A duplex electro-ultrasonic medical therapy apparatus comprising a pair of ultrasound generators connected to a common power source and keyed by a duplex keyer circuit, the output of which is connected to a transducer which converts the electrical oscillations into mechanical vibrations for application to the patient's body to administer the ultrasonic medical therapy treatment. The apparatus also comprises an integrated electrical pulse generator having outputs connected to a pair of conductive pads to supply electrical muscle stimulation to the patient's body simultaneously with the ultrasound treatment. The electrical pulse generator further serves as a driving function for the ultrasound duplex keyer circuit.

13 Claims, 9 Drawing Figures
Fig. 1

Fig. 2

Fig. 3

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Fig. 7
DUPLEX ULTRASONIC GENERATOR AND COMBINED ELECTRICAL MUSCLE STIMULATOR

This invention relates to improvements in electrotherapy apparatus and more particularly, but not by way of limitation, to a combination dual low voltage electrical generator co-acting with dual ultrasonic generators to provide simultaneous synchronized dual electrical pulse stimulation and dual ultrasonic medical treatment.

The use of a combination of electrical muscle stimulation and ultrasonic therapy is well known in medical science as disclosed in the Mark E. DeGroff U.S. Pat. No. 2,830,578, issued Apr. 15, 1958. However, heretofore the apparatus used in this application has comprised a single ultrasound head thereby limiting the treatment to only one area of the patient's body at a given time. Most muscles of the human body, to effect a given movement, have opposing muscles to effect an opposite movement. While the first mentioned set of muscles are being treated by a single ultrasound unit, the opposing muscles thereto are "antagonistic" to the muscle being treated, and hence the treatment loses effectiveness by the adverse reaction of the opposing muscles to the ones being treated. The nerve controlling the painful area of the patient to be treated is often remotely located with respect to the actual pain and hence the simultaneous use of the conductive electrode pads of the electrical muscle stimulator should be applied at that remote location and can not be used effectively to provide relief to the opposing or "antagonistic" muscles to those being treated directly by the ultrasound unit.

The present invention contemplates a dual electro-ultrasonic apparatus designed and constructed to overcome the above disadvantages. The ultrasound portion of the present invention comprises two ultrasonic oscillators, having built-in amplifiers or keyed power oscillators. The output of these amplifiers or oscillators drive two ultrasonic transducers which are used to convert the electrical oscillations into mechanical vibrations to effect the ultrasound treatment. The two ultrasound oscillators are connected to a common power supply and to dual keyer circuits to provide independent operation whereby the pulses emitted are alternately produced by each respective oscillator and are spaced by equal rest periods between the pulses. The two units may thus be simultaneously utilized to effectively treat opposing muscles without interference between said units. The present invention also combines the ultrasound application with the low voltage electrical muscle stimulator to produce simultaneously, superimposed synergistic action of the ultrasound and electro-therapy combined. Further, when there is no problem in the ultrasonic treatment of opposing "antagonistic" muscles, the two ultrasound units may be used simultaneously to cover a greater treatment area thereby greatly reducing treatment time.

It is an important object of this invention to provide a novel duplex electro-ultrasound apparatus for producing simultaneously, dual superimposed synergistic action of combined ultrasonic and electro-therapy.

It is another object of this invention to transmit through each of two single ultrasound applicators both a low voltage current and an ultrasound radio frequency for producing improved therapeutic action.

It is still another object of this invention to provide a duplex electro-therapy and dual ultrasound medical therapy apparatus in one compact and portable unit.

Another object of this invention is to provide a medical therapy unit wherein a plurality of detector pad members and a pair of sound head applicators are electrically grounded to a common ground for producing dual, co-acting electrical stimulation and mechanical vibrations for patient treatment.

And a still further object of this invention is to provide a novel medical therapy apparatus wherein the dual, co-acting electrical and mechanical stimulations may be automatically timed and controlled to provide predetermined treatment dosage for patient treatment.

Other and further objects and advantageous features of the present invention will hereinafter more fully appear in connection with a detailed description of the drawings in which:

FIG. 1 is a schematic diagram of the elements embodied in the invention depicting the functional relationship of said elements.

FIG. 2 is a schematic diagram of the electrical pulse generator device depicting the keying function of the dual ultrasonic unit and the generation of the electrical muscle stimulation pulses.

FIG. 3 is a schematic diagram depicting the functional relationship between the dual ultrasonic treatment heads and the electrical muscle stimulator pads.

FIG. 4 is an electrical circuit diagram of the electrical pulse generator circuitry.

FIG. 5 is an electrical circuit diagram of the alternate pulse controller network and keyer circuits for the ultrasound units.

FIG. 6 is an electrical circuit diagram of an ultrasound generator network.

FIG. 7 is an electrical circuit diagram of the common power control network for the ultrasound generator and the keyers.

FIG. 8 is an electrical circuit diagram of the power supply and central control circuitry.

FIG. 9 is a schematic diagram depicting the gating of the ultrasound generator output.

Referring to the figures in detail, reference character 10 generally indicates a duplex ultrasound generator and combined electrical muscle stimulator for administering ultrasonic and electro-medical therapy treatment. The medical therapy apparatus 10 specifically comprises a first and second sound head applicator 12 and 14, each of which are operably connected to a pair of radio frequency ultrasound generators 16 and 18, respectively, to provide sound waves for producing mechanical vibration in the sound head applicators 12 and 14 in a manner as will be hereinafter set forth. The medical therapy apparatus 10 also comprises a first and a second of electrode pad means 20 and 22 which are operably connected to a low voltage electrical muscle stimulator generator generally indicated by reference character 24 which produces interrupted modulated current in either a "pulsed" mode of operation or a "surge" mode of operation, in a manner as will be hereinafter set forth.

Reference character 26 generally indicates a common power supply for the medical therapy apparatus 10. The electrical input power for the apparatus 10 is supplied by connection of the power supply 26 to any suitable common alternating current line (not shown) with voltage preferably ranging from 100 to 125 volts.
AC with frequency between 50 and 60 cycles. The power supply unit 26 may be connected with the line voltage by means of a suitable plug member 28 (FIG. 8) and the input power is supplied to the power supply 26 through a suitable line filter 30 to prevent any radio frequency interference back into the power line.

The input power line is protected by suitable current limiting devices 31 and 33 connected in series with the input windings of the power transformers T4 and T5, respectively. A timer device 35 is also connected in series with the input power to provide for predetermined application dosages of the ultrasound and electrotherapy treatment.

Referring particularly to FIG. 4, which is an electrical circuit diagram of the electrical pulse generator 24, the transistor Q1 and its associated components represents a blocking oscillator 32 which generates electrical impulses which are used to provide the electrical muscle stimulation voltages in a manner as will be hereinafter set forth. The frequency of these electrical impulses is controllable by the variable resistor R1 (FIGS. 2 and 8) for varying the RC time constant in the base of the transistor Q1. The output of this blocking oscillator 32 is connected to a blocking oscillator transformer T3 (FIG. 8) which is used to couple the output voltages from the pulse generator 24 to a first electrode pad jack 21 and a second pad jack 23 for connecting the electrical pads 20 and 22 respectively thereto, and simultaneously to the alternate pulse control network, depicted in FIG. 5, through the secondary output windings S1 and S2, respectively, of the transformer T3. The amplitude of the blocking oscillator impulses is controllable by a variable resistor R2 (FIG. 8) which is operably connected across the output winding S1 of the transformer T3. It is readily apparent that by means of the two output windings S1 and S2, electrical pulses identical in frequency to the stimulation voltages are supplied to the alternate pulse control network (FIG. 5) through a coupling transformer T2. The blocking oscillator 32 also comprises a voltage supply circuit and two control transistors Q2 and Q3 and their associated components (FIG. 4). As hereinbefore set forth, the electrical pulse generator 24 may be operated in a pulse mode or in a surge mode. The mode selection is accomplished by a switching means SW1 (FIG. 8). The switch SW1 is a six-pole triple-throw switch which may be set in a first position for a pulse mode of operation, hereinbefore set forth, or a second position for a surge mode of operation wherein a standard astable multivibrator 34 (FIG. 4) is coupled to the blocking oscillator power control transistors Q2 and Q3 which in turn supply voltage to the blocking oscillator transistor Q1. The blocking oscillator 32 thus produces a series of output surges each being followed by an equal rest period. The repetition rate of these output surges for this particular application is variable from approximately one second on and one second off to six seconds on and six seconds off, by means of a rheostat R3 (FIG. 8). The astable multivibrator 34 is comprised generally of transistors Q4, Q5, the unijunction transistor Q6 and their associated components (FIG. 4). The third position of the switch SW1 is for operation of the ultrasound generator in a continuous mode in a manner as will be hereinafter set forth.

When the switch SW1 is positioned in with the pulse or the surge mode the output impulses or surges from the blocking oscillator 32 are supplied to the alternat-
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provided by the multivibrator 40. It is readily seen that these output pulses alternate in response to each input pulse provided by the blocking oscillator circuit 32. The standard output pulse from the multivibrator 42 is provided as an input to a first ultrasound keyer circuit 46 which comprises two P-N-P transistors Q17 and Q18 and their associated components (FIG. 5). The multivibrator 44 likewise provides an automatic standard pulse output to a second ultrasound keyer circuit 48 which comprises two P-N-P transistors Q19 and Q20, and their associated components (FIG. 5). Each of the keyer circuits 46 and 48 provide positive voltage output pulses for each keying pulse from the monostable multivibrators 42 and 44, respectively. For this particular application, each keyer output pulse is approximately 6.6 milliseconds in duration and 32 volts in amplitude.

The output pulses provided by the keyer circuit 46 is coupled to an oscillator and buffer circuit 51 of the first ultrasonic generator 16 (FIG. 6). The oscillator and buffer circuit 51 comprises two N-P-N transistors Q21 and Q22 and associated components. Likewise, the alternate output pulse provided by the keyer circuit 48 is coupled to a substantially identical oscillator and buffer circuit (not shown) of the second ultrasound generator 18. Each ultrasound generator 16 and 18 produces an output pulse equal in duration (6.6 milliseconds) to the input pulse from the keyer circuits 46 and 48 and of a frequency of approximately 1 megahertz, for this application. As pointed out, these output pulses alternate between the ultrasound generators 16 and 18 so that they do not produce outputs simultaneously. The amplitude of the ultrasound generator output pulses are simultaneously adjustable by means of a potentiometer R4 (FIG. 8) which adjusts the voltage supplied by an output collector circuit 52 of the ultrasound generator 16; and a second substantially identical output collector circuit (not shown) of the ultrasound generator 18. The output collector circuit 52 comprises an N-P-N transistor Q23 and its associated components which provides the 1 megahertz output through the output coupling transformer T6. It is again noted that the ultrasound generator 16 circuitry depicted in FIG. 6 is duplicated for the ultrasound generator 18. The output from the ultrasound generator 16 is provided to a first ultrasound applicator jack 54 (FIG. 8) and the output from the ultrasound generator 18 is provided to a second ultrasound applicator jack 56 (FIG. 8) for use with the ultrasound applicators 12 and 14, respectively. Referring to FIG. 1, each sound head applicator is provided with a crystal or ceramic type transducer 53 and 55, respectively, when provided with the ultrasound radio frequencies from the ultrasound generators 16 and 18, are resonated at their natural frequencies. In this applications, the transducers 53 and 55 are constructed to vibrate only at the frequency of approximately 1 megahertz. Although it is readily seen that the outputs of the ultrasound generators 16 and 18 are equal since equal voltages are applied to each collector circuit 52, two separate ultrasound intensity meters 57 and 59 are provided so that the output of each ultrasound generator may be observed separately.

When the ultrasound is operated at low duty cycle levels, the ultrasound intensity meters 57 and 59 do not indicate the peak ultrasound power (the meter circuit being a R.M.S. type measuring device). The dosage preset switch SW6 and a dummy load consisting of an adjustable resistor R6 and a capacitor C4 have been provided to permit the therapist to set the treatment dosage to a desired level without the necessity of artificially loading the vibrating transducers 53 and 55. By actuating the push button switch SW6, the dummy load resistor R6 (which has been previously calibrated) is substituted for the transducer 55 and simultaneously switches the blocking oscillator to the rapid or "tetanizing" pulse mode of operation. Further, the blocking oscillator voltage is removed from the electrode pads to prevent any unpleasantness to the patient due to unexpected changes in stimulation level. By this means, and by the use of the ultrasound intensity control R4, the treatment dosage may be set at any desired peak power level. This present peak power will then be produced in each ultrasound impulse even through the duty cycle is quite low.

A two-pole single-switch switch SW4 (FIG. 8) is provided wherein the first-mentioned ultrasound generator 16 may be switched off independently of the second ultrasound generator 18 by interrupting the keyer circuit 48 output to the oscillator buffer circuit of the ultrasound generator 16. It should be noted that when the selector switch SW1 is in the "continuous" position (as shown) the ultrasound generator 16 is automatically switched off and the ultrasound generator 18 is keyed to produce continuous ultrasonic energy of 1 megacycle frequency as distinguished from the pulse and surge modes of operation described above.

Referring to FIGS. 1 and 8, the circuitry is so arranged to provide stimulation voltage from the blocking oscillator circuit 32 directly to the two ultrasound applicators 12 and 14 through the connector jacks 54 and 56, respectively. As stated above, the amplitude of the blocking oscillator voltage is adjustable by means of the potentiometer R2 and the frequency thereof is controllable by the potentiometer R1.

Since pulsed ultrasound at a low duty cycle rate and high peak power may be applied to a patient with the ultrasound transducers strapped in place, without danger of tissue damage or peristomal pain, it may readily be seen that inadvertent switching to continuous, by means of SW1, or 100 percent duty cycle ultrasound would be very undesirable inasmuch as serious discomfort and even injury to the person under treatment could result.

To prevent this type of accident, a safety circuit, as generally indicated by reference character 61, has been devised. This circuit 61 is comprised of a portion of six-pole three position selector switch SW1, the relay RY1 and the push button switch SW5. It may be seen that when the selector switch SW1 is rotated to the "continuous" position that even though the ultrasound power switch SW3 is in the "on" position, no power will be supplied to the primary of the ultrasound power transformer TS, unless the push button switch SW5 is momentarily depressed to actuate the relay RY1. RY1 will not remain closed unless the ultrasound power switch SW3 is in the "on" position. Further, de-energizing the relay due to any cause necessitates resetting by means of SW5, thus obviating the possibility of inadvertently leaving the unit in the "on" position.

Further, in the continuous position the stimulator is simultaneously turned off by means of RY1. This is to serve as an indicator to the therapist that no ultrasound is being produced (ultrasound being sensationless at therapeutic dosage levels) because there will be no
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electrical muscle stimulation either. The electrical muscle stimulation is felt quite plainly by the patient and may also be observed by the therapist. Therefore, inadvertent failure to energize the ultrasound would be apparent immediately to both the patient and the therapist.

A single-pole single-throw switch SW2 (FIG. 8) is provided whereby the electrical power may be interrupted between the power transformer T4 and the timer T5 thereby cutting off the power to the electrical muscle stimulation generator 24. A two-pole single-throw switch SW3 is also provided whereby the electrical power may be interrupted between the power transformer TS and the line input power thereby cutting off power to the ultrasound generators 16 and 18. It is readily seen that the electrical muscle stimulation generator 24 may be operated independently of the ultrasound generators 16 and 18 by positioning the switch SW2 in the closed position and the switch SW3 in the open position.

A single ultrasound generator power supply 50 is provided to supply electrical power for the ultrasound generators 16 and 18. The power supply 50 utilizes two silicon controlled rectifiers (SCR), SCR1 and SCR2, in a typical single phase center-tip phase-controlled rectifier. By varying the rheostat R4 the DC voltage across the load can be continuously adjusted from its maximum resistance value down to zero. As in the AC phase-controlled switch a single unijunction transistor Q24 is used to develop a gate signal to fire both SCR's in an alternate half-cycles. Whichever of the two SCR's has positive anode voltage at the time the gate pulse occurs will fire, thus applying voltage to the load for the remainder of the half-cycle. The firing angle can be adjusted by means of the rheostat R4. In this application, at 60 Hertz, the firing angle of this circuit can be varied from approximately 10° to 180° (fully off).

It should be noted that the electrical circuitry depicted in FIGS. 4 through 8 may be constructed as one complete integrated circuit or as separate disconnectable modules as shown. As shown in the drawings, each of the circuit modules, FIGS. 4 through 7, are connected to the power supply and control circuitry depicted in FIG. 8, in a manner as follows:

The electrical pulse generator circuitry (FIG. 4) is connected to the circuitry of FIG. 8 by means of a common connector J4 having pin connections 1 through 7. The circuitry of FIG. 5 is connected to the circuitry of FIG. 8 by means of a common connector J5 having pin connections 1 through 7. The circuitry of FIG. 6 is connected to that of FIG. 8 by a common connector J6 having pin connections 1 through 7. The second ultrasound generator 18 circuitry (not shown) which is substantially identical to that of FIG. 6 is connected to the circuitry of FIG. 8 by a common connector J6a having pin connections 1 through 7. The circuitry of FIG. 7 is also connected to the circuitry of FIG. 8 by means of a common connector J7 having pin connections 1 through 11.

It is readily apparent that the dual alternating ultrasound treatment could be effected by the utilization of only one ultrasound generator 16a by suitable gating in conjunction with the bistable multivibrator 40. This could be accomplished by the use of two high power capacity "and" gates 67 and 69 (FIG. 9). The output of the single ultrasound generator 16a would be present simultaneously as an input to each "and" gate. The other input to the first "and" gate 67 would be provided by the first output from the bistable multivibrator 40 such that the ultrasound signal would be allowed to pass through the first "and" gate 67 only when the bistable multivibrator 40 is in its first state. The second input to the second "and" gate 69 would be provided by the second output from the bistable multivibrator 40 such that the ultrasound signal would be allowed to pass through said second "and" gate 69 only when the bistable multivibrator 40 is in its second state. Since the bistable multivibrator 40 (flip-flop) can be only in one state at a single instant in time, the ultrasound signal would necessarily alternate between the output of the first "and" gate 67 and the second "and" gate 69. The problem with this arrangement at the present time is the inability to obtain commercially available reliable components for the "and" gates which have the power capacity required to handle the ultrasound generator output.

OPERATION

In using the duplex electro-ultrasonic medical therapy apparatus 10 in the "pulse" mode of operation, to simultaneously produce a super-imposed synergistic action in patient treatment, the unit is activated by closing the switch SW2. The switch SW3 is then closed to provide electrical power to the ultrasound generators. The switch SW1 is then set in the "pulse" position and the switch SW4 is closed to provide impulses from the keyer circuit 48 of FIG. 5 to the ultrasound generator 16. Before application to the patient, and especially when intending to operate at a low duty cycle level, the switch SW6 should be closed in order to calibrate the ultrasound power level. This feature is provided since the dosage reading meters 57 and 59 (FIG. 8) are R.M.S. type measuring devices and as such do not indicate the peak ultrasound power when operated at a low duty cycle. In closing the switch SW6, the dummy load resistor R6 (FIG. 8) is substituted for the transducer 55 and the stimulator is automatically switched to the rapid pulse (or "tetanizing") mode of operation. At this point, the desired ultrasound intensity level may be adjusted by the rheostat R4. After setting the ultrasound power level to the desired intensity, adjusting to the desired pulse rate by the rheostat R1 and the stimulation voltage level by means of the potentiometer R2, the switch SW6 is opened and the apparatus 10 is ready for patient treatment.

As hereinbefore set forth, the ultrasonic pulses are being produced alternately by each ultrasound unit 16 and 18 and converted to mechanical vibrations by the transducers 53 and 55, respectively. In addition to the ultrasonic vibrations, the circuit is so arranged to simultaneously supply electrical muscle stimulation to the treatment area either through the conductive electrode pads 20 and 22 or in combination with the transducers 53 and 55. As previously mentioned, in addition to supplying ultrasonic energy for treatment, the two ultrasound applicator heads 12 and 14 may be used to simultaneously apply electrical muscle stimulation which effects massage of the musculature for reducing pain, increasing circulation and other therapeutic actions. By using the dual ultrasound heads 12 and 14 simultaneously, one of the heads may be placed on the primary area of the patient to be treated while the other head is placed on the so-called "antagonistic" muscle as hereinbefore set forth.
The use of the duplex ultrasound circuitry to produce interdependent operation of the two ultrasound units allowing only one of the two units 16 and 18 to produce output at a given instant in time, permits effective treatment of twice the normal treatment area while substantially reducing treatment time. Where the use of only one ultrasound head applicator is desired, the switch SW4 may be opened, thereby removing the keying impulses and high voltage from the ultrasound generator 16.

When it is desired to utilize the unit 10 in a surge mode of operation, the selector switch SW1 is set in the "surge" position, and the switch SW6 is temporarily closed for purposes of calibration as set forth in the pulse mode of operation above. As hereinbefore set forth, the surge mode of operation is effected by the astable multivibrator 34 which is coupled to the power controlled transistor Q2 and Q3 which in turn supply voltage to the blocking oscillator 32. The blocking oscillator 32 thus produces output surges followed by equal rest periods. The rheostat R3 is then utilized to set the desired repetition rate of the surges. The use of the unit 10 in the surge mode of operation is similar to that of the pulse mode and it will be apparent that when it is desired to use only one of the ultrasound units in the surge mode, the ultrasound unit 16 may be turned off by using the switch SW4.

It is well known that if large amounts of continuous ultrasonic energy is administered, the patient will suffer not only peristomal pain, but tissue damage as well. Hence, the use of pulsed ultrasound to reduce pain and the possibility of tissue damage is well known. When it is desired to utilize the apparatus 10 in an ultrasound continuous mode of operation, the switch SW1 is set in the "continuous" position and the safety switch SW5 is closed momentarily to actuate the relay RY1. RY1 will not remain closed unless the ultrasound power switch SW3 is in the closed position. Further, de-energizing the relay RY1 due to any cause necessitates resetting by means of the switch SW5, thus obviating the possibility of inadvertently leaving the unit operating in the "continuous" mode. When the relay RY1 is actuated, it is readily seen (FIG. 8) that the blocking oscillator 32 is simultaneously turned off.

From the foregoing it will be apparent that the present invention provides a duplex electro-ultrasonic medical apparatus particularly designed and constructed for producing simultaneously, dual superimposed synergistic action of combined ultrasonic and electrical muscle stimulation therapy by transmission through each of two ultrasound applicators both in low voltage current and ultrasonic mechanical vibrations. The novel duplex electro-ultrasonic medical therapy apparatus is economical and durable in construction and simple and efficient in operation.

Whereas the present invention has been described in particular relation to the drawings attached hereto, it should be understood that other and further modifications, apart from those shown or suggested herein, may be made within the spirit and scope of this invention.

What is claimed is:

1. A duplex electro-ultrasonic medical therapy apparatus comprising in combination a power supply, a pair of ultrasound generators connected to the power supply for producing sound waves, keying means connected to the ultrasound generators for activating said ultrasound generators, a separate sound head applicator for each ultrasound generator and operably connected therewith for converting the sound waves into mechanical vibrations; a low voltage electrical pulse generator connected to the power supply, pulse rate means connected to the pulse generator for varying the frequency of the output pulses from the pulse generator, a pair of electrode pads operably connected to the pulse generator for producing electrical stimulation for electro-therapy, and means connecting said pulse generator and keying means for providing mechanical stimulation alternately in one sound head applicator and then the other sound head applicator simultaneously with the electrical stimulations in each electrode pad.

2. A duplex electro-ultrasonic medical therapy apparatus as set forth in claim 1 wherein each sound head applicator comprises a ceramic transducer for converting the sound waves into the mechanical vibrations, and an electrode operably connected to the electrode pads whereby dual electrical and mechanical stimulation will be produced through each sound head applicator.

3. A duplex electro-ultrasonic medical therapy apparatus as set forth in claim 1 wherein each sound head applicator comprises a crystal transducer for converting the sound waves into the mechanical vibrations, and an electrode operably connected to the electrode pads whereby dual electrical and mechanical stimulation will be produced through each sound head applicator.

4. A duplex electro-ultrasonic medical therapy apparatus as set forth in claim 3 wherein the means for connecting the pulse generator and keying means comprises a bistable multivibrator means whereby each output pulse from the bistable multivibrator means is used to drive the keying means thereby alternately keying the first ultrasound generator and then the second ultrasound generator.

5. A duplex electro-ultrasonic medical therapy apparatus for comprising in combination a power supply, a pair of ultrasound generators connected to the power supply for producing sound waves, keying means connected to the ultrasound generators for activating said ultrasound generators, a pair of sound head applicators operably connected with the ultrasound generators, each of said sound head applicators having a crystal transducer for converting sound waves into mechanical vibrations, a low voltage electrical surge generator connected to the power supply, surge rate means connected to the surge generator for varying the intensity level of each sound output, a pair of electrode pads operably connected to the low voltage generator for electrically producing stimulation for electro-therapy, and means connecting the surge generator to the ultrasound keying means for alternately keying the first ultrasound generator and then the second ultrasound generator thereby producing alternating surge outputs from the ultrasound generators simultaneously with the electrical stimulation surges in each electrode pad.

6. A duplex electro-ultrasonic medical therapy apparatus as set forth in claim 5 wherein each sound head applicator also comprises an electrode operably connected to the electrode pads whereby dual electrical and mechanical stimulation will be produced through each sound head applicator.
7. A duplex electro-ultrasonic medical therapy apparatus comprising in combination a power supply, a pair of ultrasound generators connected to the power supply for producing sound waves, a pair of sound head applicators operably connected with the ultrasound generators, each of said sound head applicators having a crystal transducer for converting sound waves into mechanical vibrations, separate keying means for each ultrasound generator and operably connected thereto, separate keyer monostable multivibrators operably connected to each keying means for operating each keying means, a bistable multivibrator operably connected to both keyer monostable multivibrators for providing alternating inputs for each keyer monostable multivibrator, a triggering monostable multivibrator operably connected to the bistable multivibrator to provide triggering inputs to the bistable multivibrator; a low voltage electrical generator connected to the power supply having a pulse mode of operation and a surge mode of operation, mode selector switching means connected to the electrical generator for selecting either the pulse or surge mode of operation, pulse rate means connected to the electrical generator for varying the frequency of the output pulses, surge rate means connected to the electrical generator for varying the duration of the output pulses, voltage control means connected to the electrical generator for varying the intensity in either the pulse or surge mode of operation, a pair of electrode pads operably connected to the low voltage electrical generator for producing electrical stimulation for electro-therapy and means for connecting the low voltage electrical generator to the triggering monostable multivibrator whereby each pulse or surge from the electrical generator will operate the triggering multivibrator which in turn will trigger the bistable multivibrator causing it to change states with each triggering input thereby alternately keying the first ultrasound generator and then the second ultrasound generator simultaneously with the electrical stimulations in each electrode pad.

8. A duplex electro-ultrasonic medical therapy apparatus as set forth in claim 7 wherein the electrical generator and mode selector switching means provide, in addition, a continuous mode whereby the electrical generator and the first ultrasound generator are simultaneously turned off and the second ultrasound generator produces a continuous ultrasound output.

9. A duplex electro-ultrasonic medical therapy apparatus as set forth in claim 8 wherein a manually set timer is operably connected to the power supply such that the electrical and mechanical stimulations may be automatically turned off after a predetermined treatment dosage.

10. A duplex electro-ultrasonic medical therapy apparatus as set forth in claim 8 wherein a safety switch and positive latching relay means are provided to preclude accidental switching to the "continuous" mode of operation without manually closing the safety switch.

11. A duplex electro-ultrasonic medical therapy apparatus as set forth in claim 10 wherein calibration switching means is provided whereby the ultrasound intensity level may be preset prior to application to the patient to be treated.

12. A duplex electro-ultrasonic medical therapy apparatus comprising in combination a power supply, an ultrasound generator connected to the power supply for producing sound waves, a pair of sound head applicators operably connected to the ultrasound generator, each of said sound head applicators having a transducer for converting sound waves into mechanical vibrations; a low voltage electrical pulse generator connected to the power supply, frequency adjustment means for varying the pulse rate, a pair of electrode pads operably connected to the low voltage generator and ultrasound generator whereby mechanical vibrations will be provided alternately in one sound head applicator and then in the other simultaneously with the electrical stimulation in each electrode pad.

13. A duplex electro-ultrasonic medical therapy apparatus as set forth in claim 12 wherein the means connecting the low voltage generator and the ultrasound generator comprises a monostable multivibrator for conditioning the output pulses from the low voltage generator, a bistable multivibrator connected to the output of said monostable multivibrator, two high power capacity "and" gates operably connected to the dual outputs of the bistable multivibrator and to the output of the ultrasound generator such that the ultrasound signal is allowed to pass through the first "and" gate only when the bistable multivibrator is in a first state and said ultrasound signal is allowed to pass through the second "and" gate only when the bistable multivibrator is in its second state, the output of the first "and" gate being operably connected to one sound head applicator and the output of the second "and" gate being operably connected to the other sound head applicator.