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DIVISIÓN DE NUEVAS CREACIONES
SUPERINTENDENCIA DE INDUSTRIA Y COMERCIO
Bogotá, D.C.

SUPERINTENDENCIA DE INDUSTRIA Y COMERCIO



No. 07-098979- -00004-0000

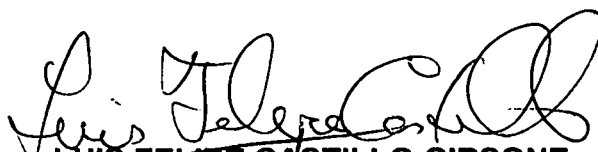
Fecha: 2008-09-24 11:05:11 Dep: 2020 NUECREACIONI
Tra: 11 PATENTEIYII Eve: 378 FASENACIONALI
Act: 538 PETICION Folios: 2

Re.: Expediente No. 07 98.979
Fase Nacional Solicitud de Patente PCT
a nombre de
SULPHCO, INC.
Código 011 – 378 - 538

En relación con la solicitud contenida en el Expediente de la referencia y, en particular, con la publicación del extracto de la misma en la Gaceta de la Propiedad Industrial No. 591 de 30 de Abril de 2008, por medio del presente escrito muy respetuosamente me permito solicitarle se sirva proceder a efectuar el **EXAMEN DE PATENTABILIDAD** de la solicitud aquí contenida.

Para tal efecto, acompaño el comprobante de pago por concepto de la tasa respectiva, Recibo No. **75,490**

De Usted Atentamente,


LUIS FELIPE CASTILLO GIBSON
T.P. No. 68.995 del C.S.J.

SUPERINTENDENCIA DE INDUSTRIA Y COMERCIO

NIT : 800176089-2

RECIBO OFICIAL DE CAJA : 08 - 75,490
FECHA : SEPTIEMBRE 23 DE 2008

SUPERINTENDENCIA DE INDUSTRIA Y COMERCIO



No. 07-098979- -00004-0000

Fecha: 2008-09-24 11:05:11 Dep. 2020 NUECREACION
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***** CONSIGNACION *****

DEPOSITANTE	TIPO PAGO	BANCO	CUENTA	No. PAGO	FECHA PGO	Vr. PAGO
CASTILLO GRAU Y ASOCIADOS	CONSIGNACION	BANCO DE BOGOTA	062754387	80863856	23/09/2008	3,883,000.00

***** CONCEPTO *****

CANT.	RENTISTICO	CONCEPTO	TOTAL CONCEPTO
1	50005-01-01	SOLICITUDES	
		85 EXAMEN DE PATENTABILIDAD DE INVEN	420,000.00
		TOTAL :	\$ 420,000.00

SON: CUATROCIENTOS VEINTE MIL PESOS

RESPONSABLE : _____

RECIBO DE CAJA APLICADO AL EXPEDIENTE No. _____

DIVISIÓN DE NUEVAS CREACIONES

RADICACIÓN EXPEDIENTE No. 07-98979

EL EXTRACTO DE LA PRESENTE SOLICITUD DE **PATENTE DE INVENCION**

FUE PUBLICADO EN LA GACETA DE PROPIEDAD INDUSTRIAL No **591** DE

FECHA **30 DE ABRIL DE 2008** EL TÉRMINO HÁBIL SEÑALADO POR LA LEY

EXPIRA EL **30 DE JULIO DE 2008**

NOTA: Dentro del plazo de los seis (6) meses siguientes a partir de la fecha de publicación en la gaceta de Propiedad Industrial, deberá solicitar y cancelar el examen de patentabilidad so pena de que la solicitud caiga en abandono, de acuerdo con lo establecido en el Artículo 44 de la Decisión 486/2000.

SE PRESENTARON OPOSICIONES POR PARTE DE TERCEROS.

SI _____

NO X



US 20050017599A1

(19) **United States**(12) **Patent Application Publication** (10) **Pub. No.: US 2005/0017599 A1****Puskas**(43) **Pub. Date: Jan. 27, 2005**(54) **APPARATUS, CIRCUITRY, SIGNALS AND METHODS FOR CLEANING AND/OR PROCESSING WITH SOUND**(76) **Inventor: William L. Puskas, Sutton, NH (US)**

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McDermott, Will & Emery
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Boston, MA 02109 (US)

(21) **Appl. No.: 10/855,135**(22) **Filed: May 27, 2004****Related U.S. Application Data**

(60) Continuation-in-part of application No. 10/178,751, filed on Jun. 24, 2002, now Pat. No. 6,822,372, which is a continuation-in-part of application No. 09/370,302, filed on Aug. 9, 1999, which is a division of application No. 09/097,374, filed on Jun. 15, 1998, now Pat. No. 6,016,821, which is a continuation of application No. 08/718,945, filed on Sep. 24, 1996, now Pat. No. 5,834,871.

Said application No. 10/178,751 is a continuation-in-part of application No. 09/609,036, filed on Jun. 30, 2000, now Pat. No. 6,462,461, and which is a continuation-in-part of application No. 09/678,576, filed on Oct. 3, 2000, now Pat. No. 6,433,460, which is a division of application No. 09/066,158, filed on Apr. 24, 1998, now Pat. No. 6,181,051, which is a continuation of application No. 08/718,945, filed on Sep. 24, 1996, now Pat. No. 5,834,871.

Said application No. 10/178,751 is a continuation-in-part of application No. 10/029,751, filed on Oct. 29,

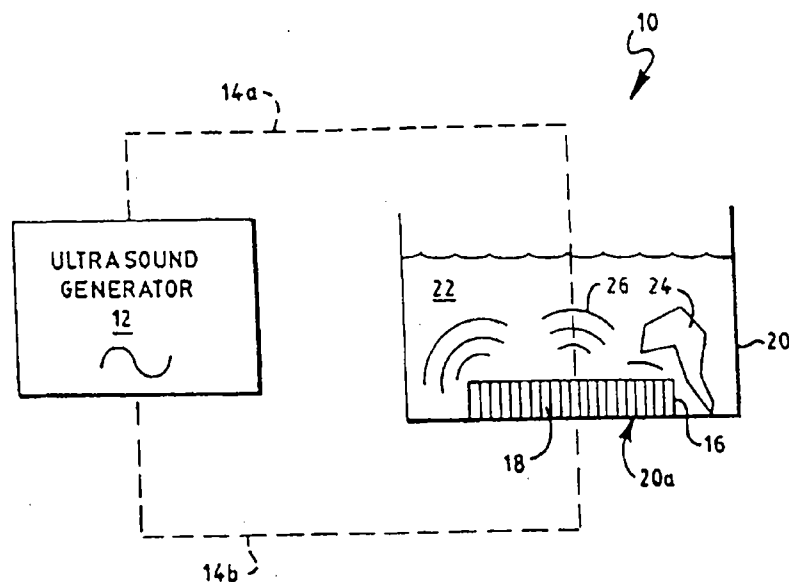
2001, now Pat. No. 6,538,360, which is a division of application No. 09/504,567, filed on Feb. 15, 2000, now Pat. No. 6,313,565.

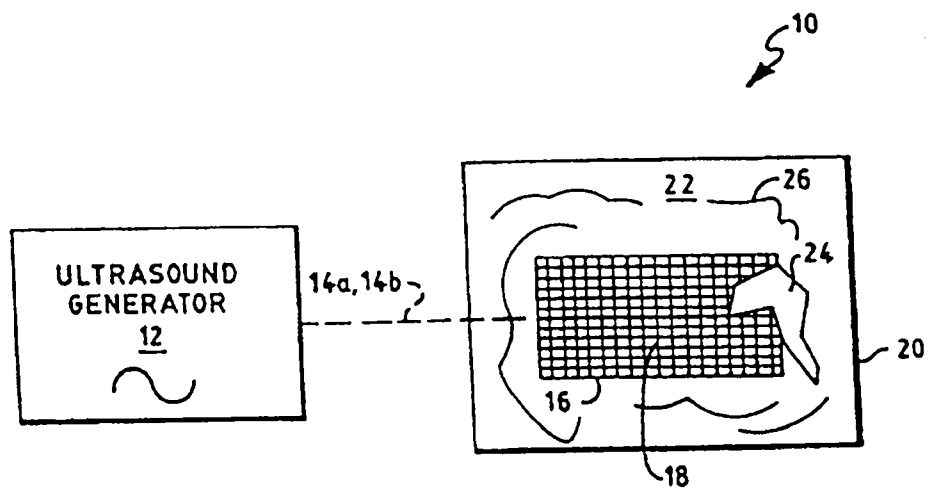
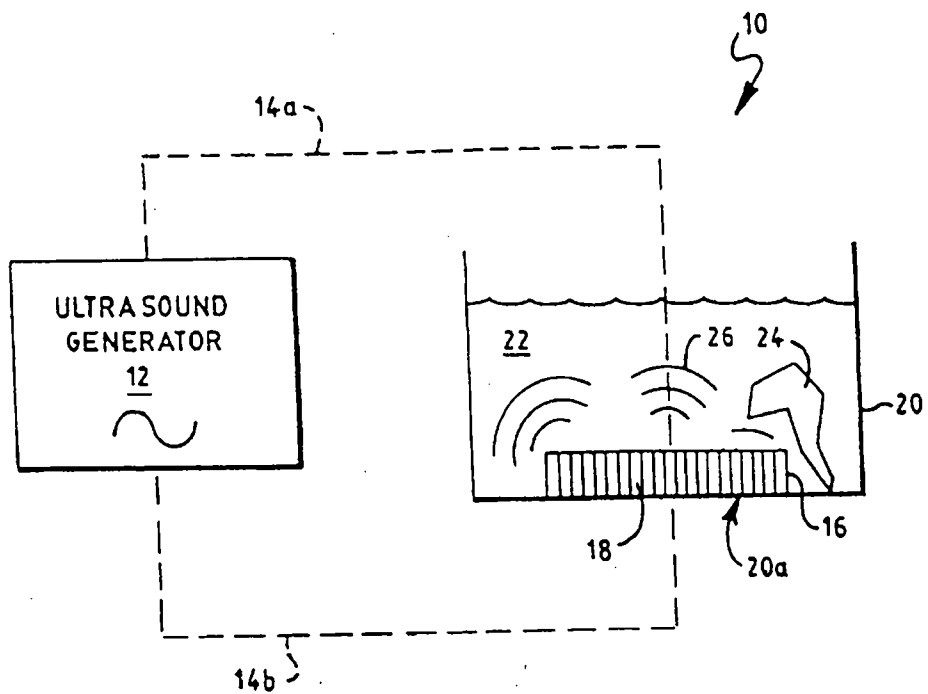
Continuation-in-part of application No. 10/825,036, filed on Apr. 15, 2004, which is a continuation-in-part of application No. 09/370,302, filed on Aug. 9, 1999, which is a division of application No. 09/097,374, filed on Jun. 15, 1998, now Pat. No. 6,016,821, which is a continuation of application No. 08/718,945, filed on Sep. 24, 1996, now Pat. No. 5,834,871.

(60) Provisional application No. 60/049,717, filed on Jun. 16, 1997. Provisional application No. 60/023,150, filed on Aug. 5, 1996. Provisional application No. 60/049,717, filed on Jun. 16, 1997.

Publication Classification(51) **Int. Cl.⁷ H01L 41/09**(52) **U.S. Cl. 310/317**(57) **ABSTRACT**

The invention utilizes a multiple frequency ultrasound generator driving a multiple frequency harmonic transducer array to improve cleaning and processing effects while eliminating damage to parts being cleaned. An AC switch and circuitry to modify the output of an ultrasound generator in combination with techniques such as random AM and FM signals are used to produce ultrasound waves that have no single frequency components which eliminates exciting parts being cleaned into resonance. Generator signals that increase cavitation efficiency and that have successive time periods with predominately stable cavitation and predominantly transient cavitation further improve the performance of the cleaning or processing systems.





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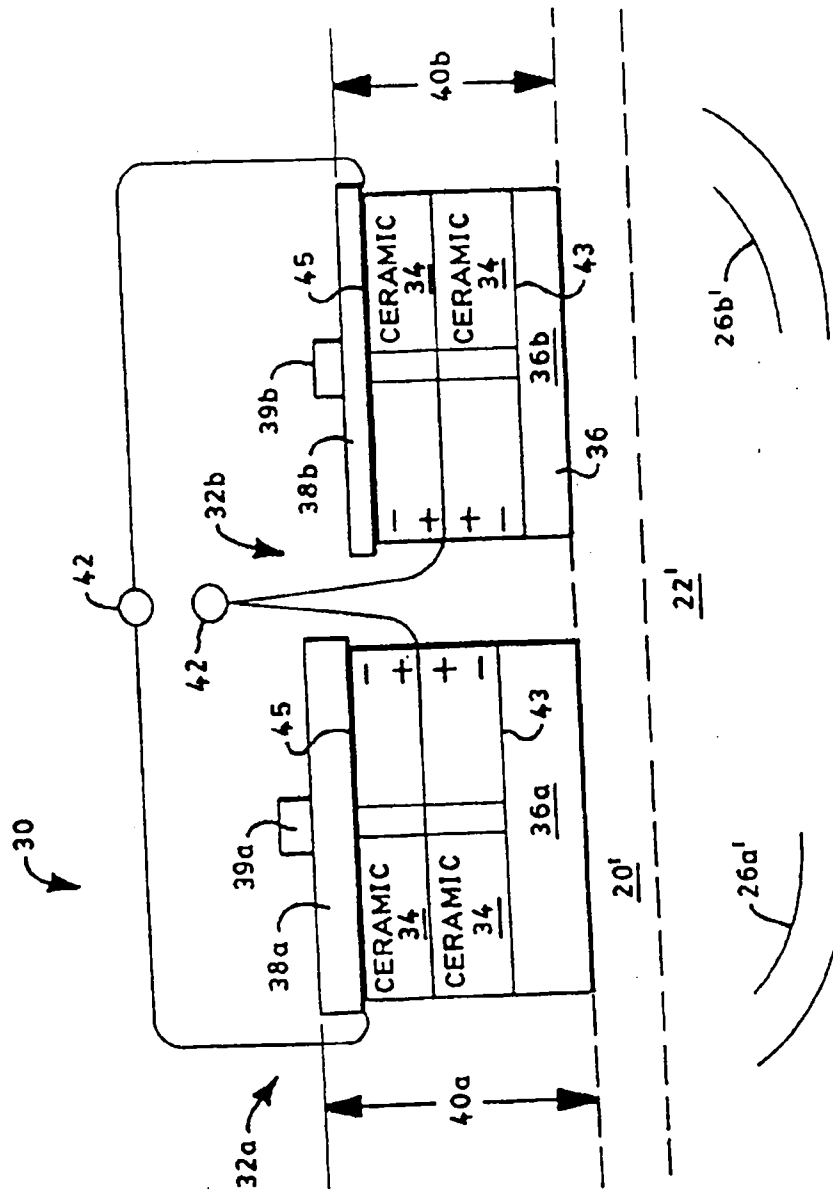


FIG. 3

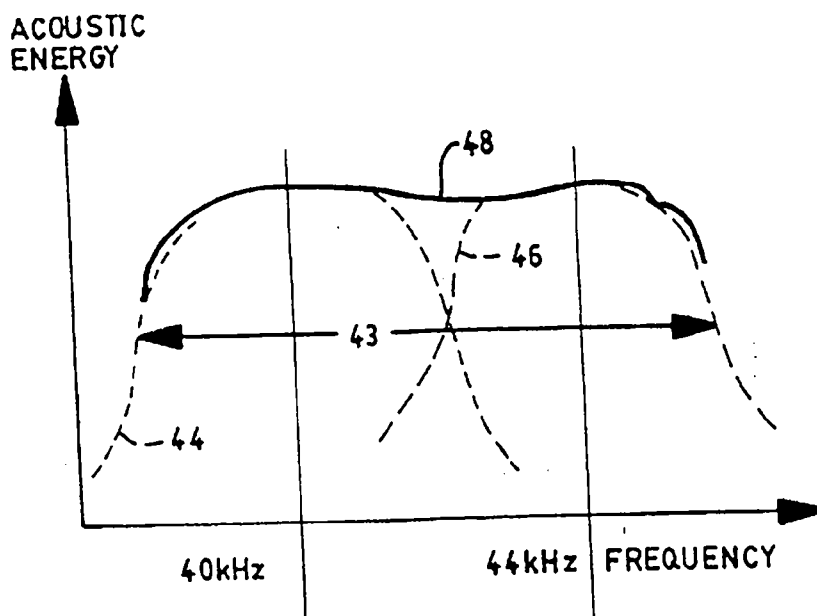


FIG. 4

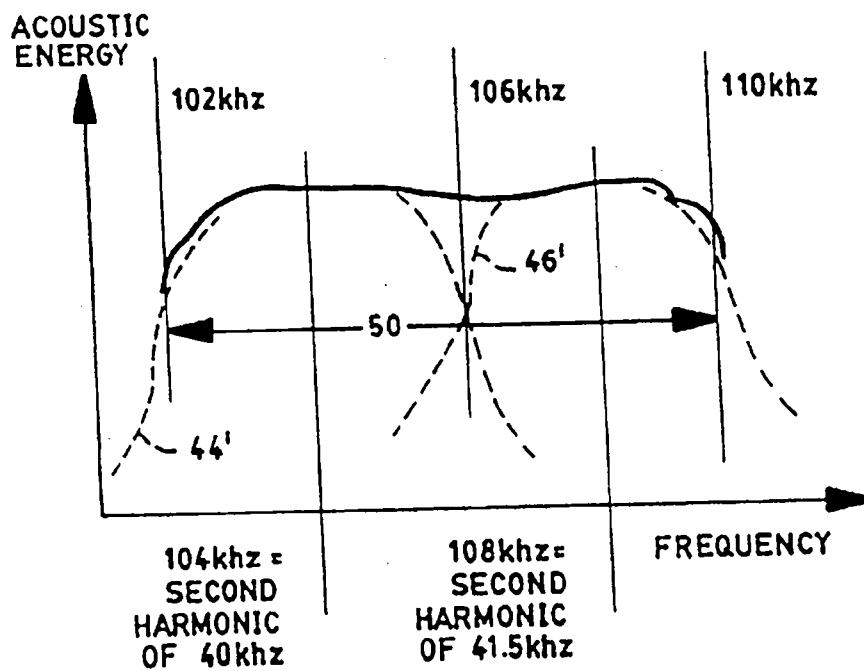
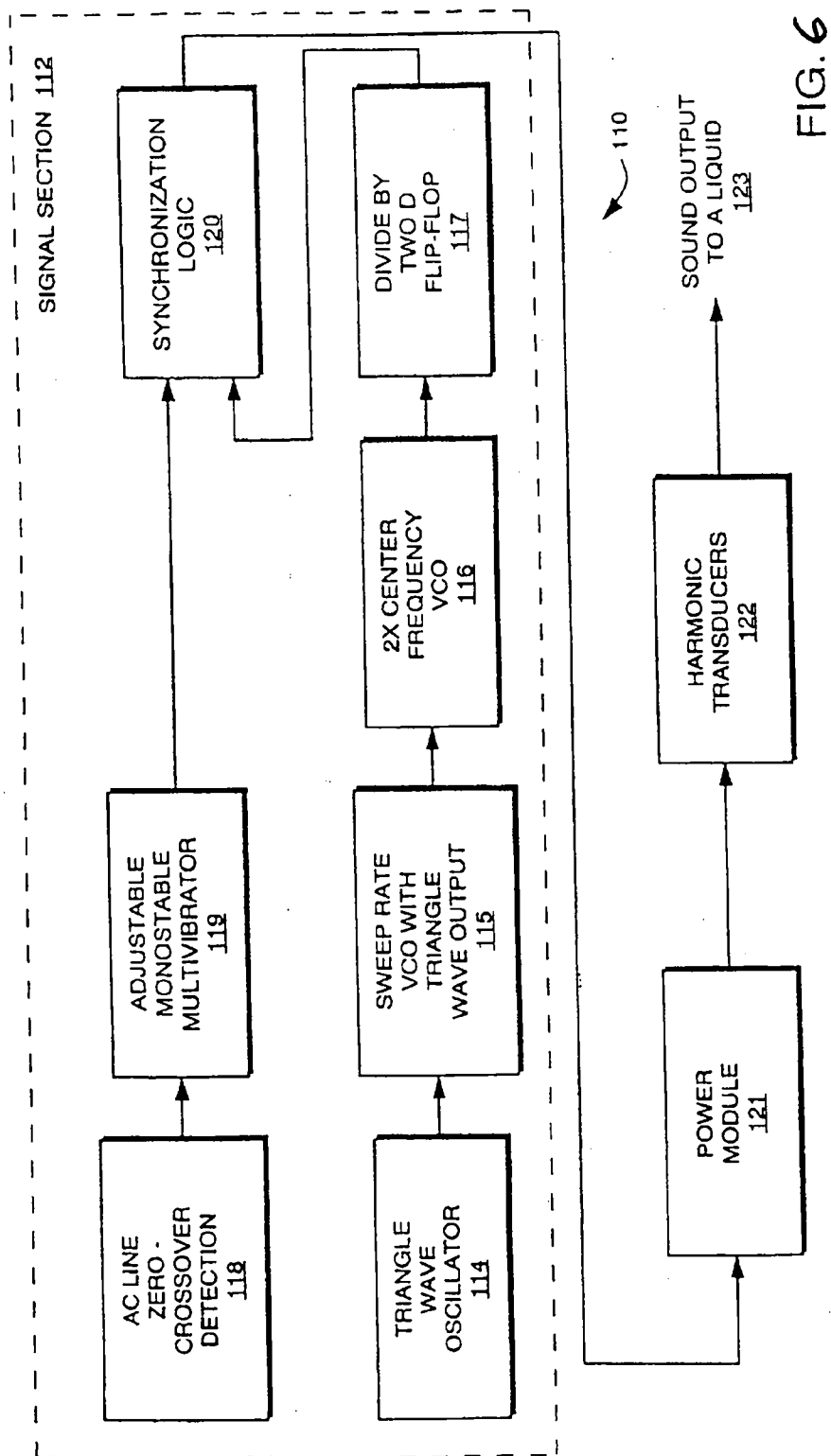


FIG. 5



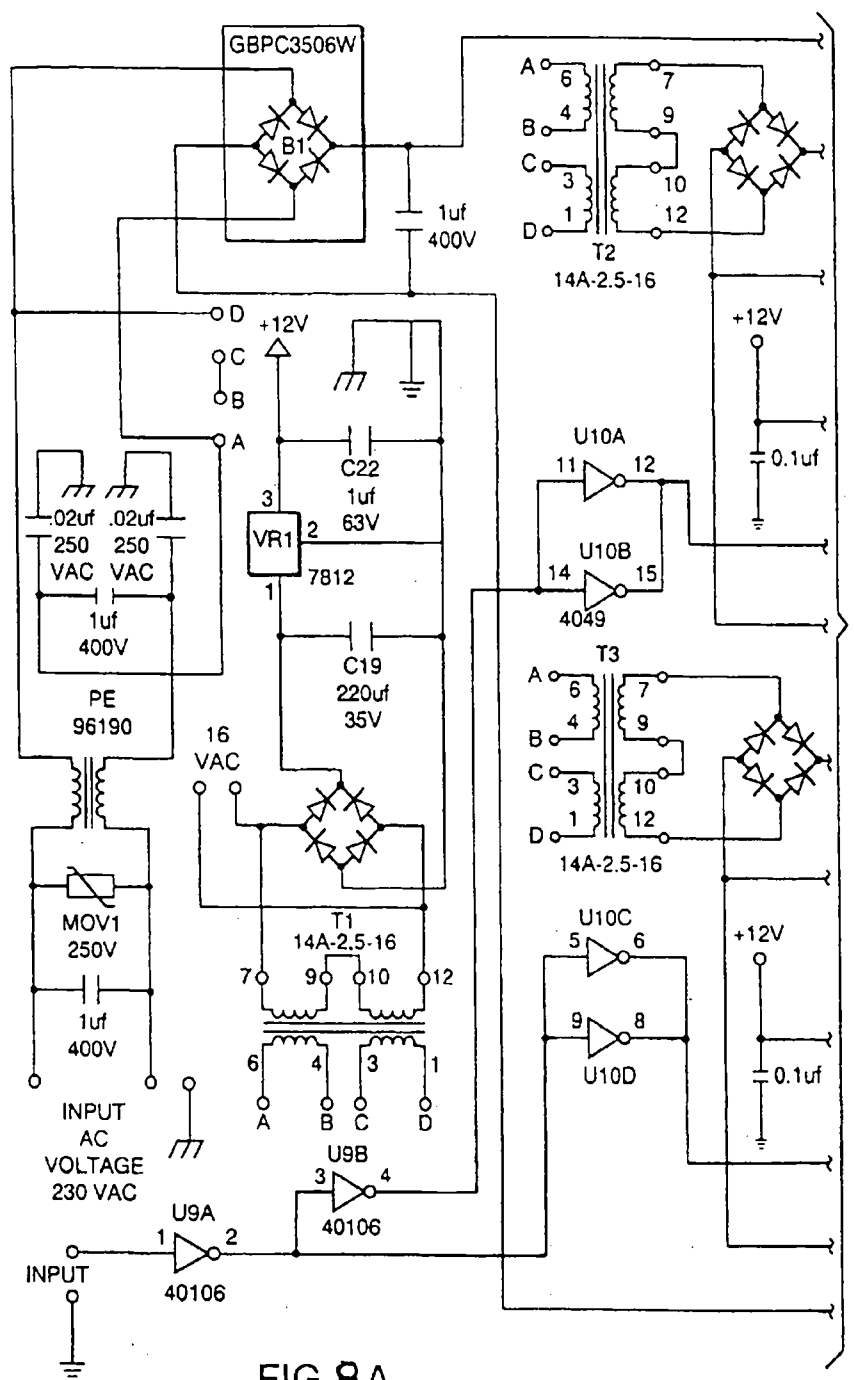
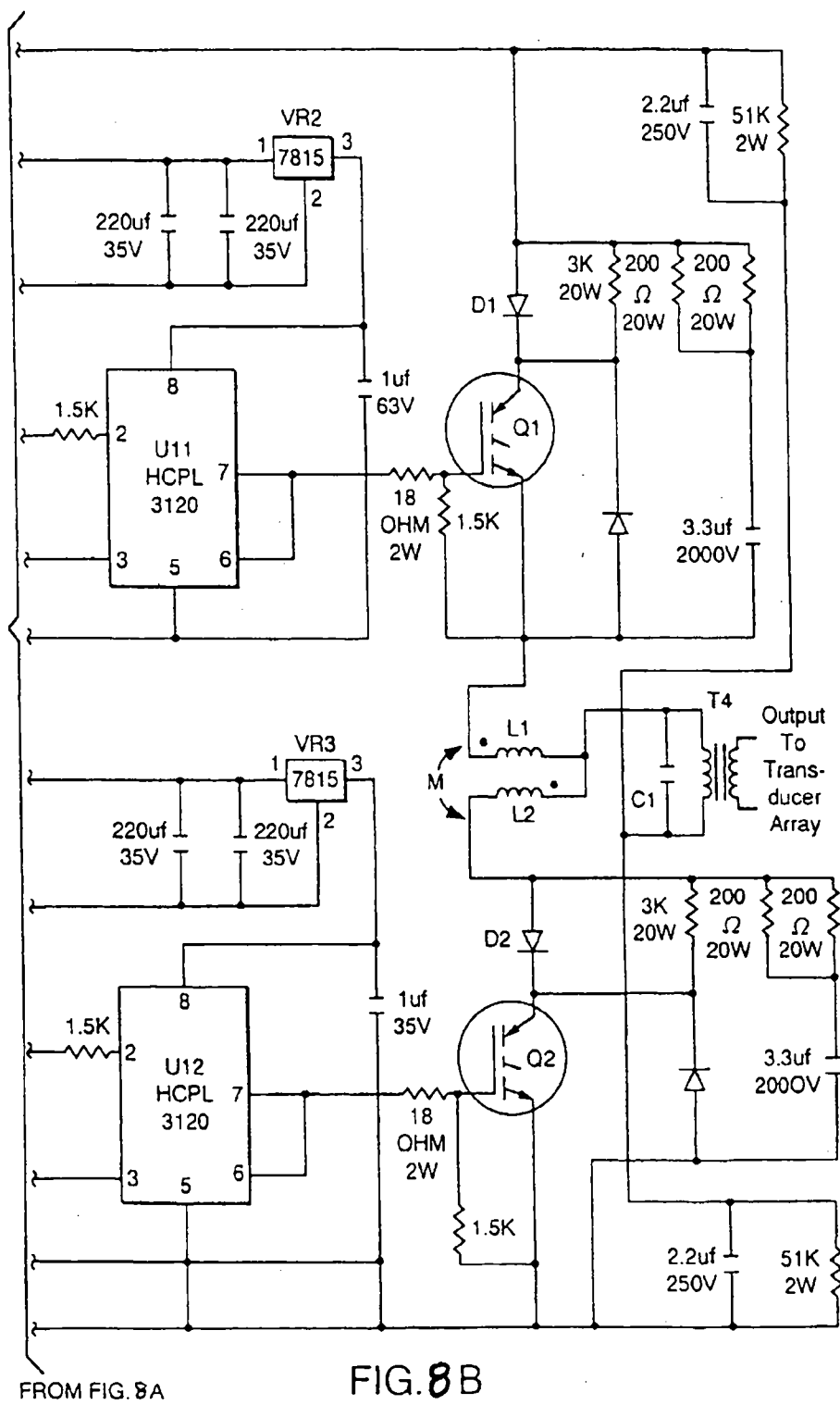


FIG. 8A

TO FIG. 8B

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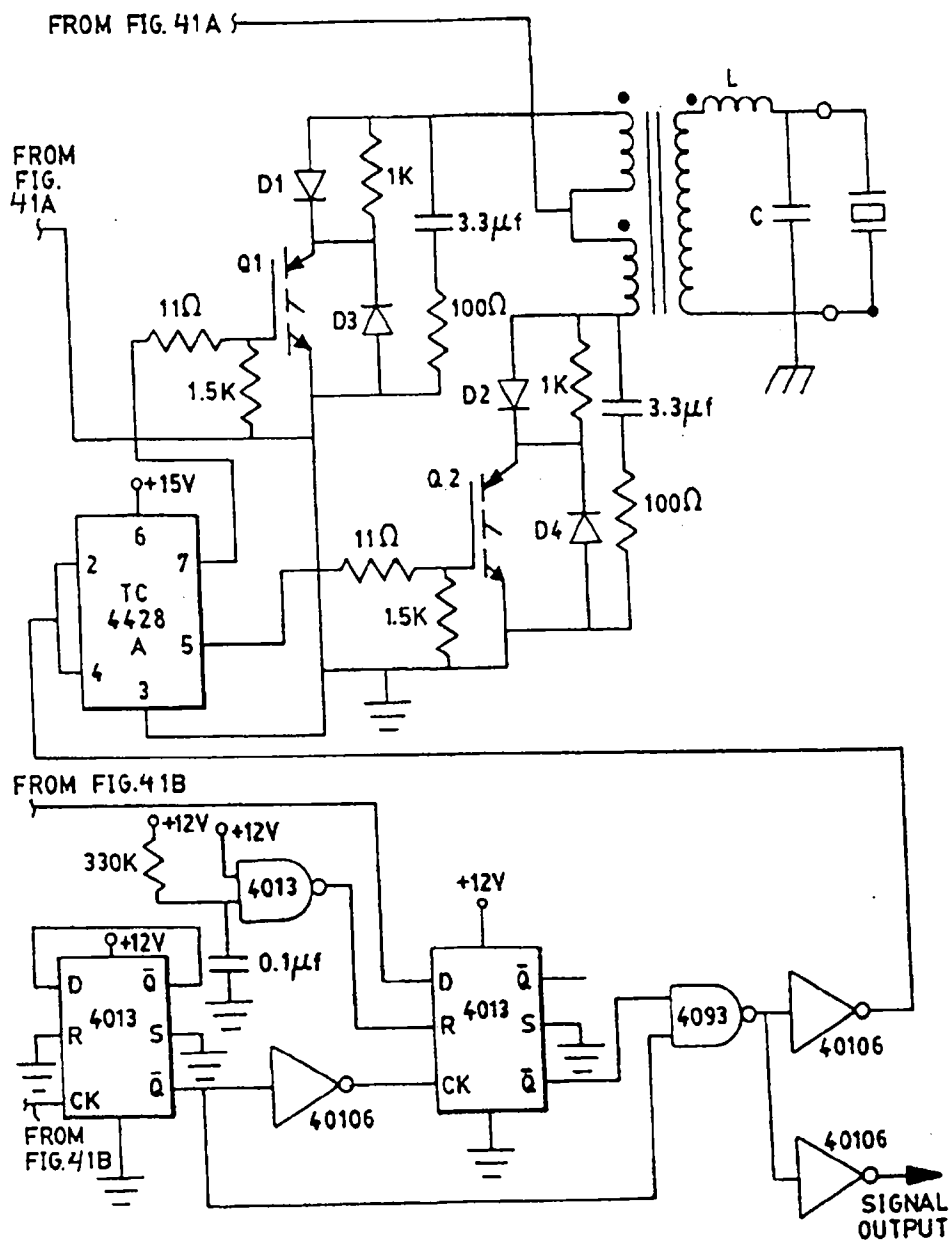
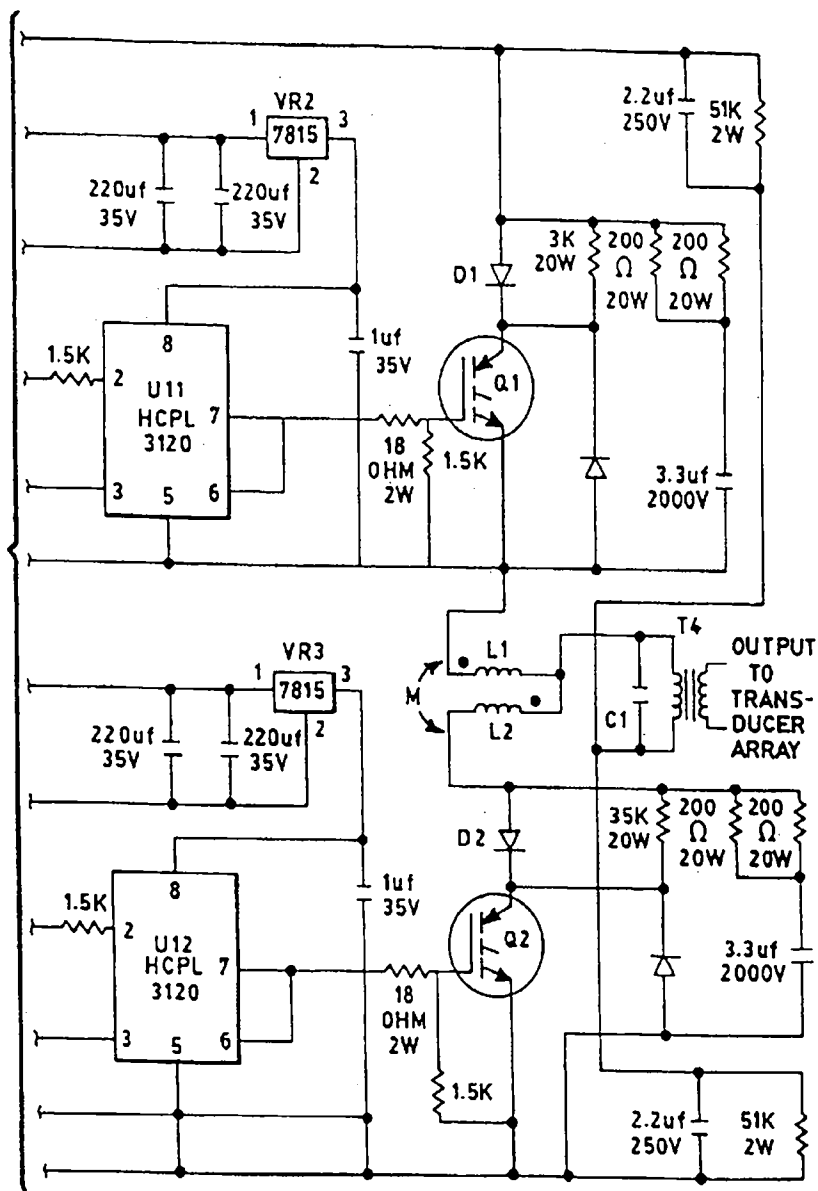


FIG. 41C



FROM FIG. 56

FIG. 57

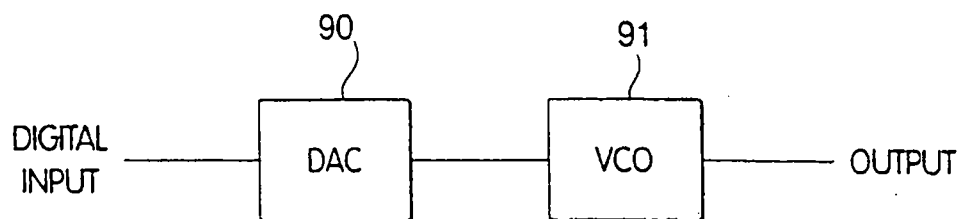


Fig.78A

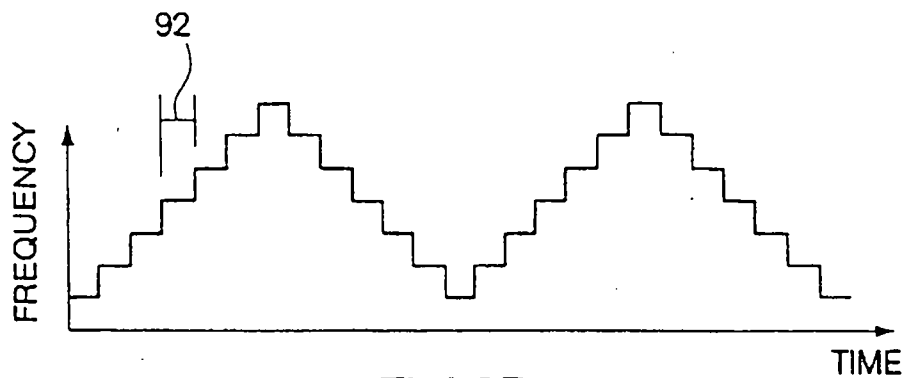


Fig.78B

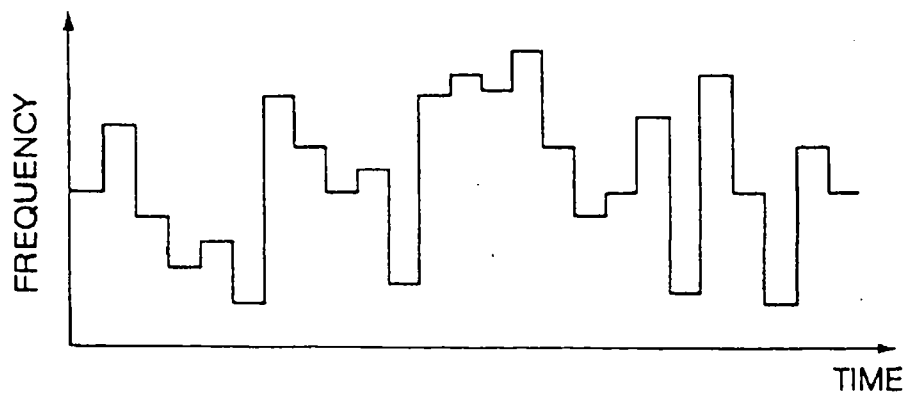


Fig.78C

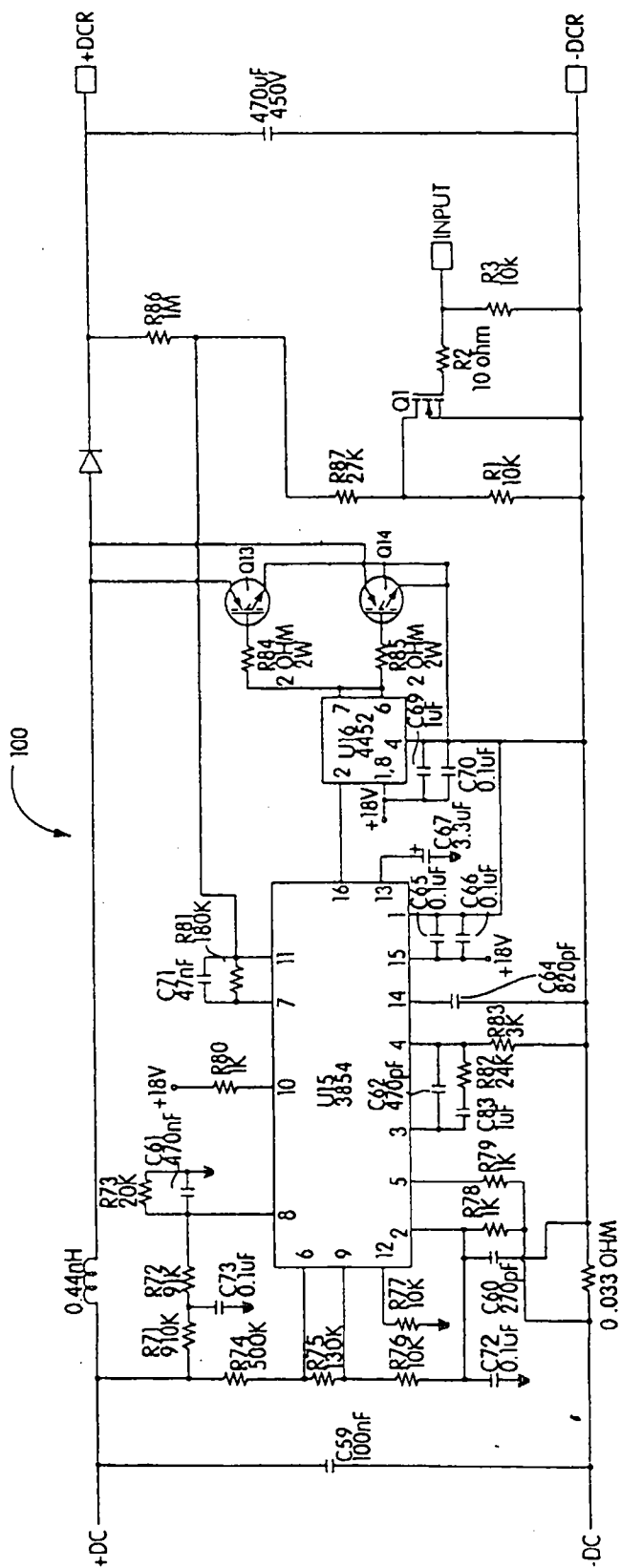


Fig.79

APPARATUS, CIRCUITRY, SIGNALS AND METHODS FOR CLEANING AND/OR PROCESSING WITH SOUND

RELATED APPLICATIONS

[0001] The subject application is a continuation-in-part of commonly owned and co-pending U.S. patent application Ser. Nos. 10/178,751 and 10/825,036, each of which is expressly incorporated herein by reference. Each of these applications has a history that is detailed below.

[0002] History of U.S. patent application Ser. No. 10/178,751: U.S. patent application Ser. No. 10/178,751 filed Jun. 24, 2002, entitled "Apparatus, Circuitry and Methods for Cleaning and/or Processing with Sound Waves", still pending, which is a continuation in part of four U.S. patent application Ser. Nos. 09/370,302, 09/609,036, 09/678,576 and 10/029,751 the history of each is described below.

[0003] History of U.S. patent application Ser. No. 09/370,302: U.S. patent application Ser. No. 09/370,302 filed Aug. 9, 1999, entitled "Probe System for Ultrasonic Processing Tank", still pending, which is a division of U.S. patent application Ser. No. 09/097,374 (now U.S. Pat. No. 6,016,821, granted Jan. 25, 2000); which is a continuation of U.S. patent application Ser. No. 08/718,945 (now U.S. Pat. No. 5,834,781, granted Nov. 10, 1998) and U.S. Provisional Application No. 60/049,717, each of which is expressly incorporated herein by reference.

[0004] History of U.S. patent application Ser. No. 09/609,036: U.S. patent application Ser. No. 09/609,036 was filed Jun. 30, 2000, entitled "Circuitry to Modify the Operation of Ultrasonic Generators" (now U.S. Pat. No. 6,462,461, granted Oct. 8, 2002), which is expressly incorporated herein by reference.

[0005] History of U.S. patent application Ser. No. 09/678,576: U.S. patent application Ser. No. 09/678,576 filed Oct. 3, 2000, entitled "Apparatus and Methods for Cleaning and/or Processing Delicate Parts", (now U.S. Pat. No. 6,433,460, granted Aug. 13, 2002) is a Divisional Application of Continuation-in-Part application Ser. No. 09/066,158, filed Apr. 24, 1998 (now U.S. Pat. No. 6,181,051, granted Jan. 30, 2001), which is a continuation of U.S. patent application Ser. No. 08/718,945 filed on Sep. 24, 1996 (now U.S. Pat. No. 5,834,871, entitled "Apparatus And Methods For Cleaning And/Or Processing Delicate Parts"), and U.S. Provisional Patent Application Ser. No. 60/023,150, filed on Aug. 5, 1996, each of which is expressly incorporated herein by reference.

[0006] History of U.S. patent application Ser. No. 10/029,751: U.S. patent application Ser. No. 10/029,751 filed Oct. 29, 2001, entitled "Multiple Frequency Cleaning System" (now U.S. Pat. No. 6,538,360, granted Mar. 25, 2003) is a divisional application of U.S. patent application Ser. No. 09/504,567 entitled "Multiple Frequency Cleaning System," filed on Feb. 15, 2000 (now U.S. Pat. No. 6,313,565, granted Nov. 6, 2001), the disclosure of which is entirely incorporated herein by reference.

[0007] History of U.S. patent application Ser. No. 10/825,036: U.S. patent application Ser. No. 10/825,036 is a continuation-in-part of commonly-owned and co-pending U.S. patent application Ser. No. 09/370,302, still pending; which is a division of U.S. patent application Ser. No. 09/097,374

(now U.S. Pat. No. 6,016,821, granted Jan. 25, 2000); which is a continuation of U.S. patent application Ser. No. 08/718,945 (now U.S. Pat. No. 5,834,781, granted Nov. 10, 1998) and U.S. Provisional Application No. 60/049,717, each of which is expressly incorporated herein by reference.

FIELD OF THE INVENTION

[0008] The invention relates to systems and methods for cleaning and/or processing parts. In particular, the invention relates to ultrasound systems, ultrasound generators, ultrasound transducers, ultrasound signals and methods which support or enhance the application of ultrasound energy within liquid.

BACKGROUND OF THE INVENTION

[0009] The present invention relates to ultrasound cleaning systems, and more particularly, to systems, generators, transducers, circuitry, signals and methods that clean and/or process by coupling sound waves into a liquid. Prior art ultrasound systems lack the ability to remove a wide range of particle types and sizes without doing damage to the part being cleaned or processed. This invention improves the performance of an ultrasound system while eliminating the damage causing mechanisms.

SUMMARY OF THE INVENTION

[0010] As defined in the technical literature, "ultrasound", "ultrasonic" and "ultrasonics" generally refer to acoustic disturbances in a frequency range above about eighteen kilohertz (khz) and which extend upwards to over four megahertz (Mhz). As is commonly used in the cleaning industry and as used herein, "ultrasonic" will generally refer to acoustic disturbances in a frequency range above about eighteen kilohertz and extending up to about 90 khz. Ultrasound and ultrasonics will be used to mean the complete range of acoustic disturbances from about 18 khz to 4 Mhz, except when they are use with terms such as "lower frequency" ultrasound, "low frequency" ultrasound, "lower frequency" ultrasonics, or "low frequency" ultrasonics, then they will mean ultrasound between about 18 khz and 90 khz. "Megasonics" or "megasonic" refer to acoustic disturbances between about 600 khz and 4 Mhz. The prior art has manufactured "low frequency" and "megasonic" ultrasound systems. Typical prior art low frequency systems, for example, operate at 25 khz, 40 khz, and as high as 90 khz. Typical prior art megasonic systems operate between 600 khz and 1 Mhz. Certain aspects of the invention apply to low frequency ultrasound and to megasonics. However, certain aspects of the invention apply to ultrasound in the 100 khz to 350 khz region, a frequency range which is sometimes denoted herein as "microsonic" or "microsonics." The upper end of the microsonic frequency range from about 300 khz to 350 khz is called herein "higher microsonics" or "higher frequency microsonic".

[0011] As used herein, "resonant transducer" means a transducer operated at a frequency or in a range of frequencies that correspond to a one-half wavelength ($\lambda/2$) of sound in the transducer stack. "Harmonic transducer" means a transducer operated at a frequency or in a range of frequencies that correspond to 1 λ , 1.5 λ , 2 λ or 2.5 λ of sound, and so on, in the transducer stack. The harmonics of a practical physical structure are

[0172] FIGS. 15A, 15B and 15C graphically illustrate methods of sweeping the sweep rate in accord with the invention.

[0173] FIGS. 16-26 show transducer and backplate embodiments for systems, methods and transducers of the invention; and FIG. 27 shows representative standing waves within one transducer of the invention;

[0174] FIG. 28 illustrates preferential placement and mounting of multiple transducers relative to a process tank, in accord with the invention;

[0175] FIG. 29 illustrates a representative standing wave relative to the process tank as formed by the arrangement of FIG. 28;

[0176] FIG. 30 illustrates another preferential pattern of placing transducers onto a mounting surface such as an ultrasound tank, in accord with the invention;

[0177] FIG. 31 illustrates, in a side view, the mounting of two transducers (such as the transducers of FIG. 30) to a tank, in accord with the invention;

[0178] FIG. 32 shows an exploded side view of further features of one transducer such as shown in FIG. 31;

[0179] FIG. 33 illustrates a two stage ultrasound delivery system constructed according to the invention; and FIGS. 34 and 35 show alternative timing cycles through which the system of FIG. 33 applies ultrasound from upper to lower frequencies;

[0180] FIGS. 36-40 show alternate sweep down cyclical patterns for applying a power-up sweep pattern in accord with the invention;

[0181] FIGS. 41A, 41B and 41C schematically illustrate ultrasound generator circuitry for providing dual sweeping power-up sweep and variable degas periods, in accord with the invention;

[0182] FIGS. 42 and 43 show multi-frequency ultrasound systems constructed according to the invention;

[0183] FIG. 44 illustrates a process control system and ultrasound probe constructed according to the invention;

[0184] FIGS. 45 and 46 illustrate two process tanks operating with equal input powers but having different cavitation implosion activity;

[0185] FIG. 47 illustrates a process probe constructed according to the invention and for monitoring process characteristics within a process chemistry such as within an ultrasound tank;

[0186] FIG. 48 shows a schematic view of a system incorporating the probe of FIG. 47 and further illustrating active feedback control of energy applied to an ultrasound tank, in accord with the invention;

[0187] FIGS. 49-51 illustrate alternative embodiments of ultrasound generators with universal voltage input, in accord with the invention;

[0188] FIG. 52 graphically illustrates an AM burst pattern in accord with the invention; and

[0189] FIG. 53 illustrates one burst of primary frequency ultrasound within one of the non-zero AM periods;

[0190] FIG. 54 illustrates an AM sweep pattern, in accord with the invention;

[0191] FIGS. 55, 56 and 57 schematically show one AM power up-sweep generator circuit constructed according to the invention;

[0192] FIG. 58 shows a quick dump rinse (QDR) tank constructed according to the invention;

[0193] FIG. 59 shows an improved high frequency transducer constructed according to the invention;

[0194] FIG. 60 illustrates, in a side exploded view, a double compression transducer constructed according to the invention;

[0195] FIG. 61 shows a prior art transducer with a bias bolt threaded into the upper part of the front driver;

[0196] FIG. 62 shows an improved transducer, constructed according to the invention; with a bias bolt threaded into a lower part of the front plate;

[0197] FIG. 63 illustrates one transducer of the invention utilizing a steel threaded insert to reduce stress on the front driver;

[0198] FIG. 64 shows a side view of a printed circuit board coupled with transducers as a single unit, in accord with the invention; and FIG. 65 shows a top view of the unit of FIG. 64;

[0199] FIG. 66 shows an acid-resistant transducer constructed according to the invention;

[0200] FIG. 67 schematically shows one power up-sweep generator circuit of the invention;

[0201] FIG. 68 illustrates a wiring schematic that couples a common voltage supply to one generator of a system that includes multiple generators, in accord with the invention; FIG. 69 shows a wiring schematic to couple the generators to a single processing tank with transducers; and FIG. 70 schematically shows a circuit coupled to the rotary switch of FIG. 68; and

[0202] FIG. 71 shows a multi-generator system constructed according to the invention.

[0203] FIG. 72A shows in diagram form the multiple frequency system according to the present invention;

[0204] FIG. 72B shows, in graphical form, characteristics of the transducer array of FIG. 72A;

[0205] FIG. 72C shows, in graphical form, characteristics of the generator of FIG. 72A;

[0206] FIG. 73A shows, in schematic form, a portion of a generator built to produce multiple frequency drive signals for an array of transducers formed from paralleled transducers of FIG. 9;

[0207] FIG. 73B shows, in schematic form, additional components of the generator of FIG. 73A;

[0208] FIG. 73C shows, in schematic form, additional components of the generator of FIG. 73A;

[0209] FIG. 73D shows, in schematic form, additional components of the generator of FIG. 73A;

[0210] FIG. 73E shows, in schematic form, additional components of the generator of FIG. 73A;

[0211] FIG. 73F shows, in schematic form, additional components of the generator of FIG. 73A;

[0212] FIG. 74 shows, in diagram form, a multiple frequency system according to the present invention, controlled by a probe measuring sound characteristics in the liquid.

[0213] FIG. 75 shows the multiple frequency system of FIG. 74, controlled by a PLC or a computer.

[0214] FIG. 76 shows a typical sound profile of the system of FIG. 74, where quiet times are inserted into the bursts of sound energy;

[0215] FIG. 77 shows a block diagram of the generator according to the present invention, with phase lock loop control;

[0216] FIG. 78A shows a VCO controlled by a DAC according to the present invention, to change the frequencies of the generator;

[0217] FIG. 78B shows an example of a staircase function that can result from the DAC controlled VCO of FIG. 78A;

[0218] FIG. 78C shows an example of a random staircase that can be produced by the DAC controlled VCO of FIG. 78A; and,

[0219] FIG. 79 shows a schematic of a modified PFC (power factor correction) circuit that adds amplitude control to the system according to the present invention.

[0220] FIG. 80 shows a schematic diagram of a conduction line of an ultrasound generator.

[0221] FIG. 81 shows a schematic diagram of an ultrasound generator conduction line and the AC switch and modification circuitry, in a parallel connection. The control function of the AC switch is also shown.

[0222] FIG. 82 shows a schematic diagram of two nodes in the power section of an ultrasound generator.

[0223] FIG. 83 shows a schematic diagram of the AC switch and modification circuitry connected in series between two nodes in the power section of an ultrasound generator. The control function of the AC switch is also shown.

[0224] FIG. 84 shows a schematic diagram of a triac circuit employing the invention as used in the output of a multiple frequency generator.

[0225] FIGS. 85A and 85B show a schematic diagram of a control circuit that produces on and off signals for the gates of the triacs in FIG. 84 and on and off signals for the frequency generation of the ultrasound generator.

[0226] FIG. 86 shows a schematic diagram of an ultrasound frequency oscillator with a triac network in the output to step sweep the frequency output of the oscillator.

[0227] FIG. 87 shows a schematic diagram of a control circuit that produces on and off signals for the gates of the triacs in FIG. 86 and on and off signals for the oscillator in FIG. 86.

[0228] FIG. 88 shows a schematic diagram of an ultrasound frequency oscillator with a triac network in the output using inductive, capacitive and resistive modification circuits.

[0229] FIGS. 89A, 89B and 89C show schematic diagrams of AC switches formed from various active components.

[0230] FIG. 90 shows a waveform of a sweeping frequency signal according to the invention.

[0231] FIG. 91 shows a time sequence of different forms of cavitation according to the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0232] FIGS. 1 and 2 show schematic side and top views, respectively, of an ultrasound processing system 10 constructed according to the invention. An ultrasound generator 12 electrically connects, via electrical paths 14a, 14b, to an ultrasound transducer 16 to drive the transducer 16 at ultrasound frequencies above about 18 khz, and usually between 40 khz and 350 khz. Though not required, the transducer 16 is shown in FIG. 1 as an array of transducer elements 18. Typically, such elements 18 are made from ceramic, piezoelectric, or magnetostrictive materials which expand and contract with applied voltages or current to create ultrasound. The transducer 16 is mounted to the bottom, to the sides, or within the ultrasound treatment tank 20 through conventional methods, such as known to those skilled in the art and as described above. A liquid 22 fills the tank to a level sufficient to cover the delicate part 24 to be processed and/or cleaned. In operation, the generator 12 drives the transducer 16 to create acoustic energy 26 that couples into the liquid 22.

[0233] Although the transducer 16 is shown mounted to the bottom of the tank 20, those skilled in the art will appreciate that other mounting configurations are possible and envisioned. The transducer elements 18 are of conventional design, and are preferably "clamped" so as to compress the piezoelectric transducer material.

[0234] FIG. 3 illustrates a two transducer system 30. Transducer 32a, 32b are similar to one of the elements 18, FIG. 1. Transducer 32a includes two ceramic sandwiched elements 34, a steel back plate 38a, and a front drive plate 36a that is mounted to the tank 20'. Transducer 32b includes two ceramic sandwiched elements 34, a steel back plate 38b, and a front drive plate 36b that is mounted to the tank 20'. Bolts 39a, 39b pass through the plates 38a, 38b and screw into the drive plates 36a, 36b, respectively, to compress the ceramics 34. The transducers 32 are illustratively shown mounted to a tank surface 20'.

[0235] The transducers 32a, 32b are driven by a common generator such as generator 12 of FIG. 1. Alternatively, multiple generators can be used. The ceramics 34 are oriented with positive "+" orientations together or minus "-" orientations together to obtain cooperative expansion and contraction within each transducer 32. Lead-outs 42 illustrate the electrical connections which connect between the generator and the transducers 32 so as to apply a differential voltage there-across. The bolts 39a, 39b provide a conduction path between the bottoms 43 and tops 45 of the transducers 32 to connect the similar electrodes (here shown as -, -) of the elements 34.

[0236] The thicknesses 40a, 40b of transducers 32a, 32b, respectively, determine the transducer's fundamental resonant frequency. For purposes of illustration, transducer 32a has a fundamental frequency of 40 khz, and transducer 32b has a fundamental frequency of 44 khz. Transducers 32a, 32b each have a finite ultrasound bandwidth which can be adjusted, slightly, by those skilled in the art. Typically, however, the bandwidths are about 4 khz. By choosing the correct fundamental frequencies, therefore, an overlap between the bandwidths of the two transducers 32a, 32b can occur, thereby adding additional range within which to apply ultrasound 26a', 26b' to liquid 22'.

[0237] The acoustic energy 26' applied to the liquid 22' by the combination of transducers 32a, 32b is illustrated graphically in FIG. 4. In FIG. 4, the "x" axis represents frequency, and the "y" axis represents acoustical power. The outline 44 represents the bandwidth of transducer 32a, and outline 46 represents the bandwidth of transducer 32b. Together, they produce a combined bandwidth 43 which produces a relatively flat acoustical energy profile to the liquid 22', such as illustrated by profile 48. The flatness of the bandwidth 43 representing the acoustical profile 48 of the two transducers 32a, 32b is preferably within a factor of two of any other acoustical strength within the combined bandwidth 43. That is, if the FWHM defines the bandwidth 43; the non-uniformity in the profile 48 across the bandwidth 43 is typically better than this amount. In certain cases, the profile 48 between the two bandwidths 44 and 46 is substantially flat, such as illustrated in FIG. 4.

[0238] The generator connected to lead-outs 42 drives the transducers 32a, 32b at frequencies within the bandwidth 43 to obtain broadband acoustical disturbances within the liquid 22'. As described herein, the manner in which these frequencies are varied to obtain the overall disturbance is important. Most preferably, the generator sweeps the frequencies through the overall bandwidth, and at the same time sweeps the rate at which those frequencies are changed. That is, one preferred generator of the invention has a "sweep rate" that sweeps through the frequencies within the bandwidth 43; and that sweep rate is itself varied as a function of time. In alternative embodiments of the invention, the sweep rate is varied linearly, randomly, chaotically or as some other function of time to optimize the process conditions within the tank 20'.

[0239] With further reference to FIGS. 1 and 2, each of the elements 18 can have a representative bandwidth such as illustrated in FIG. 4. Accordingly, an even larger bandwidth 43 can be created with three or more transducers such as illustrated by transducers 32a, 32b. In particular, any number of combined transducers can be used. Preferably, the bandwidths of all the combined transducers overlap to provide an integrated bandwidth such as profile 48 of FIG. 4. As such, each transducer making up the combined bandwidth should have a unique resonant frequency.

[0240] Those skilled in the art understand that each of the transducers 18 and 32a, 32b, FIGS. 2 and 3, respectively, have harmonic frequencies which occur at higher mechanical resonances of the primary resonant frequency. It is one preferred embodiment of the invention that such transducers operate at one of these harmonics, i.e., typically the first, second, third or fourth harmonic, so as to function in the frequency range of 100 khz to 350 khz. This frequency range

provides a more favorable environment for acoustic processes within the tanks 20, 20' as compared to low frequency disturbances less than 100 khz. For example, ultrasound frequencies around the 40 khz frequency can easily cause cavitation damage in the part 24. Further, such frequencies tend to create standing waves and other hot spots of spatial cavitation within the liquid.

[0241] Accordingly, the benefits of applying a broadband acoustic disturbance to the liquid also apply to the 100-350 khz microsonic frequencies. Similar to FIG. 4, FIG. 5 illustrates a combined bandwidth 50 of harmonic frequencies in the range 100-350 khz. Specifically, FIG. 5 shows the combined bandwidth 50 that is formed by the bandwidth 44' around the second harmonic of the 40 khz frequency, and the bandwidth 46' around the second harmonic of the 41.5 khz frequency.

[0242] FIG. 6 shows in block diagram embodiment of a system 110 constructed according to the present invention. The system 110 includes a signal section 112 which drives a power module 121. The power module 121 powers the harmonic transducer array 122. The transducer array 122 is coupled to a liquid 123 by one of several conventional means so as to generate acoustic energy within the liquid 123. By way of example, the array 122 is similar to the array 16 of FIG. 1; and the liquid 123 is similar to the liquid 22 of FIG. 1.

[0243] The signal section 112 includes a triangle wave oscillator 114 with a frequency typically below 150 hz. The purpose of the oscillator 114 is to provide a signal that sweeps the sweep rate of the ultrasound frequencies generated by the transducer arrays 122.

[0244] The oscillator 114 is fed into the input of the sweep rate VCO 115 (Voltage Controlled Oscillator). This causes the frequency of the output of VCO 115 to linearly sweep at the frequency of the oscillator 114. The optimum sweep rate frequency output of VCO 115 is typically from about 10 hz, for magnetostrictive elements, to about 1.2 khz, for piezoelectrics. Therefore, the optimum center sweep rate frequency can be anywhere within the range of about 10 hz to 1.2 khz, and that sweep rate is varied within a finite range of frequencies about the center sweep frequency. This finite range is typically set to about 10-50% of the center sweep rate frequency. For example, the center sweep rate frequency for one process might be 455 hz, so the VCO 115 output is set, for example, to sweep from 380 hz to 530 hz. If, additionally, the oscillator 114 is set to 37 hz, then the output of VCO 115 changes frequency, linearly, from 380 hz to 530 hz, and back to 380 hz at thirty seven times per second.

[0245] The output of VCO 115 feeds the VCO input of the 2x center frequency VCO 116. The VCO 116 operates as follows. If, for example, the center frequency of VCO 116 is set to 208 khz and the bandwidth is set to 8 khz, the center frequency linearly changes from 204 khz to 212 khz and back to 204 khz in a time of 1.9 milliseconds (i.e., $\frac{1}{300}$ hz) to 2.63 milliseconds (i.e., $\frac{1}{380}$ hz). The specific time is determined by the voltage output of the oscillator 114 at the time of measurement. Since the voltage output of oscillator 114 is constantly changing, the time it takes to linearly sweep the center frequency from 204 khz to 212 khz and back to 204 khz is also constantly changing. In this example, the time changes linearly from 1.9 milliseconds to 2.63 milliseconds and back to 1.9 milliseconds at thirty seven times per second.

[0246] The oscillator 114, VCO 115 and VCO 116 operate, in combination, to eliminate the repetition of a single sweep rate frequency in the range of 10 hz to 1.2 khz. For example, the highest single frequency that exists in the stated example system is 37 hz. If an unusual application or process were found whereby a very low frequency resonance around 37 hz exists, then the oscillator 114 would be replaced by a random or chaotic voltage generator to reduce the likelihood of exciting any modes within the part.

[0247] The VCO 116 drives a divide-by-two D flip-flop 117. The purpose of the D flip-flop 117 is to eliminate asymmetries in the waveform from the VCO 116. The output of the D flip-flop 117 is thus a square wave that has the desired frequency which changes at a sweep rate that is itself sweeping. In the stated example, the output square wave from D flip-flop 117 linearly changes from 102 khz to 106 khz and back to 102 khz at different times in the range of 1.9 milliseconds to 2.63 milliseconds. This sweeping of the sweep rate is sometimes referred to herein as "double sweep" or "double sweeping."

[0248] The AC line zero-crossover detection circuit 118 produces a signal with a rise time or narrow pulse at or near the time that the AC line voltage is at zero or at a low voltage, i.e., at or near zero degrees. This signal triggers the adjustable monostable multivibrator 119. The timed pulse out of monostable multivibrator 119 is set to a value between zero degrees and ninety degrees, which corresponds to a time from zero to 4.17 milliseconds for a 60 hz line frequency.

[0249] If the maximum amplitude were desired, for example, the monostable multivibrator 119 is set to a time of 4.17 milliseconds for a 60 hz line frequency. For an amplitude that is 50% of maximum, the monostable multivibrator 119 is set to 1.389 milliseconds for a 60 hz line frequency. In general, the monostable multivibrator 119 time is set to the arcsine of the amplitude percent times the period of the line frequency divided by 360 degrees.

[0250] The double sweeping square wave output of the D flip-flop 117 and the timed pulse output of the monostable multivibrator 119 feed into the synchronization logic 120. The synchronization logic 120 performs three primary functions. First, it only allows the double sweeping square wave to pass to the output of the synchronization logic 120 during the time defined by the pulse from the monostable multivibrator 119. Second, the synchronization logic 120 always allows a double sweeping square wave which starts to be completed, even if the monostable multivibrator 119 times out in the middle of a double sweeping square wave. And lastly, the synchronization logic 120 always starts a double sweeping square wave at the beginning of the ultrasound frequency, i.e., at zero degrees.

[0251] The output of synchronization logic 120 is a double sweeping square wave that exists only during the time defined by the monostable multivibrator 119 or for a fraction of a cycle past the end of the monostable multivibrator 119 time period. The synchronization logic 120 output feeds a power module 121 which amplifies the pulsed double sweeping square wave to an appropriate power level to drive the harmonic transducers 122. The transducers 122 are typically bonded to a tank and deliver sound waves into the liquid within the tank. These sound waves duplicate the pulsed double sweeping characteristics of the output of the signal section 112.

[0252] FIG. 7 shows a schematic embodiment of the signal section 112 in FIG. 6. U1 is a XR-2209 precision oscillator with a triangle wave output at pin 8. The frequency of the XR-2209 is $1/(RC)=1/((27 \text{ Kohm})(1 \text{ microfarad}))=37 \text{ hz}$. This sets the frequency of the triangle wave oscillator 114, FIG. 6, to sweep the sweep rate at 37 hz. The other components associated with the XR-2209 are the standard configuration for single supply operation of this integrated circuit.

[0253] U2 is a XR-2209 precision oscillator with a triangle wave output at pin 8. The center frequency of U2 is $1/(RC)=1/((2.2 \text{ Kohm})(1 \text{ microfarad}))=455 \text{ hz}$. The actual output frequency is proportional to the current flowing out of pin 4 of U2. At 455 hz, this current is 6 volts/2.2 Kohm=2.73 milliamperes. It is generally desirable, according to the invention, to sweep the 455 hz sweep rate through a total change of 150 hz, i.e., 75 hz either side of 455 hz. Since 75 hz/455 hz=16.5%, the current flowing out of pin 4 must change by 16.5% in each direction, that is, by (16.5%)(2.73 milliamperes)=0.45 milliamperes. The triangle wave from U1 causes this change. The triangle wave changes from 3 volts to 9 volts; therefore, there is 3 volts on either side of 6 volts at pin 4 of U2 to cause the 0.45 milliamperes change. By making $R1=3 \text{ volts}/0.45 \text{ milliamperes}=6.67 \text{ Kohm}$, the sweep rate is changed 75 hz either side of 455 hz. The actual R1 used in FIG. 7 is 6.65 Kohm, a commercially available value giving an actual change of 75.2 hz.

[0254] U3 is an XR-2209 precision oscillator with a center frequency of approximately $1/(RC)=1/((12 \text{ Kohm}+2.5 \text{ Kohm})(330 \text{ microfarad}))=209 \text{ khz}$ with the potentiometer set to its center position of 2.5 Kohm. In the actual circuit, the potentiometer is adjusted to about 100 ohms higher to give the desired 208 khz center frequency. Out of U3 pin 4 flows 6 volts/(12 Kohm+2.5 Kohm+100 ohms)=0.41 milliamperes. To change the center frequency a total of 8 khz, the 0.41 milliamperes is changed by 4 khz/208 khz=1.92%, or 7.88 microamperes. This means that $R2=3 \text{ volts}/7.88 \text{ microamperes}=381 \text{ Kohm}$. In FIG. 7, however, the commercial value of 383 Kohm was used.

[0255] U3 pin 7 has a square wave output that is changing from 204 khz to 212 khz and back to 204 khz at a rate between 380 hz and 530 hz. The actual rate is constantly changing thirty seven times a second as determined by U1.

[0256] U4 is a D flip-flop in a standard divide by two configuration. It squares up any non 50% duty cycle from U3 and provides a frequency range of 102 khz to 106 khz from the 204 khz to 212 khz U3 signal.

[0257] The output of U4 feeds the synchronization logic which is described below and after the description of the generation of the amplitude control signal.

[0258] The two 1N4002 diodes in conjunction with the bridge rectifier form a full wave half sinusoid signal at the input to the 40106 Schmidt trigger inverter. This inverter triggers when the half sinusoid reaches about 7 volts, which on a half sinusoid with an amplitude of 16 times the square root of two is close enough to the zero crossover for a trigger point in a practical circuit. The output of the 40106 Schmidt trigger falls which triggers U5, the edge triggered 4538 monostable multivibrator wired in a trailing edge trigger/retriggerable configuration. The output of U5 goes high for a period determined by the setting on the 500 Kohm poten-

**SUPERINTENDENCIA DE INDUSTRIA Y COMERCIO
DIVISIÓN DE NUEVAS CREACIONES**

2020
Bogotá, D.C.,

Abogado
LUIS FELIPE CASTILLO GIBSON

ASUNTO	Radicación	07-98979
	Trámite	011
	Evento	378
	Actuación	430
	Oficio	No 5 9 8 0
	Folios	021

Patente de Invención	☒	Patente de Modelo de Utilidad	☐
Vía Nacional	☐		
Vía PCT (fase nacional)	☒	Cap. I	☒ Cap. II ☐
No. Sol. Internacional	PCT/US2006/002911		
Fecha de Presentación Internac.	2006-01-27		

Como resultado del examen de fondo, realizado con fundamento en el artículo 45 de la Decisión 486 de la Comisión de la Comunidad Andina, se le comunica:

1. Documentos estudiados

<u>Descripción:</u>	Folios: <u>4</u> a <u>15</u> como se radicó inicialmente
<u>Reivindicaciones:</u>	Folios: <u>16</u> a <u>18</u> como se radicó inicialmente
<u>Dibujos:</u>	Folios: <u>19</u> a <u>22</u> como se radicó inicialmente
<u>Prioridad:</u>	Folio: <u>1</u> . (2005-02-28, US, N° 11/069492).

2. Objeto de la invención

La presente solicitud se titula "CIRCUITO DE POTENCIA PARA CONTROLAR UN TRANSDUCTOR ULTRASONICO DE CARGA VARIABLE", Folio N° 1.

El objeto de la presente solicitud se relaciona con un circuito de alta potencia para impulsar un generador ultrasónico el cual puede alimentar diferentes cargas sin presentar daños.

De otra parte, el pliego reclama un generador ultrasónico para entregar energía ultrasónica de alta potencia a una carga variable, relacionado en las reivindicaciones 1 a 6, y un circuito de potencia para un transductor ultrasónico relacionado en las reivindicaciones 7 a 11.

El objeto de la solicitud definido anteriormente se clasificó en la IPC H04N 5/228.

3. De la solicitud de Patente

3.1. Reivindicaciones (artículo 30 D 486)

Las reivindicaciones calificadas no definen de manera suficientemente clara la materia que se desea proteger. En primer lugar la solicitud presenta un circuito de potencia para controlar un transductor ultrasónico, y la reivindicación reclama un generador ultrasónico, es decir que la materia reclamada no corresponde a la materia que se esta aportando al estado del arte.

Por otro lado, la reivindicación presenta una serie de componentes, pero no establece claramente las relaciones estructurales existentes entre tales componentes. Por ejemplo la reivindicación presenta un modulador de impulsos acoplado con un generador de onda, sin establecer como es tal modulador ni como es el acople con el generador.

La reivindicación 4 especifica la configuración del IGBT en lugar de presentar la forma de conexión de tal dispositivo.

La reivindicación 6 presenta elementos adicionales del generador como lo son un microprocesador y un oscilador, pero no establece la relación funcional ni estructural existente entre estos elementos y el resto de elementos que conforman al generador. Adicionalmente se presentan características de método tal como explorar el rango de frecuencia y registrar la corriente de potencia, lo cual no es permitido en una reivindicación de producto.

Las reivindicaciones 7 a 11 se refieren a un circuito de potencia, sin embargo las características que definen tal circuito son exactamente las mismas que definen el generador de las reivindicaciones 1 a 6. Como se puede ver estas reivindicaciones repiten la materia por lo cual el pliego no es conciso.

Por los motivos anteriores, el pliego reivindicatorio calificado no cumple con los requisitos de claridad y concisión exigidos en el artículo 30 de la Decisión.

4. Determinación del Estado de la Técnica

Considerando que la solicitud reclama prioridad del 28 de febrero de 2005, se buscaron documentos del estado de la técnica relacionados, con fecha de publicación anterior a esta. Se realizo búsqueda de documentos relevantes dentro del estado de la técnica, entendiendo como estado de la técnica la definición provista en el Art. 16 D 486, y las excepciones fijadas en el Art. 17 de la misma.

No obstante, la solicitud presenta problemas de claridad, se realizó una búsqueda parcial la cual se complementara una vez se realicen los ajustes a la solicitud.

Se encontró como anterioridades los documentos relacionados a continuación que pueden afectar la patentabilidad del objeto de la presente solicitud

N°	Documento*	Título	Fecha de publicación
D1	US2005/0017599	APPARATUS, CIRCUITRY, SIGNALS AND METHODS FOR CLEANING AND/OR PROCESSING WITH SOUND	2005-01-27

*los documentos mencionados se anexan al expediente

5. Análisis de patentabilidad (artículo 14 D486)

En cumplimiento del Art. 14 D486 se procedió a evaluar los requisitos de novedad, nivel inventivo y aplicabilidad industrial, con el fin de establecer la patentabilidad de la invención reivindicada de la solicitud en estudio.

5.1. Novedad (artículo 16 D486)

El requisito de novedad se evaluó por comparación entre lo solicitado y los documentos citados en el numeral 4.

La reivindicación 1 se refiere a un generador ultrasónico para entregar energía ultrasónica de alta potencia que comprende:

- Un generador de forma de onda variable.
- Un modulador de duración de impulsos.
- Un transistor bipolar de puerta aislada IGBT que tiene una puerta acoplada con la salida de dicho modulador
- Una fuente de voltaje acoplada a través del colector y emisor de dicho IGBT.
- Un transductor magnetostrictivo.

El documento **D1** se refiere a arreglo de transductores de múltiple frecuencia alimentado por un generador de frecuencia ultrasónico lo cual permite limpiar y procesar mientras se eliminan daños a las piezas que van siendo limpiadas. El dispositivo presentado en este documento esta conformado entre otros por los siguientes elementos:

- Un generador de onda de frecuencia variable **114** (Fig. 6, párrafo [0243])
- Un modulador de impulsos **121** acoplado al generador de onda **114** y configurado para proveer una señal de salida (Figs. 6 y 8, párrafo [0251]).
- Un transistor de puerta aislada IGTB que esta acoplado con la salida del modulador (Fig. 8B, Fig. 57 párrafo [0262]).
- Una fuente de alimentación acoplada al colector y emisor de los transistores IGBT Q1 y Q2 (Fig. 8A y 8B).
- Un transductor magnetostrictivo **122** (Fig. 6).

La reivindicación 2 reclama que el generador esta configurado para generar una onda triangular.

El generador **114** de la anterioridad **D1** (Fig. 6) genera una onda triangular.

La reivindicación 3 reclama que los transistores están en configuración de puente completo.

Las Figuras 8 y 57 del documento **D1** muestran que los transistores están en configuración de puente completo.

La reivindicación 5 reclama que la fuente DC es una fuente regulada.

El documento **D1** muestra que la fuente de alimentación es una fuente regulada.

La reivindicación 6 reclama que el generador además comprende:

- Un microprocesador
- Un oscilador controlado por voltaje

El generador expuesto en **D1** cuenta con microprocesadores (Fig. 79) y un oscilador controlado por voltaje **VCO 91** (Fig. 78A).

Como se puede ver la materia reclamada en las reivindicaciones 1 a 6 se encuentra incluida en la anterioridad **D1** por lo cual se puede concluir que el generador reclamado no tiene novedad.

Las reivindicaciones 7 a 11 comprenden los mismos elementos presentados en las reivindicaciones 1 a 6, motivo por el cual, el circuito de potencia reclamado tampoco tiene novedad.

Es claro que el objeto solicitado no presenta ninguna ventaja o efecto novedoso con respecto al estado del arte, por consiguiente se considera que el objeto de la solicitud no tiene Novedad y no cumple con los requisitos del artículo 14 de la decisión.

6. Conclusión:

Los requisitos de patentabilidad de la presente solicitud se encuentran afectados así:

N°	Documento N°	Reivindicaciones Afectadas	Requisito que Afecta
D1	US2005/0017599	1 a 11	Novedad

Si el interesado desea continuar la tramitación, deberá presentar un pliego reivindicatorio que defina claramente la materia, que se desea proteger, acorde a lo explicado anteriormente.

Se recomienda, que tenga en cuenta que el replanteamiento de esos apartes NO podrá implicar una ampliación de la protección que correspondería a la divulgación contenida en la solicitud inicial, de acuerdo a lo que establece el artículo 34 de la Decisión 486.



En cumplimiento del artículo 45 de la Decisión 486 de la Comisión de la Comunidad Andina, se le indica que debe dar respuesta dentro del término de sesenta días contados a partir de la fecha de notificación de la presente comunicación. En caso de no dar respuesta al presente requerimiento, o si a pesar de la respuesta subsistieran los impedimentos para la concesión, se denegará la patente.

Notifíquese el presente oficio conforme a lo dispuesto en el numeral 5.2, literal e), del capítulo quinto del título primero de la Circular Única N° 10 de 2001.



ALIX CARMENZA CÉSPEDES DE VERGEL
Jefe de División de Nuevas Creaciones

El anterior requerimiento fue notificado por fijación en lista, de fecha
22 MAYO 2009

CONCEPTO TÉCNICO No. 1166	EXAMINADOR TÉCNICO Código No. 202082
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