biological reaction from the active properties of the fluid, the fluid should be delivered as close as possible to the active zone of the instrument and to the region under treatment. This is particularly true in the case of cavitation effects. Because of peculiarities in their construction, known inserts do not permit maximum cooling, cavitation, and biological effects. In these devices fluid to be atomized is directed over the active zone of the treatment instrument by an erratically swivelling tip attached to an end of tubing through which the fluid flows. As a result poor contact between the active zone of the treatment instrument and the atomized fluid is realized.

Another important limitation of known instruments results from the means by which a flow path of the fluid is established. The juxtaposition along the treatment instrument of a flow path means for the fluid creates an obstruction rendering the instrument inapplicable for certain operations.

SUMMARY OF THE INVENTION

It is a principal object of the invention to provide an insert for ultrasonic medical instruments eliminating the problems of the aforementioned inserts.

The insert according to the invention is part of an ultrasonic medical device usable, for example, for disintegrating kidney stones. The device comprises a hollow handle or holder with the insert inserted therein. The insert comprises an electro-mechanical transducer for generating ultrasonic vibration and a treatment instrument fixed to the transducer and coactive therewith for applying ultrasonic vibrations developed by the transducer to an area of a biological specimen or patient undergoing treatment. The hollow handle of the device defines a fluid flow path through which fluid flows enveloping the transducer. Flow path means extend the flow path to an end of the treatment instrument adjacent the transducer. The treatment instrument is in the form of a slender needle, hollow along its longitudinal axis, and flared at its end opposite the transducer. Fluid flowing through the hollow handle continues through the flow path means, through the treatment instrument and out an orifice in the flared end. As the fluid flows through the orifice it is atomized. When the transducer is energized it develops ultrasonic mechanical vibrations in the treatment instrument which are applied to the region of a patient under treatment by the instrument. The ultrasonic vibrations also develop cavitation in the atomized fluid.

BRIEF DESCRIPTION OF THE DRAWINGS

Other features and advantages of the insert will be better understood as described in the following specification and appended claims, in conjunction with the following drawings in which:

FIG. 1 is a perspective view of the insert;
FIG. 2 is a partial section view of the insert inserted in a handle.

DESCRIPTION OF THE PREFERRED EMBODIMENT

As illustrated in FIGS. 1 and 2 the present invention comprises a plurality of magnetostrictive plates or reeds 1 connected at one end of a joining stem 2, the other end of which is connected to a treatment instrument 3. A hollow case or sleeve 4 extends over the end of the joining stem 2 at which the magnetostrictive reeds 1 are connected. An orifice 8 is one of a plurality of orifices through the side of the hollow case 4 in the region of the end where the magnetostrictive reeds 1 are connected. The hollow case 4 is juxtaposed a hollow body 5, through which the joining stem 2 extends, with an exit channel 10 on its side. An instrument holder 2a is fixed to an opposite end of the joining stem 2 from the magnetostrictive reeds 1. The instrument 3 is fixed to the instrument holder 2a by means not shown. Although the instrument 3 is rigidly fixed to the instrument holder 2a so as to render it coactive therewith, the means fixing the instrument 3 thereto allow the instrument 3 to be removed and to be laterally shifted parallel to the axis of the joining rod 2. A flexible tubing 11 extends from the exit channel 10 of the body 5 to an end of the instrument 3a adjacent the instrument holder 2a.

The insert is illustrated in FIG. 2 inserted into a handle 6. The hollow case 4 carries a toroidal member or
3 O-ring 4a which supports the handle 6 and insures a tight fit between the insert and the handle 6. The insert is inserted into the handle 6 so as to block the opening 6a. The toroidal member 4e establishes one end of an interior zone 13 in the hollow handle 6.

A fluid channel 7 is attached to an opening in an end of the hollow handle 6 opposite the magnetostrictive reeds 1. The fluid channel 7 contains wires carrying electric power to a solenoid not shown in the figures, surrounding the magnetostrictive reeds 1. The electric power delivered to the solenoid is time varying at an ultrasonic frequency, and develops an alternating magnetic field in the solenoid alternating at the same frequency as the electric power. This alternating magnetic field causes the magnetostrictive reeds 1 to vibrate at ultrasonic frequencies. These ultrasonic mechanical vibrations propagate through the joining stem 2 to the treatment instrument 3 which then vibrates at ultrasonic frequencies.

An important feature of this invention is the treatment instrument 3 which is formed like a slender needle, hollow along its longitudinal axis. At one end of the instrument 3 its body flares out into a bulge 12 in which an orifice 12a establishes a communication between the interior of the needle and the exterior. When used for the disintegration of kidney stones the instrument 3 may be in the form of a needle with a diameter of approximately 0.8 millimeters and approximately eight to ten centimeters long.

The operation of the invention can best be understood by following a description of the fluid flow path through the instrument. The fluid is supplied by a reservoir to a pump, not shown, which pumps the fluid through the fluid channel 7 in a direction indicated by the arrow 14. The fluid flows into the handle 6 in a direction indicated by arrow 15, envelops the magnetostrictive reeds 1, and fills the interior zone 13 of the handle 6. The orifice 8 provides a flow path for the fluid through the hollow case 4 into the interior chamber 9 of the body 5, and through the exit channel 10 of the body 5. The flexible tubing 11 provides a flow path from the exit channel 10 into the treatment instrument 3. The fluid flows through the hollow in the instrument 3 and out the orifice 12a in the direction of the arrow 16. Because the instrument 3 is provided with a bulge 12 the fluid is atomized as it passes through the orifice 12a.

Thus in the embodiment of the invention cooling of the insert is realized by immersing it in a flow of fluid, cavitation is developed in the fluid when it is applied to the region of the patient under treatment, active fluids can be applied directly to the region under treatment, and the treatment instrument is constructed to allow it access to heretofore inaccessible regions. It is to be understood that the invention is not limited to the embodiment described herein but that alternate embodiments may include variations from the embodiment disclosed herein and still be within the scope of the invention. For instance one variation would include several orifices 8 in the case 4 and several orifices 12a in the bulge 12. According to another variation, the treatment instrument 3 is not parallel to the joining stem 2 but is fixed with its longitudinal axis making some angle with the longitudinal axis of the stem 2.

One embodiment of the invention found to be effective was constructed using magnetostrictive reeds 1 approximately twenty six hundredths of a millimeter thick, 90 millimeters long and 4 and 7500 millimeters wide and made of nickel. The needle 3 and the joining stem 2 were both made of an unoxidizable metal "INOX 18.08" (French Trade Mark). The diameter of the bulge 12 was 1 millimeter, the internal diameter of the needle 3 equalled the internal diameter of the bulge 12 and the orifice 12a in the bulge 12 was circular. An electric current having a frequency on the order of 25 kilohertz was used to energize the solenoid.

What I claim and desire to secure by letters patent is:
1. A medical device for applying ultrasonic vibrations to a patient which comprises a hollow handle, an insert supported in said handle, said insert comprising an ultrasonic vibration generator inserted in said handle, a treatment instrument comprising a slender needle provided with a bore passing along its longitudinal axis defining a fluid flow path for flowing a fluid therethrough, said vibration generator having a joining stem protruding from said handle for coactively joining said ultrasonic vibration generator in use to said treatment instrument for applying ultrasonic vibrations developed by said generator to a patient, said treatment instrument having one end bulged with an outlet orifice communicating with said bore for inducing cavitation in said fluid when discharged through said outlet orifice, said hollow handle defining a fluid flow path for delivery of said fluid to said ultrasonic vibration generator to cool said ultrasonic vibration generator, a flexible tubing connected between said flow path in said handle and said flow path in said treatment instrument, and said flow of fluid passing through said bulge and having cavitation induced therein by said bulge in order to reinforce said ultrasonic vibrations.

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