United States Patent

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[54] **METHOD FOR CRUSHING STONES IN URINARY BLADDER AND INSTRUMENT FOR SAME**
4 Claims, 2 Drawing Figs.

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[51] **Int. Cl.** **A61b 17/00**
[50] **Field of Search** ..... 128/328, 311—312, 319, 341, 49, 353, 6, 2.1, 4, 412, 414, 417, 405, 408, 421, 23, 303, 303.14, 24.05

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ABSTRACT: A method for crushing stones in the urinary bladder comprises successive multiple mechanical actions on the stone to be crushed by a working organ vibrating at ultrasonic frequency and hydraulic impacts formed by electrical discharge in the liquid medium which surrounds the stones. An instrument for effecting the method comprises elongated flexible ultrasonic and electrohydraulic lithotrites and respective ultrasonic drive means and electrical pulse means for exciting the lithotrites which have uniform systems of groundings and remote control.

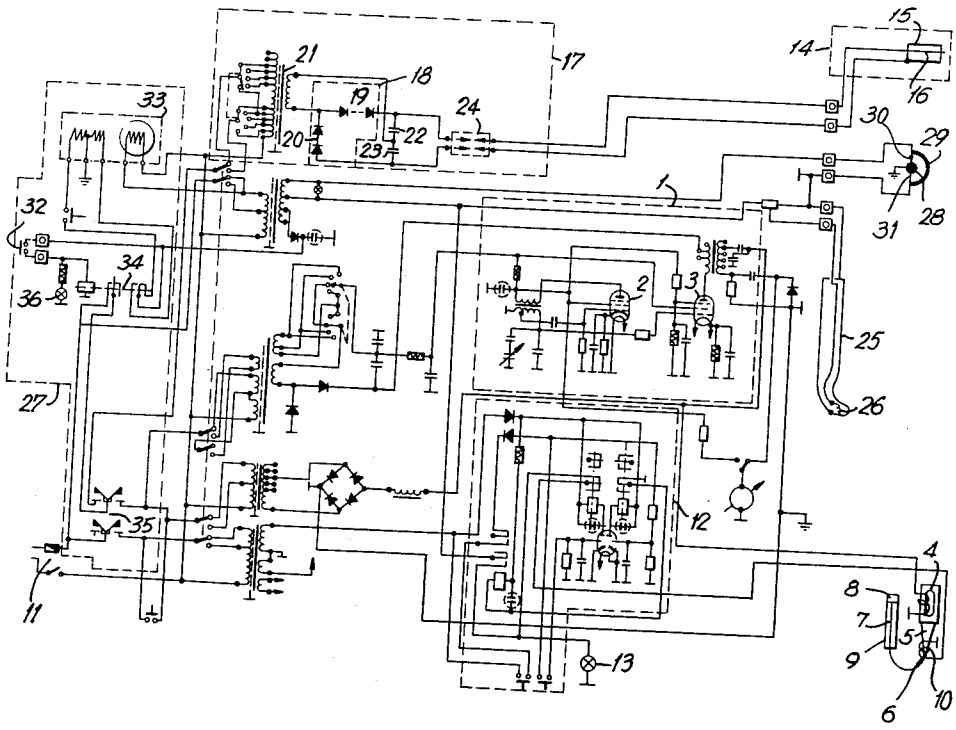
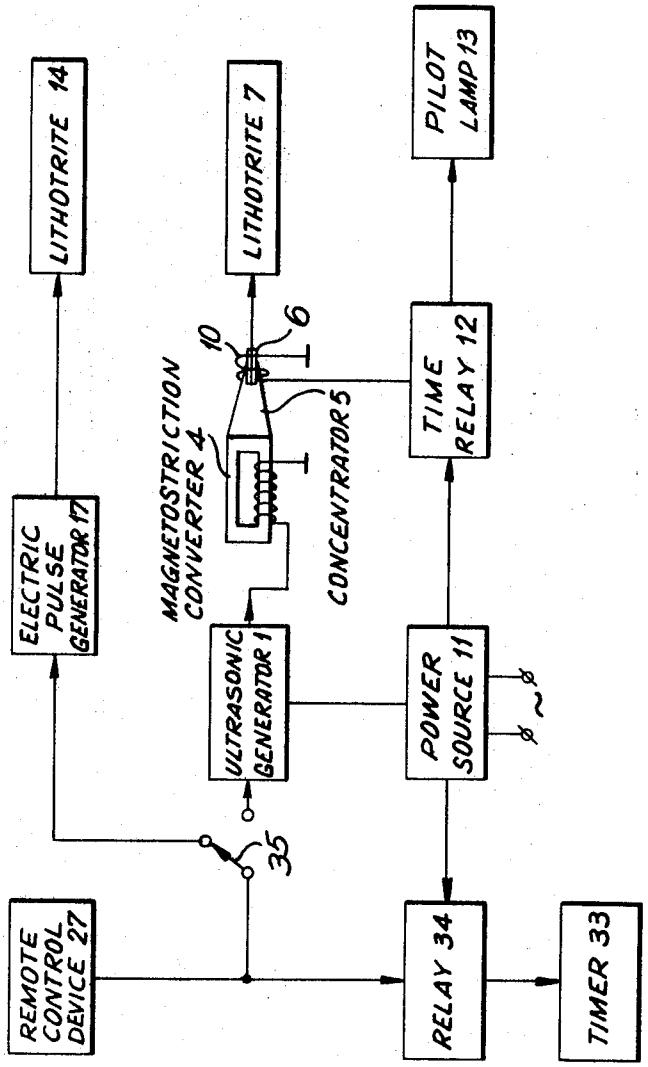


FIG. 1


LITHOTRITE 14
LITHOTRITE 7
PILOT LAMP 13
10
6
MAGNETOSTRICTION CONVERTER 4
CONCENTRATOR 5
TIME RELAY 12
ELECTRIC PULSE GENERATOR 17
ULTRASONIC GENERATOR 1
POWER SOURCE 11
35
REMOTE CONTROL DEVICE 27
RELAY 34
TIMER 33

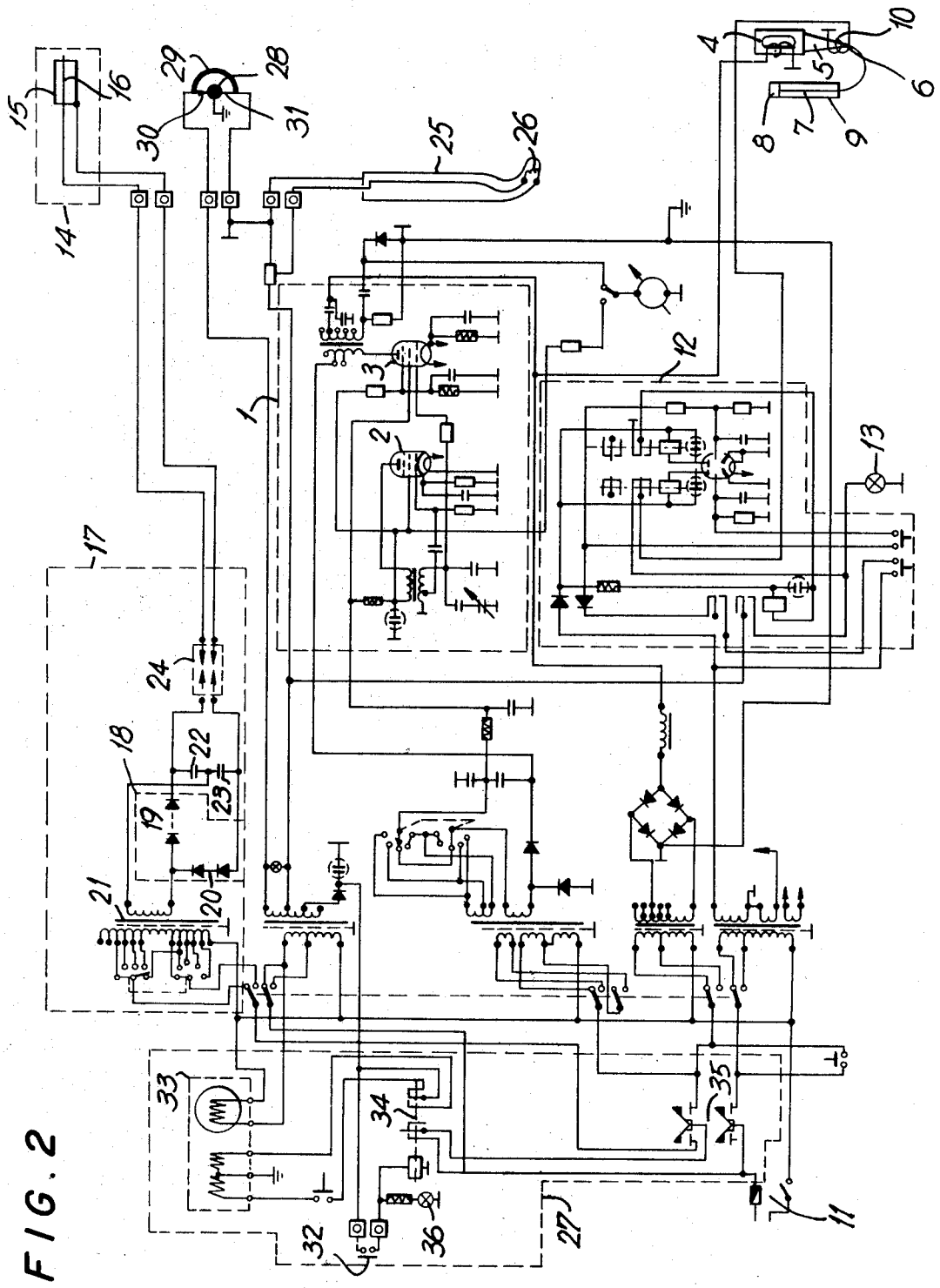

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FIG. 2

METHOD FOR CRUSHING STONES IN URINARY BLADDER AND INSTRUMENT FOR SAME

This invention relates to methods and instruments for crushing concretions in the urinary ducts, and more particularly, it relates to the methods and instruments for crushing concretions in the urinary bladder.

Methods are known wherein stones in the urinary bladder are reduced in size by mechanical crushing for which purpose such mechanical means as lithotrites and cystolithotrites are used. The substantial drawback of these instruments is that they cannot break stones larger than 20 mm. in diameter, are not sufficiently safe in use and besides they are not applicable in constricted spaces of small urinary bladders.

Attempts have been made to use instruments for crushing concretions in the urinary bladder which employ ultrasonic oscillations supplied to the working organ introduced in the urinary bladder to contact the concretion to be crushed.

However, these methods and instruments proved of little or no effect in crushing stones of varying structure and size and in case s cases when their number is great.

Therefore it is an object of the invention to develop a method for effectively crushing stones of various structure and size, whatever their number in the urinary bladder may be.

Another object of this invention is to provide an operation and which allows crushing of concretions in the urinary bladder by the said method.

The principal object of the invention is to develop a method for crushing concretions in the urinary bladder and to provide an instrument for realization of this method which would exert, on the stone to be crushed, remotely controlled actions varying in their character and intensity.

To achieve said principal object according to the invention, the method for crushing stones in the urinary bladder consists in that the concretion to be broken is acted upon alternately by mechanical oscillations of ultrasonic frequency and a controlled hydraulic impact produced by an electric discharge in the liquid medium surrounding the concretion. An instrument for crushing concretion by said method comprises, according to the invention, elongated elastic lithotrites, which are introduced into the urinary bladder through the operating cystoscope, one of which lithotrites is connected with the drive means producing mechanical oscillations at predominantly ultrasonic frequency, the other of said lithotrite being made in the form of coaxial insulated electrodes and coupled to a pulser means, said drive means and pulser means being operatively connected with a remote control device provided with a selector switch by which the required kind of operation is set and a timer by which the time of operation of each of said means is recorded.

The drive means preferably comprises a generator of ultrasonic oscillations, series connected with a remote control device through a grounding system which is connected with the cystoscope illuminating lamp supply circuit, a converter of electric oscillations to mechanical ones, and with a concentrator of mechanical oscillations, said concentrator being connected with the lithotrite which is provided at its end with a working organ in the form of a hollow cylinder having a side bypass opening.

Said pulser means consists mainly of pulse-forming dischargers connected with the lithotrite electrodes and an accumulating device with capacitors, supplied for instance from a power transformer, which is connected with a remote control device through the grounding system connected with the cystoscope illuminating lamp supply circuit.

The invention will be described in greater detail hereafter with respect to the accompanying drawings in which:

FIG. 1 is a diagrammatic illustration of the instrument for crushing stones in the urinary bladder; and

FIG. 2 is an electric circuit diagram of the instrument shown in FIG. 1.

For effective crushing of stones or concretions in the urinary bladder they are first subjected to the mechanical effect of a member, oscillating predominantly with an ultrasonic

frequency which results in the formation of primary defects in the stone surfaces such as cavities, cracks, grooves and the like. Then an electric discharge is effected in the liquid medium surrounding the stone, produce a controlled hydraulic impact as a result of which the stone is split into fragments which are subsequently crushed into minute removable fractions.

In the process of crushing very resistant stones ultrasonic oscillations and electrohydraulic impacts can be arbitrarily alternated several times.

The instrument for crushing stones in the urinary bladder (FIGS. 1 and 2) comprises a generator 1 or ultrasonic oscillations employing tubes 2 and 3, a magnetorestriction converter 4 of the electric oscillations to ultrasonic mechanical oscillations and an exponential concentrator 5 of said mechanical oscillations, said generator, converter and concentrator being connected in series.

The output of concentrator 5 is connected by means of a low-melting link 6 with an elongated elastic lithotrite 7 carrying at its end a working organ 8 which comes into contact with the stone to be crushed.

The working organ 8 should preferably be made in the form of a hollow cylinder with a lateral bypass opening. The shank of the working organ 8 and a portion of the lithotrite are enclosed in a hermetic protective catheter 9 tightly attached to the working organ 8.

The low-melting link 6 is enveloped with an with an electric heating element 10 supplied from a power source 11 and controlled from a time relay 12 connected with a pilot lamp 13. This allows interchange lithotrites. As soon as power is supplied to the heater 10, the low-melting link 6 melts and the time relay 12 cuts off power supply.

The instrument has also another lithotrite 14 with two coaxial electrodes 15 and 16 insulated from each other.

Lithotrite 14 is connected with the electric pulse generator 17 comprising rectifier 18 assembled in accordance with a doubling circuit employing semiconductor elements 19, 20 and supplied form a power transformer 21.

To the rectifier 18 is connected an accummulating device with capacitors 22 and 23 whose charge is transmitted to the pulse-forming dischargers 24 made, for example, as two tungsten cylinders having plane-parallel discharge surfaces.

Electric pulses from dischargers 24 pass to electrodes 15, 16 between the insulated ends of which an electric arc is formed as a result of which a shock wave is produced in the liquid medium surrounding the stone. To obtain a shock wave of a required form and direction, the mutual position of the ends of electrodes 15 and 16 can be arranged either in the same plane or in different planes.

Said lithotrites 7 and 14 are introduced into the urinary bladder through an operative cystoscope 25 having an illuminating lamp 26.

Generator 1 of ultrasonic oscillations and electric pulse generator 17 are associated with a general remote control device 27 through a grounding system connected with illuminating lamp 26 of cystoscope 25.

The grounding system has a grounding busbar 28 to which a semiannular clamp 29 is attached by means of two pins, viz. a stationary pin 30 insulated from the clamp 29 and a pin 31 connected with the clamp 29 by means of the thread. One of wires supplying power to the lamp 26 is so shorted through the grounding busbar 28 that the lamp 26 goes out when there is no contact in the grounding circuit. This will provide for the safety of operating with the instrument.

A remote control device 27 comprises a foot pedal 32, time recording unit or timer 33, actuated by an electromechanical relay 34 and a selector switch 35 which sets the required mode of operation.

After the instrument is switched on by means of the foot pedal 32, a red pilot lamp 36 is lighted and the electromechanical relay 34 operates switch on the time recording unit (electric stopwatch) 33. Simultaneously, depending on the position of the selector switch 35, either the generator 1 of ultrasonic oscillations or the pulser 17 starts working together with either lithotrite 7 or 14 respectively.

The process of stone crushing is controlled visually through cystoscope 25. Stone structure and size determine the choice of action.

By alternating ultrasonic and hydraulic actions on the stone and by changing the duration of such actions, stones in the urinary bladder can be effectively crushed.

I claim:

1. A method for crushing stones in the urinary bladder, comprising alternately applying mechanical action to a stone to be crushed by a working element vibrating at ultrasonic frequency and applying hydraulic impact by producing electrical discharges in a liquid medium surrounding the stone to be crushed.

2. An instrument for crushing stones in the urinary bladder in combination with an operative cystoscope having an illuminating lamp with power supply and comprising elongated lithotrites adapted for being introduced into the urinary bladder through said cystoscope to contact the stone to be crushed; one of said lithotrites being capable of transmitting ultrasonic oscillations for crushing the stone; the other lithotrite having coaxial electrodes and separating insulating material, drive means for generation and conversion of electrical oscillations into mechanical ultrasonic oscillations and their transmission to the first lithotrite; an electrical pulser means connected to said other lithotrite for producing electrical discharges between end faces of said coaxial electrodes in the liquid medium of the urinary bladder to cause the formation of hydraulic impacts crushing the stones; remote control means for said drive and electric pulser means, said remote control means including a selector switch, an operating time register for each of said drive means and said electric pulser means and means for turning the registers on and off successively and a grounding circuit connected to the power supply circuits of said cystoscope lamp and to said means for turning the registers on and off.

3. An instrument for crushing stones in the urinary bladder in combination with an operative cystoscope having an illuminating lamp with power supply and comprising two elongated lithotrites adapted for being introduced alternatively into the urinary bladder through said cystoscope to contact the stone to be crushed; the first lithotrite including at one end thereof a working element in the form of a hollow cylinder with a bypass opening, and a protective waterproof sheath on said cylinder capable of transmitting an ultrasonic vibration which crushes the stone, the second lithotrite including coaxial electrodes insulated the entire length up to the end face surfaces thereof by an insulation material with substantial electrical and impact strength; a drive means for imparting to the first lithotrite mechanical strength ultrasonic oscillations, said drive means comprising a generator of electric oscillations, a converter of electric oscillations into ultrasonic mechanical oscillations connected in series with said generator, a concentrator of mechanical oscillations connected to said converter and to the first lithotrite; an electric pulser means connected to the second lithotrite for producing electrical discharges between the end faces of said coaxial electrodes in the liquid medium of the urinary bladder to cause the formation of hydraulic impacts for crushing of the stone; remote control means for said drive means and said electrical pulser means, said remote control means including a selector switch, an operating time register for each of said drive means and said electrical pulser and means for turning said registers on and off successively, and a grounding circuit connected to the power supply circuits of said cystoscope lamp and to said means for turning said registers on and off.

4. An instrument for crushing stones in the urinary bladder in combination with an operative cystoscope having an illuminating lamp with power supply, and comprising two elongated lithotrites adapted for being introduced alternatively into the urinary bladder through said cystoscope to contact the stone to be crushed; the first lithotrite including at an end thereof a working element in the form of a cylinder with a bypass opening, and a protective waterproof sheath capable of transmitting ultrasonic vibratory impacts for crushing the stone, the second lithotrite having coaxial electrodes insulated the entire length thereof up to the end face surfaces by insulation material with high electric and impact strength; a drive means for imparting mechanical ultrasonic oscillations to the first lithotrite, said drive means comprising a generator of electrical oscillations, a converter of electrical oscillations into mechanical ultrasonic oscillations connected in series with said generator, a concentrator of mechanical oscillations connected to the first lithotrite by means of a fusible welding alloy; an electrical electrical pulser means comprising a series-connected rectifier, an accumulating means with capacitors and at least two pulse shaping dischargers connected to said electrodes of the second lithotrite for producing between their end faces electric discharges in the liquid medium of the urinary bladder to cause the formation of hydraulic impacts for crushing the stone; remote control means for said drive means and said electrical pulser means, said remote control means including a selector switch, an operating time register of each of said drive means and said electrical pulser means and means for turning said registers on and off successively; and a grounding circuit connected to the power supply circuits of said cystoscope lamp and to said means for turning said registers on and off, said grounding circuit including a hand screw having two stems insulated from each other and affixed on a grounded collecting bar.