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[54] **METHOD AND APPARATUS FOR FLUID IMPREGNATION UTILIZING SONIC MECHANICAL VIBRATION**

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Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 454,335, May 10, 1965, abandoned.

[52] **U.S. Cl.**.....**117/113**, 21/7, 47/58, 111/1, 111/7, 117/115, 117/147, 117/148, 118/429, 118/423, 401/126, 401/138

[51] **Int. Cl.**.....**B44d 1/06**

[58] **Field of Search**.....117/113, 115; 111/1, 7; 47/58; 401/126, 138, 8, 6

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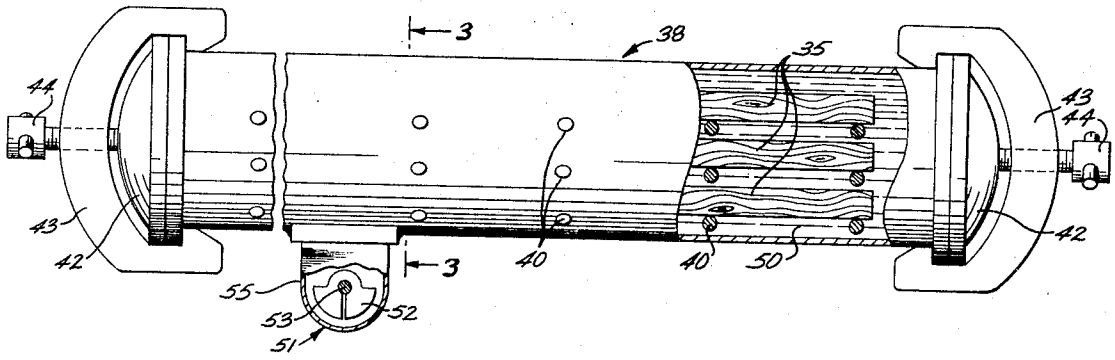
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[57] **ABSTRACT**

A solid material to be impregnated with a liquid material is held in intimate contact with such liquid material. High-level sonic energy is applied to the materials to cause thorough impregnation of the solid by the liquid. This sonic energy is provided from a resonant vibration system which is vibrationally excited at a resonant frequency by means of an orbiting mass oscillator which is coupled thereto, such oscillator automatically adjusting its frequency to maintain resonant vibration of the system.

14 Claims, 10 Drawing Figures



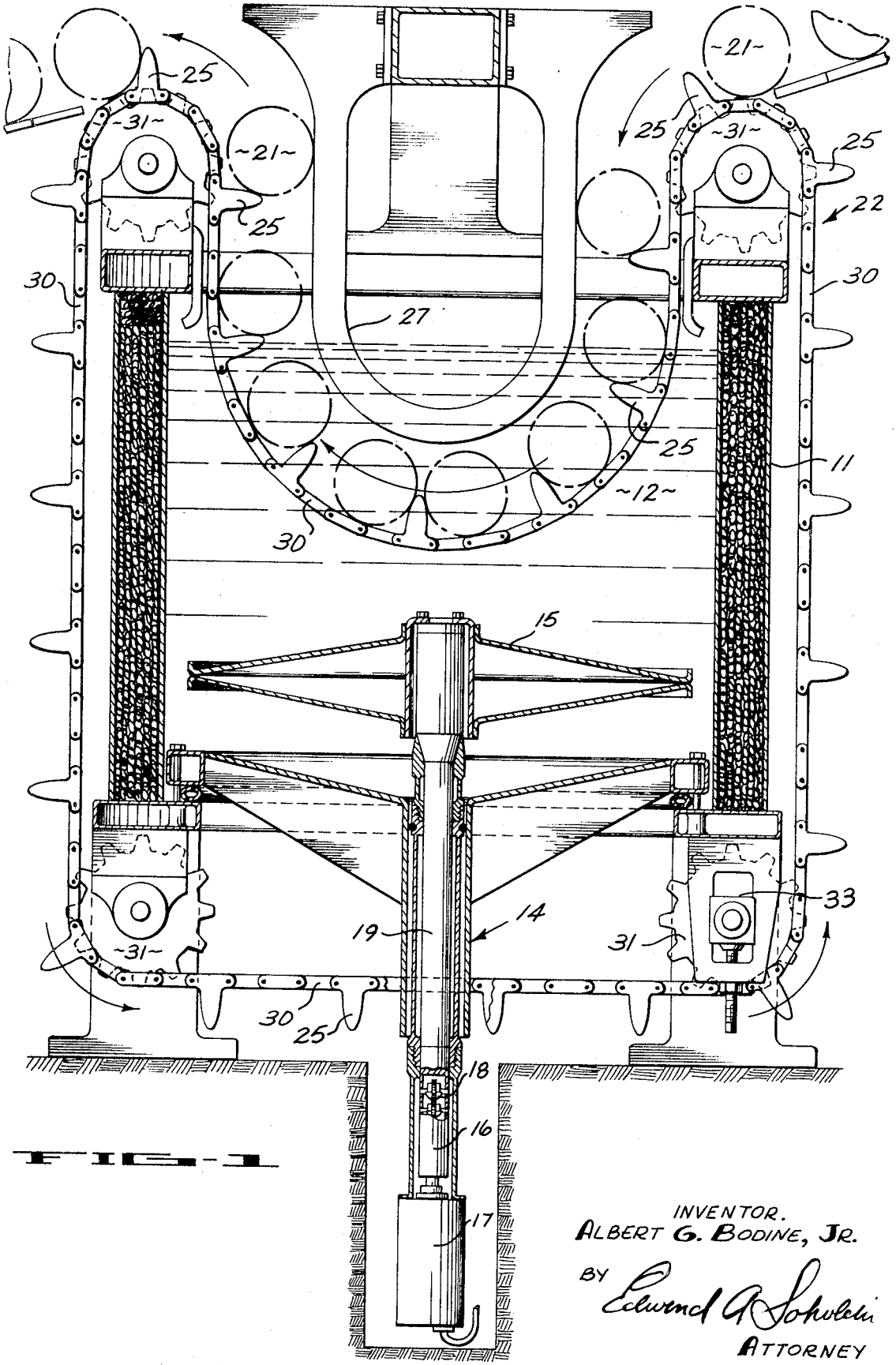
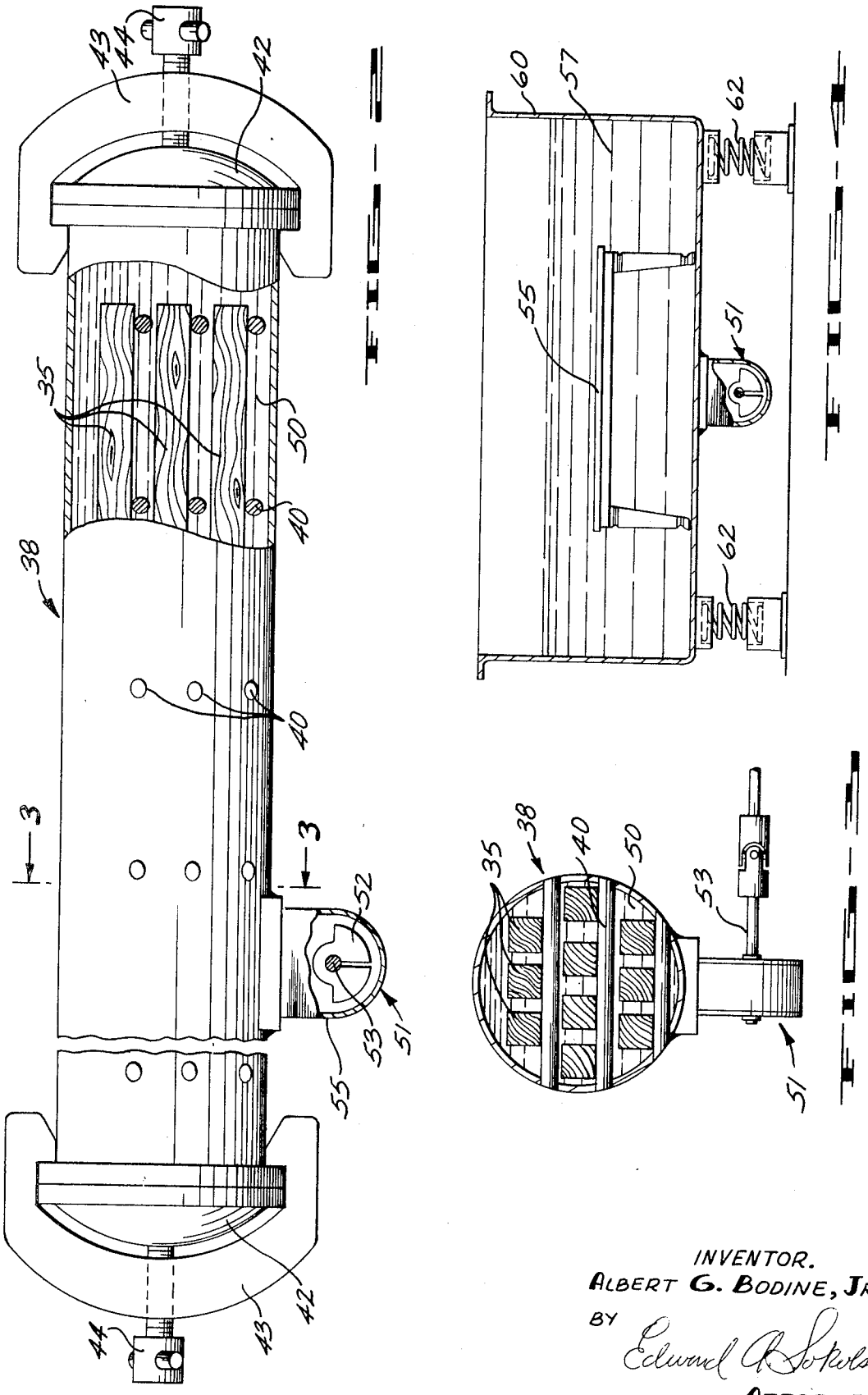


FIG. 1

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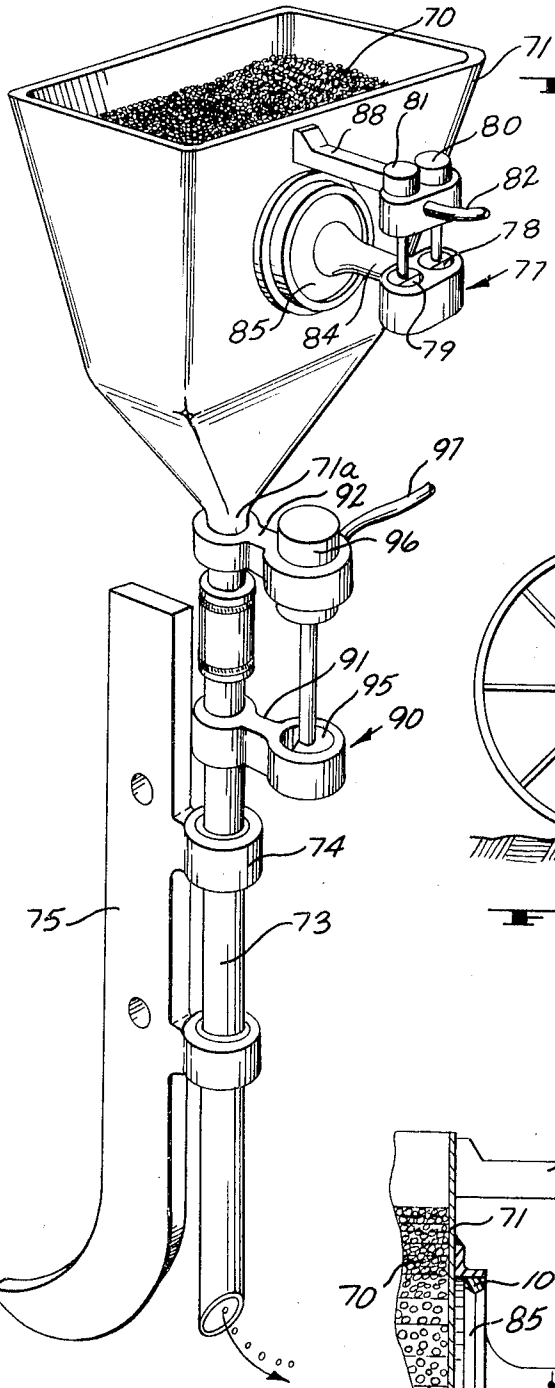


FIG. 5

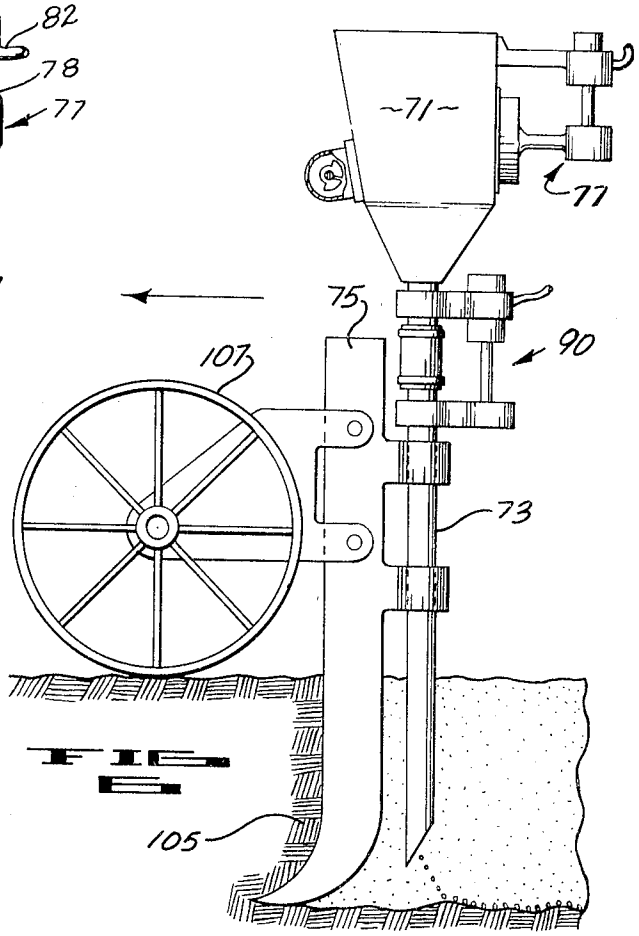


FIG. 6

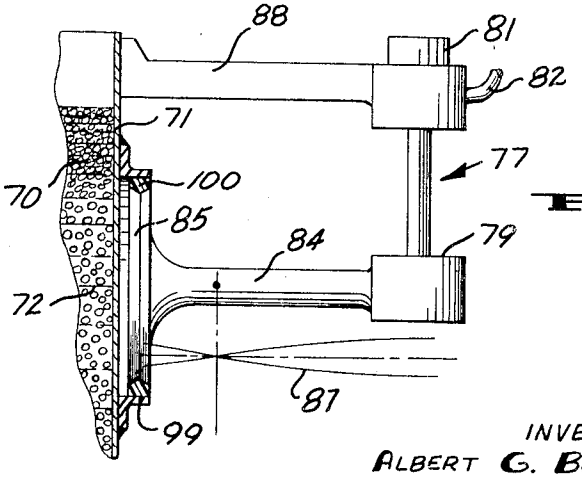


FIG. 7

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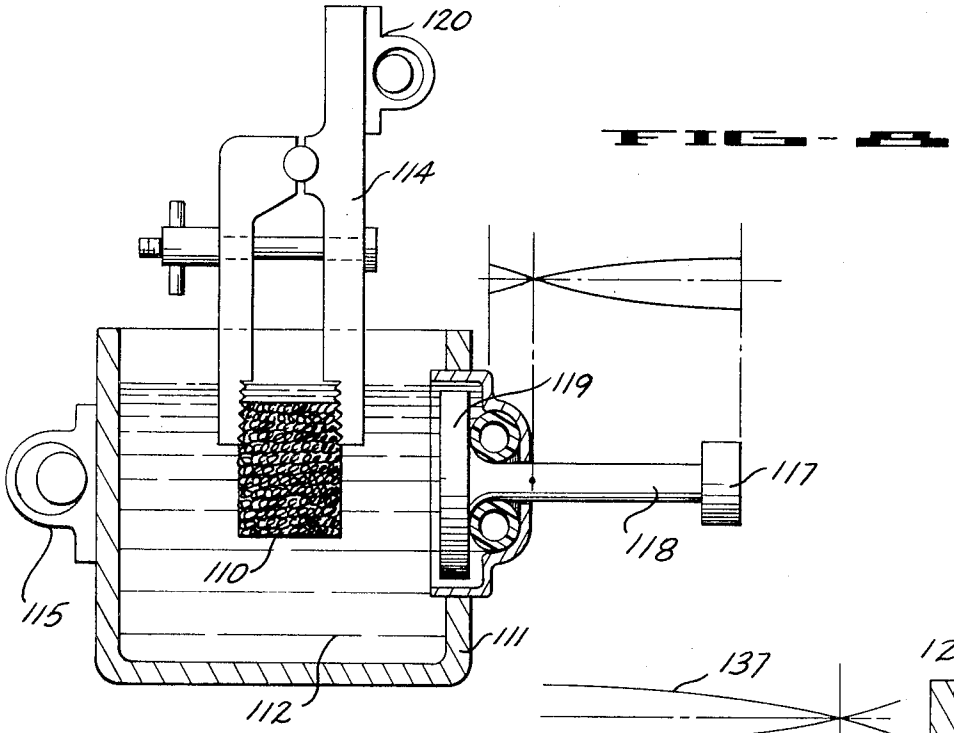


FIG. 8

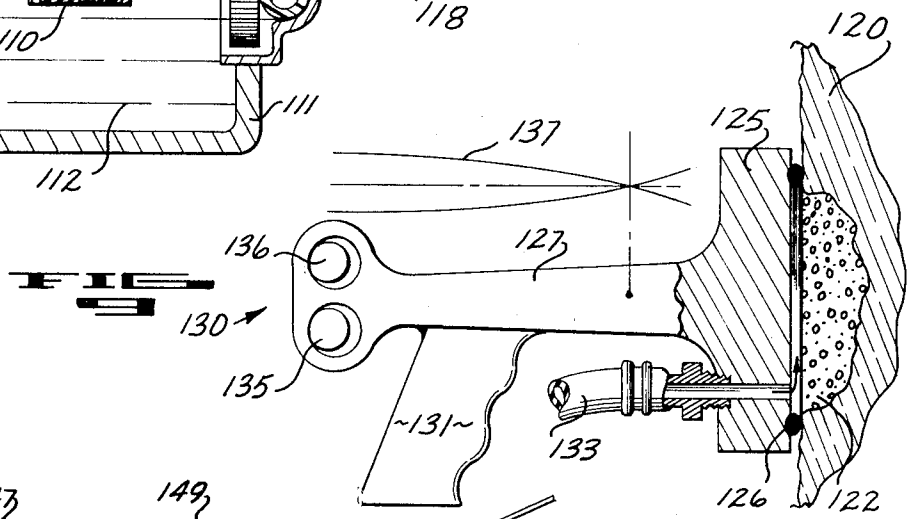


FIG. 9

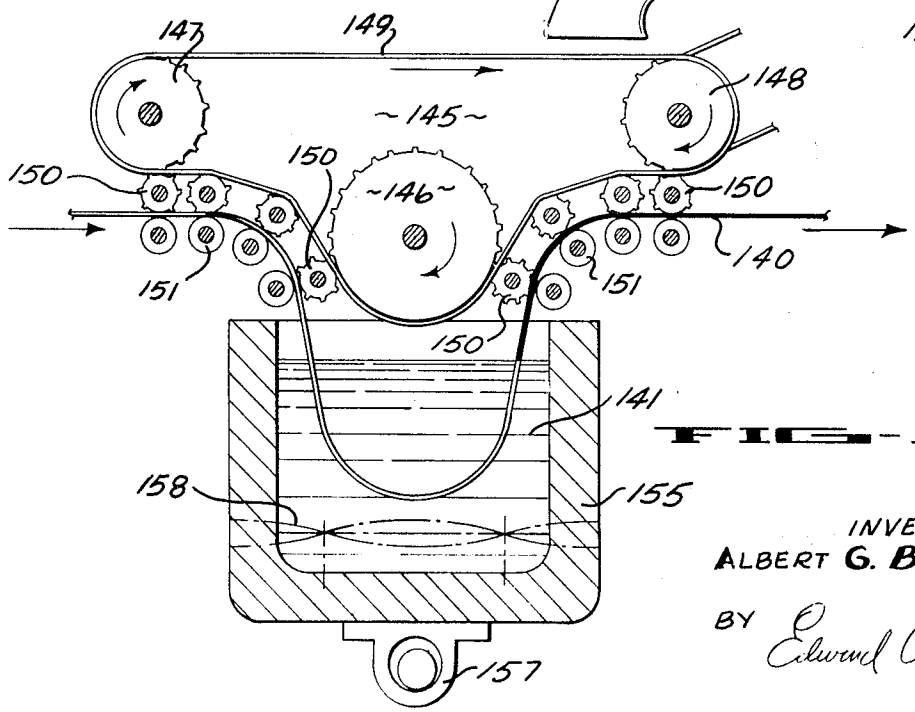


FIG. 10

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METHOD AND APPARATUS FOR FLUID IMPREGNATION UTILIZING SONIC MECHANICAL VIBRATION

This application is a continuation-in-part of my application, Ser. No. 454,335, filed May 10, 1965, now abandoned.

This invention relates to a method and apparatus for the fluid impregnation of material by means of mechanical sonic vibration, and more particularly to such a method and apparatus whereby relative elastic vibration is achieved between the member to be impregnated and an impregnation fluid with which it is in contact so as to cause thorough intermingling of the particles of said member and such fluid.

This invention provides methods and apparatus enabling the liquid impregnation of various types of solid structures with fluids to attain various desirable end results, such as, for example, the water impregnation of seeds to facilitate the germination thereof, the impregnation of certain material with pesticide, the impregnation of certain members with metallic fluids, and the plastic impregnation of certain members.

The use of sonic energy in the impregnation of solid material with fluid material in accordance with the methods and apparatus of this invention offers several advantages. Firstly, more effective penetration of the solid structure with the fluid is achieved. This is particularly advantageous in the plastic impregnation of wood in that it enables the utilization of higher viscosity plastics than heretofore feasible. Secondly, close control of the impregnation process is possible so that ideal impregnation can be achieved and overimpregnation avoided. This control capability has advantages in the water impregnation of seeds in that oversonic activation which might damage the seeds can be avoided. Also such control of the sonic energization enables the control of thermosetting where thermosetting plastic material is involved. Thirdly, the sonic action removes moisture, etc., from the material being impregnated, thus avoiding the necessity for drying same prior to impregnation.

It is helpful to the comprehension of this invention to make an analogy between a mechanical resonant circuit and an electrical resonant circuit. This type of analogy is well known to those skilled in the art and is described, for example, in Chapter 2 of *Sonics* by Hueter and Bolt, published in 1955 by John Wiley and Sons. In making such an analogy, force, F, is equated with electrical voltage, E; velocity of vibration, u, is equated with electrical current, i; mechanical compliance, C_m, is equated with electrical capacitance, C_e; mass M, is equated with electrical inductance, L; mechanical resistance (friction), R_m, is equated with electrical resistance, R; and mechanical impedance, Z_m, is equated with electrical impedance, Z_e. Thus, it can be shown that if a member is elastically vibrated by a sinusoidal force, $F_0 \sin \omega t$, ω being equal to 2π times the frequency of vibration, that

$$Z_m = R_m + j(\omega M - 1/\omega C_m) = f_0 \sin \omega t/u \quad (1)$$

Where ωM is equal to $1/\omega C_m$, a resonant condition exists, and the effective mechanical impedance, Z_m, is equal to the mechanical resistance, R_m, the reactive impedance components, ωM and $1/\omega C_m$, cancelling each other out. Under such a resonant condition, velocity of vibration, u, is at a maximum, effective power factor is unity, and energy is most efficiently delivered to the object being vibrated. It is such a high efficiency resonant condition in the elastic system being driven that is preferably utilized in the methods and devices of this invention to achieve the desired end results.

It is to be noted by reference to equation (1) that velocity of vibration, u, is highest where impedance, Z_m, is lowest, and vice versa. Therefore, a high impedance load will tend to vibrate at relatively low velocity, and vice versa. Thus, at an interface between high and low-impedance elements, a high relative movement results by virtue of such impedance mismatch which, as in the equivalent electrical circuit, results in a high reflected wave. Such an impedance mismatch between a "host" material and a fluid impregnating "intruder" results in high relative motion between the two materials and low friction therebetween, which facilitates the movement of the intruder into the host.

Just as the sharpness of resonance of an electrical circuit, is defined as the "Q" thereof, and is indicative of the ratio of energy stored to the energy used in each cycle, so also the "Q" of a mechanical resonant circuit has the same significance and is equal to the ratio between ωM and R_m. Thus, high efficiency and considerable cyclic motion can be achieved by designing the mechanical resonant circuit for high "Q."

Of particular significance in the implementation of the methods and devices of this invention is the high acceleration of the components of the elastic-resonant system that can be achieved at sonic frequencies. It can be shown that the acceleration of a vibrating mass is a function of the square of the frequency of the drive signal times the amplitude of vibration. Under resonant conditions, the amplitude of vibration is at a maximum and thus even at moderately high sonic frequencies very high accelerations are achieved. Such high acceleration of the vibrating system results in high fluidization of the intruder medium, such that such medium behaves like it has a greatly reduced viscosity. This is particularly evident where the intruder has high internal friction, such as in the case of granular material and the like. This reduced effective viscosity achieved by means of this invention is significant, for example, in the impregnation of wooden surfaces with plastic material in that it facilitates the use of higher viscosity plastics which often afford certain advantages.

In considering equation (1), several factors are to be noted. First, this equation represents the total effective resistance, mass, and compliance in a vibrating circuit, and these parameters are generally distributed throughout the system rather than being lumped in any one component or portion thereof. Secondly, the vibrating system often includes surrounding components, a conduit holding the fluid material and the fluid material itself. Thus, it may be desirable to purposely add members exhibiting predominantly compliance, C_m, or mass, M, characteristics to balance out one or the other of these parameters to make for a resonant system.

It is important to note that by involving a matrix in such a resonant "circuit" or system, it is possible to cause cyclic elastic distortion of the matrix so as to cyclically change the dimensions of the interstices and thus increase the mobility of fluids therein.

It is also to be noted that orbiting mass oscillators are utilized in the devices of the invention that automatically adjust their output frequencies to maintain resonance with changes in the characteristics of the load. Thus, in situations where we are dealing with fluid material which changes in its characteristics during the impregnation process, the system automatically is maintained in optimum resonant operation by virtue of the "lock in" characteristics of applicant's orbiting mass oscillators. The vibrational outputs from such orbiting mass oscillators are generated along a controlled predetermined coherent path to provide maximum output along a desired axis or axes. The orbiting mass oscillator automatically changes not only its frequency but its phase angle and therefore its power factor with changes in the impedance load to assure optimum efficiency of operation at all times. Such orbiting mass oscillators are capable of efficiently generating high level vibrational outputs.

The devices and methods of this invention thus enable the thorough impregnation of a host material by a fluid intruder medium by virtue of sonic vibrational energy. Such sonic activation enables superior end results in such operations as, for example, the water impregnation of seeds to hasten germination and the impregnation of wood with fluid material, such as in pest control, or the plastic impregnation of wood members. The sonic action has several effects contributing to these better end results, including the degassing and cleansing of the host surfaces to facilitate close molecular contact between the host and intruder, the dispelling of electrostatic forces between the materials to be interspersed thereby permitting intimate contact therebetween and the causing of the host material to have elastic dimensional changes or, so to speak, to "breath," so as to literally cause the intruder to be pumped through the interstices of the host.

It is therefore an object of this invention to provide an improved method and apparatus for enabling the thorough impregnation of a material with a fluid medium.

It is a further object of this invention to enable an improved impregnation of solid members with a liquid medium.

It is still another object of this invention to lessen the time necessary for thorough impregnation of a member with a liquid medium.

It is still a further object of this invention to speed up the germination of seeds by means of sonic energy.

It is still a further object of this invention to facilitate the impregnation of wood members with a liquid medium.

It is still another object of this invention to enable the close control of the impregnation of material with a liquid medium.

Other objects of this invention will become apparent from the following description taken in connection with the accompanying drawings, of which

FIG. **1** is an elevational view illustrating a first embodiment of the device of the invention utilizing a conveyor system suitable for the fluid impregnation of members,

FIG. **2** is an elevational view illustrating an embodiment of the device of the invention utilizing a pressure vessel suitable for fluid impregnating members,

FIG. **3** is a cross-sectional view of the embodiment of FIG. **2** taken along the plane indicated by **3**—**3** in FIG. **2**,

FIG. **4** is an elevational view of a third embodiment of the device of the invention suitable for the plastic impregnation of assembled pieces of furniture,

FIG. **5** is a perspective view of a fourth embodiment of the device of the invention suitable for the fluid impregnation of seeds,

FIG. **6** is an elevational view illustrating the use of the embodiment of FIG. **5** in planting seeds,

FIG. **7** is an elevational view showing the details of the resonant oscillator unit of the embodiment of FIG. **5**,

FIg. **8** is an elevational view illustrating an embodiment of the device of the invention suitable for fluid impregnating sintered metal and the like,

FIG. **9** is an elevational view of an embodiment of the device of the invention suitable for use in the fluid impregnation of flat surface areas such as walls and the like, and

FIG. **10** is an elevational view illustrating an embodiment of the device of the invention suitable for the liquid impregnation of flat sheets of material in a continuously moving conveyor-type operation.

Referring now to FIG. **1**, a method and embodiment of the invention utilizing a conveyor device for the liquid impregnation of members such as wooden logs is illustrated. This device and process is useful, for example, in the impregnation of logs with pesticide.

Tub **11** is filled with liquid pesticide **12**. Vibration generator **14** is installed in tub **11** with its vibration radiator dome **15** immersed in liquid **12** so as to impart vibrational energy thereto. Vibration generator **14** comprises an orbiting mass oscillator **16** having eccentric rotors **18** which are rotationally driven by motor **17**, the orbiting mass oscillator generating mechanical vibrational energy in the sonic-frequency range. This energy is transferred to radiating dome **15** through casing member **19**. Vibration generator **14** may be of the type described in my U.S. Pat. No. 3,033,158, filed May 8, 1962.

Logs **21** to be impregnated with liquid **12** are fed in a continual flow through the liquid on conveyor **22**, the logs being held onto the conveyor as they pass through the liquid by means of tooth members **25** operating in conjunction with positioning member **27**. Conveyor **22** comprises an endless chain **30** which is driven by means of sprocket wheels **31**, one of said sprocket wheels being driven by motor **33**.

Logs **21** as they pass through liquid **12** are thoroughly impregnated with such liquid by virtue of the high level vibrational energy imparted to the liquid by means of radiating dome **15**. In penetrating into the wood structure, the impregnation liquid displaces fluids such as moisture, natural sap, and the like, thus effectively "washing out" such wood structure. This obviates the necessity for thoroughly drying the wood prior to impregnation. The vibrational energy also removes gases and dirt from the wood structure, thus assuring intimate contact between the liquid and solid structures in effecting the desired thorough impregnation.

The degree and speed of impregnation can be controlled by either varying the speed of conveyor **22** and/or the vibrational output of vibration generator **14**. Thus, and desired degree and rate of impregnation can be obtained to suit particular application requirements. It is to be noted that while the device and method illustrated in FIG. **1** has been suggested as suitable for the impregnation of logs with pesticide, it may be utilized to equal advantage for impregnating such members with other liquid substances, such as, for example, plastic material or pigmentation, etc.

Referring now to FIGS. **2** and **3**, an embodiment of the device of the invention suitable for the liquid impregnation of timbers is illustrated. This embodiment is shown as being utilized for the impregnation of wooden beams **35**. This embodiment is particularly suitable for the plastic impregnation of such members.

Beams **35** are supported within pressurized container member or autoclave **38** on bars **40**. Bars **40** are supported in the sides of the container. Autoclave **38**, which is substantially cylindrical in shape, has end pressure covers **42** which are held in place in fluidtight relationship with the main body of the container by means of clamping members **43**. Clamping members **43** are tightened in place by means of threaded handle members **44**. Container **38** is filled with the impregnation liquid **50**.

Attached to the wall of container **38** is orbiting mass oscillator **51**. Oscillator **51** includes rotatably mounted eccentric rotor unit **52** which is rotatably driven on shaft **53** by means of motor (not shown). With the rotation of rotor **52**, vibrational energy is generated in oscillator housing **55** and this energy is transferred to container **38**. The rotation speed of rotor **52** is preferably adjusted so as to cause resonant vibration of container **38**, thus providing optimum vibrational output. As already noted, once such a vibrational condition has been setup, orbiting mass oscillator **51** tends to automatically adjust its rotation frequency to maintain such resonant condition. The vibrational energy is transferred from the walls of container **38** to the impregnation liquid **50** and thus highly efficient impregnation of beam members **35** is achieved. The degree of impregnation can be precisely controlled by controlling the impregnation time and the amplitude of the vibrational energy utilized. Thus, depending on the particular materials utilized and the end results desired, the impregnation precess can be varied as necessary.

Referring now to FIG. **4**, the impregnation of completed pieces of furniture is illustrated. A table **55** to be impregnated with liquid plastic **57** is shown. Table **55** is placed within vat **60** which is filled with the impregnation plastic **57**. Sonic energy is imparted to vat **60** and thence to liquid **57** by means of orbiting mass oscillator **51**, which is similar to the orbiting mass oscillator described in connection with FIGS. **2** and **3**. Vat **60** is mounted on vibration isolators **62** to minimize the transfer of vibrational energy to surrounding members. The entire table is thus impregnated with the plastic. The plastic impregnation of completely assembled units, such as table **55**, has the advantage of solidifying the joints by virtue of the plastic impregnation thereof. This makes for strong joints without the necessity for taking any pains along these lines in the assembly of the furniture. Thus, temporary holding joints can be utilized in the initial assembly with the final holding action being provided in the plastic impregnation process.

The utilization of the apparatus and method of this invention for the plastic impregnation of wooden members has several advantages. First, the utilization of sonic energy to achieve impregnation provides a thorough filling of the wood pores with the plastic material, such filling going well below the wood surface. This makes for an end product having superior strength, rigidity and moisture resistant characteristics. Close control can be exercised over the impregnation process

and thus the thermosetting of the plastic material can be controlled and overpenetration of the wooden members avoided. Further, the sonic action removes moisture, dirt and impurities from the wood so that it need not be dried and thoroughly cleaned prior to impregnation. Thus, greener wood can be utilized and less care in the pretreatment of the wood is necessary.

It is to be noted that the sonic impregnation technique described is not only applicable to solid wood structure but may also be used in causing the penetration and wetting of adhesives and plastics into particulate wood materials such as wood chips in the fabrication of fiberboard and wood board. Thus, thorough impregnation of such particles can be achieved with the particles joining together with the solidification of the liquid to form a homogeneous mass.

It is further to be noted that the technique described can be utilized to cause water or other liquid media to penetrate into wood and actually disintegrate the wood in the fabrication of pulp. This is particularly useful in making fiberboard and paper. The pulp so formed can subsequently be dehydrated by means of sonic energy, such sonic vibration during the drying process resulting in a good random and intimate arrangement of the particles to provide a superior fiber structure in the end product.

An autoclave-type container as shown in FIGS. **2** and **3** can be utilized in either of the fiberboard or paper processes just described.

Referring now to FIGS. **5–7**, an embodiment of the device of the invention for planting seeds is shown. Seeds to be planted **70** are placed in hopper **71** which is filled with a liquid **72** which may comprise water or a liquid fertilizer solution. The bottom end **71***a* of hopper **71** is open and feeds into tube member **73**. Attached to tube member **73** by means of ring clamps **74** is cultivator member **75**. Orbiting mass oscillator unit **77** comprises a pair of eccentric rotors **78** and **79**, which are driven in opposite directions by means of pneumatic motors **80** and **81** respectively. Pneumatic motors **80** and **81** utilize conventional turbine blades (not shown) which are driven by an airstream fed thereto through pneumatic line **82**. Rotors **78** and **79** are phased with respect to each other as indicated in FIG. **5**, so that vibrational components along the longitudinal axis of vibration arm **84** are additive and vibrational components transverse to this longitudinal axis effectively cancel each other out. The rotation frequency of rotors **78** and **79** is such as to set up standing wave resonant vibration of vibration arm **84** and its associated vibration disc **85**, as indicated in FIG. **7** by graph line **87**. The oscillator motor assembly is supported on the wall of hopper **71** by means of support bracket **88**.

Disc member **85** is abutted tightly against the surface of hopper **71**, being resiliently held within ring member **99** by means of rubber O-ring **100**. Ring member **99** is fixedly attached to the wall of hopper **71** as, for example, by welding. Arm **84** thus, in response to the vibrational output of oscillator **77**, longitudinally vibrates disc **85** against the wall of hopper **71**, this vibrational energy being transferred to the wall of the hopper. If desired, the portion of the hopper wall opposite disc **85** can be cut out so as to permit disc **85** to apply its resonant sonic energy directly to the contents of the hopper.

A second orbiting mass oscillator unit **90** is mounted on tube member **83** by means of mounting brackets **91** and **92**. Oscillator unit **90** utilizes a single eccentric rotor **95** which is driven by pneumatic motor **96**, which receives its pneumatic drive through input line **97**. Oscillator **90** sets up both torsional and transverse vibrations in tube member **73**.

The high level resonant vibration of arm **84** provides high-amplitude vibrational energy to the liquid and seeds within hopper **71**. Such resonant condition is maintained by virtue of the lock-in characteristics of orbiting mass oscillator **77**. The sonic energy acts on the seeds to cause thorough liquid impregnation thereof and acts both to start the germination process and to soften the seed shells to ease the passage of the first sprouts therethrough. It is important to avoid damage to the seeds and therefore that the application of sonic energy be closely controlled. This can be accomplished either by regulating the power level of the oscillator output, controlling the time interval during which sonic energy is applied, or controlling the rate at which the seeds pass through tube **73**.

Referring now to FIG. **6**, the utilization of the device of the invention described in connection with FIGS. **5** and **7** in planting seeds is illustrated. Cultivator **75** is drawn through the earth **105** to be planted by means of wheel member **107** which is attached to appropriate locomotion means (not shown). Sonic energy is not only utilized in preparing the seed, as described in connection with FIGS. **5** and **7**, but also passes from tube **73** through cultivator **75** to the earth **105** where it acts to fluidize the soil. This brings the soil into more intimate contact with the seedlings thereby improving the planting action.

In treating relatively obdurate seeds, such as, for example, cottonseed, it is often desirable to utilize separate sonic treatment of the seed for some time prior to the planting operation. It has been found that superior results can sometimes be achieved if the seeds are first sonically treated as described in connection with FIGS. **5** and **6** prior to planting, then allowed to soak without sonic activation for a period of time, and finally removed from the liquid and allowed to sit for a time in the air. The seeds so pretreated can then be planted in normal fashion, (i.e., without further sonic activation) except perhaps for the sonic excitation of the cultivator to facilitate the planting operation.

Referring now to FIG. **8**, the utilization of the technique of the invention for fluid impregnating metallic material is shown. This embodiment is suitable, for example, in impregnating sintered metal with oil where a preoiled bearing is desired.

The sintered metal workpiece **110** is supported within container **111** submersed in the impregnation liquid **112** by means of holder **114**. Container **111** is sonically excited by orbiting mass oscillator **115**, while the liquid **112** is sonically activated by means of orbiting mass oscillator **117** which resonantly vibrates shaft **118**, which in turn drives disc **119** which is immersed in the liquid. Holder **114** is sonically activated by means of orbiting mass oscillator **120**. Thus, the workpiece **110**, the container **111** and fluid **112** are all simultaneously sonically activated.

Orbiting mass oscillators **115**, **117** and **120** may be of the type utilizing a rotor which rides around in a raceway formed in the oscillator housing, as described, for example, in connection with FIGS. **21** and **22** of my U.S. Pat. No. 2,960,314 filed Nov. 15, 1960. By virtue of the high-level sonic activation, sintered material **110** is in a relatively short period of time thoroughly impregnated with the fluid **112** which, as indicated, may for example comprise a lubricating oil, a plastic, or a molten metal.

Referring now to FIG. **9**, a device for the liquid impregnation of wall surfaces is illustrated. This embodiment is particularly suitable for impregnating a wall **120** with a coating material **122** which may, for example, comprise a protective plastic. Applicator head **125** may be circular in configuration and has an O-ring **126** imbedded in its face. Extending from applicator head **125** is an arm **127** at the extreme end of which is an orbiting mass oscillator **130**. Handle member **131**, usually located near a quiescent node in the sonic pattern **137**, is provided to enable an operator to hold the applicator head opposite wall **120** with O-ring **126** abutting against the wall. The liquid material with which the wall is to be impregnated is fed into the space contained by O-ring **126** through inlet pipe **133**.

Orbiting mass oscillator **130** includes a pair of rotor units **135** and **136**, which are phased in the manner described for oscillator **77** in connection with FIG. **5**, so as to generate vibrational energy solely along the longitudinal axis of arm **127**. The frequency of rotation of rotors **135** and **136** is adjusted to cause resonant vibration so as to set up standing waves **137** in arm **127** and the associated members. Orbiting

mass oscillators 135 and 136 tend to maintain such resonant vibration by in effect "locking in" with the vibrational load. The vibrational energy transferred from head 125 to liquid and thence to the wall material causes thorough impregnation of the wall with the liquid in a relatively short period of time by virtue of the sonic energy, in the same general fashion as heretofore explained. Oscillator unit 130 may be of the same type as oscillator units 115 and 120 (see FIG. 8) as described in the aforementioned U.S. Pat. No. 2,960,314.

Referring now to FIG. 10, the utilization of the technique of the invention for liquid impregnating flexible sheets of material is illustrated. The flexible sheet material 140 to be impregnated is passed through the impregnation liquid 141 by means of roller drive mechanism 145. Roller drive mechanism 145 may include a drive wheel 146 which is rotatably driven by a motor (not shown), which in turn drives wheels 147 and 148 by means of drive belt 149. Wheels 146–148 by virtue of their gear teeth mesh with and drive associated ones of roller wheels 150, which operating in conjunction with idler wheels 151 drive flexible sheet 140.

Container 155, which holds liquid 141 therein, has an orbiting mass oscillator 157 fixedly attached thereto. Orbiting mass oscillator 157, which may be similar in configuration to those described in connection with FIGS. 8 and 9, is adjusted to have a vibrational output at a frequency which sets up standing waves 158 in container 155. The high-level resonant vibrational energy set up in liquid 141 causes thorough impregnation of sheet material 140 thereby.

The techniques and apparatuses of this invention thus provide means for facilitating the thorough liquid impregnation of solids with fluid material by virtue of sonic energy. The sonic impregnation not only affords a more efficient impregnating action, but also provides certain side benefits such as the removal of unwanted matter such as dirt, impurities and moisture from the impregnated material and the working of the material to place it in better condition for its subsequent use. The sonic techniques involved have the further advantage of lending themselves to close control of the impregnation operation so that the material can be impregnated to the precise desired amount.

While the methods and devices of the invention have been described and illustrated in detail it is to be clearly understood that this is intended by way of illustration and example only and is not to be taken by way of limitation, the spirit and scope of this invention being limited only by the terms of the following claims.

I claim:

1. Apparatus for the fluid impregnation of a solid wall surface material with a liquid material comprising:
- an applicator head for holding said wall surface material in intimate contact with said liquid material,
- means in said applicator head for forming liquid container means when said applicator head is placed against said wall surface material,
- means for feeding said liquid material into said liquid container means,
- are means extending from said applicator head,
- means for sonically activating at least one of said materials, said last mentioned means including an orbiting mass oscillator, a resonant-vibration system including said are means coupled to said oscillator to receive the vibrational output thereof, and means for driving said oscillator at a frequency such as to cause resonant elastic vibration of said system, said oscillator being adapted to automatically adjust its frequency to maintain resonant vibration of said system, and
- means for controlling the application of said sonic energy to said materials to cause impregnation of said solid material by said liquid material to a predesired amount.

2. The apparatus as recited in claim 1 wherein said means in said applicator head forming liquid container means comprises an O-ring imbedded in the face of said applicator head.

3. Apparatus for the fluid impregnation of solid material with a liquid material comprising:
- means for holding said solid material in intimate contact with said liquid material including a container for holding said liquid material and means for immersing said solid material in said liquid material comprising holder means for suspending said solid material in said liquid material,
- means for sonically activating said materials including a first orbiting mass oscillator attached to said holder means, a second orbiting mass oscillator attached to said container, a third orbiting mass oscillator, means for connecting the output of said third oscillator to said liquid material, a resonant-vibration system coupled to at least one of said oscillators to receive the vibrational output thereof and means for driving at least said one of said oscillators at a frequency such as to cause resonant elastic vibration of said vibration system, said oscillator being adapted to automatically adjust its frequency to maintain resonant vibration of said system, and
- means for controlling the application of said sonic energy to said materials to cause the impregnation of said solid material by said liquid material to a predesired amount.

4. The apparatus as recited in claim 3 wherein said means for connecting the output of said third orbiting mass oscillator to said liquid material comprises a disc immersed in said liquid material and a shaft attached to said disc, said third orbiting mass oscillator being attached to said shaft.

5. Apparatus for the fluid impregnation of seeds with a liquid material including water comprising:
- means for holding said seeds in intimate contact with said liquid material including a container for holding said material and means for holding the seeds in the container immersed in the liquid material,
- tube means extending from the bottom of the container for providing an exit channel from said container for said seeds,
- means for sonically activating said seeds and liquid material comprising a first orbiting mass oscillator unit coupled to said tube means and a second orbiting mass oscillator coupled to the wall of the container, a resonant-vibration system coupled to at least one of said oscillators to receive the vibrational output thereof and means for driving at least said one of said oscillators at a frequency such as to cause resonant elastic vibration of said system, said oscillator being adapted to automatically adjust its frequency to maintain resonant vibration of said system, and
- means for controlling the application of said sonic energy to said seeds and said liquid material to cause impregnation of the seeds by the liquid material to a predesired amount.

6. The apparatus as recited in claim 5 wherein said second orbiting mass oscillator unit includes a vibration arm, an orbiting mass oscillator mounted on said vibration arm for causing resonant vibration thereof, and a vibration disc coupling said arm to the wall of said container.

7. The apparatus as recited in claim 5 and further including cultivator means attached to said tube means for coupling sonic energy to the soil in which the seeds are being planted so as to cause the fluidization of such soil.

8. A method for impregnating wood material with liquid plastic material comprising the steps of:
- placing the wood into intimate contact with the plastic,
- applying high-level mechanical sonic-vibrational energy to cause resonant elastic vibration of at least one of said materials, and
- terminating the application of said sonic energy to said materials when said plastic has impregnated said wood to a predetermined degree.

9. The method as recited in claim 8 wherein said solid material is an assembled piece of furniture.

10. The method as recited in claim 8 wherein said wood is placed in an autoclave filled with said plastic and the walls of said autoclave are sonically excited by means of an orbiting mass oscillator attached thereto.

11. A method for impregnating wood timbers with liquid pesticide comprising the steps of:
- placing the pesticide in a container,

bringing the timbers into intimate contact with the pesticide by passing the timbers through the pesticide by means of a conveyor belt,

applying high-level sonic energy from an orbiting mass oscillator to the pesticide to cause resonant vibration thereof,

said timbers being passed through the pesticide at a predetermined rate of speed so that the application of sonic energy to the timbers is terminated when the liquid material has impregnated the solid material to a predetermined degree.

12. A method for impregnating seeds with a liquid material including water held in a container comprising the steps of:

immersing the seeds in the liquid material to provide intimate contact therebetween,

applying high-level mechanical sonic-vibrational energy to cause resonant elastic vibration of at least one of said materials, and

passing the seeds from an aperture at the bottom of the container into the soil at a predetermined rate so that the application of sonic energy is terminated when the liquid material has impregnated the seeds to a predetermined degree.

13 The method as recited in claim 12 and additionally including the step of sonically exciting a cultivator connected to said container to fluidize the soil as the seeds are dropped therein.

14. A method for preparing seeds for planting comprising the steps of

placing a liquid comprising water in a container,

immersing the seeds in said liquid,

applying a predetermined amount of high-level mechanical sonic energy to a resonant-vibration system including at least one of said seeds and said liquid,

allowing said seeds to soak in said liquid for a period of time without sonic activation, and

removing said seeds from the liquid and allowing them to sit in the air for a period of time.

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