June 2, 1964 A. G. BODINE, JR 3,134,990

SONIC LAUNDERING MACHINE

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Fig. 1

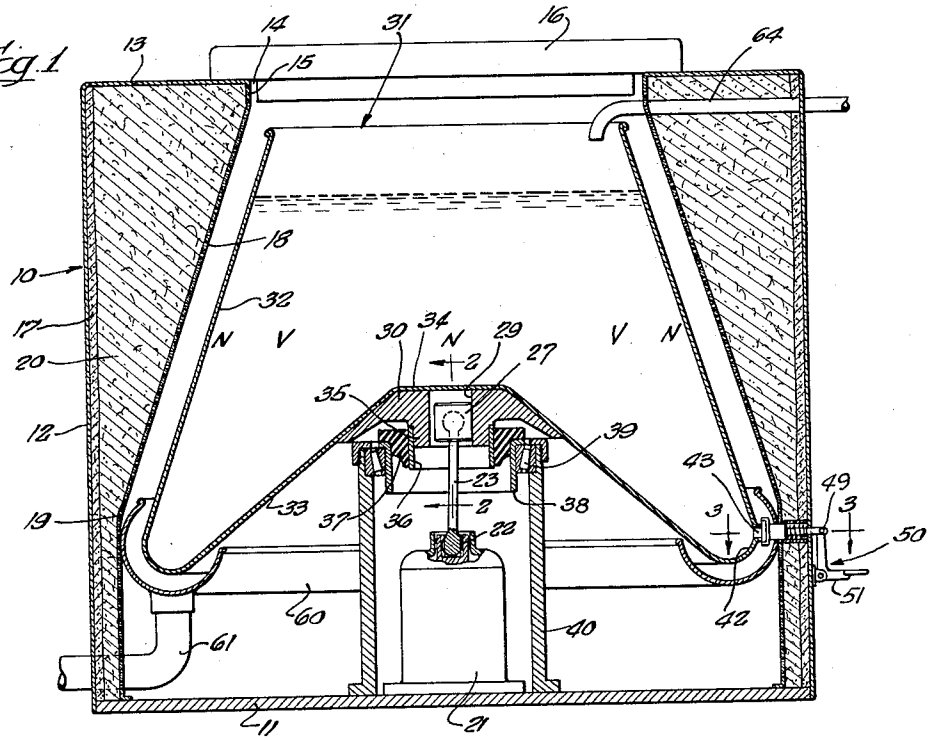


Fig. 2

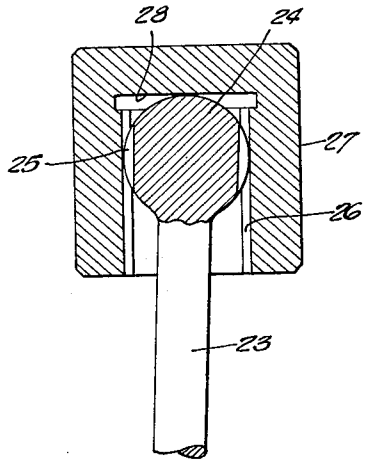
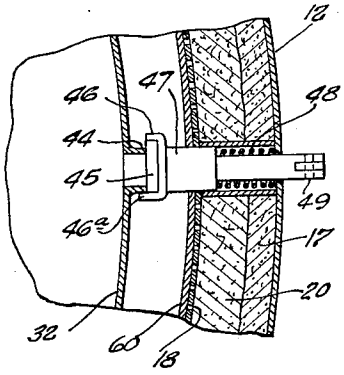


Fig. 3



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Fig. 5

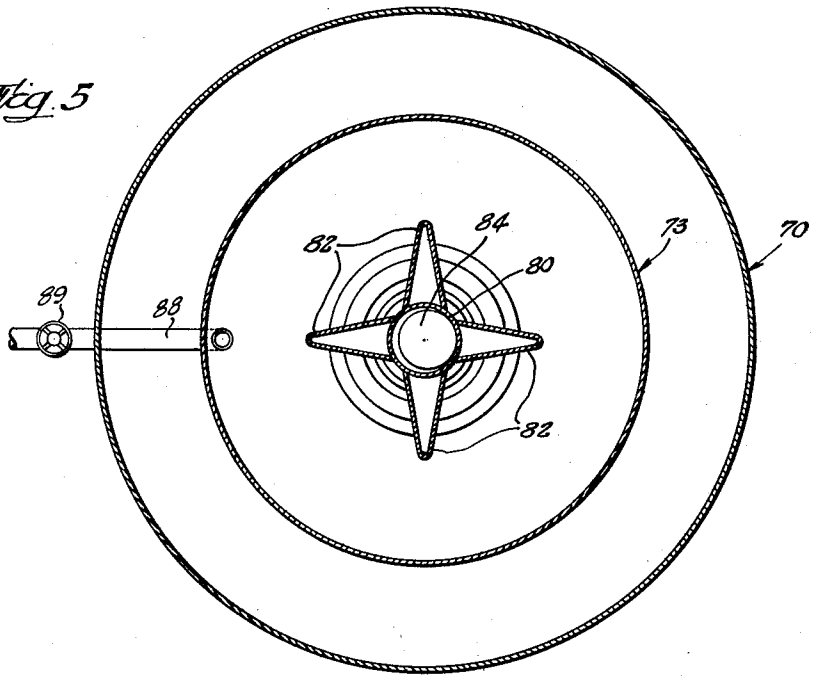
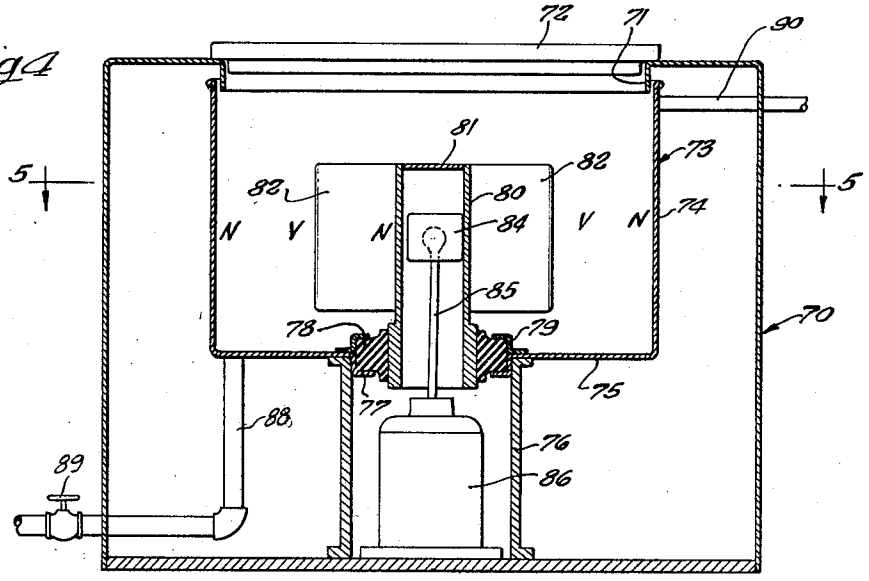


Fig. 4



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SONIC LAUNDERING MACHINE

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5 Claims. (Cl. 8—159)

This invention relates generally to sonic cleaning, and more particularly to sonic methods for laundering articles of clothing and the like.

It is known that ordinary laundering of clothing and the like can be accelerated and carried to better completion with aid of sonic vibrations. The general theory underlying sonic aid to laundering therefore need not be dealt with herein.

Only briefly and broadly stated, the invention provides, in one illustrative form, a tub which is mounted for what may be described as gyratory motion. In this motion, the tub does not rotate on its axis, but gyrates bodily. In other words, each point on the tub describes a small circle. This gyrational motion of the tub acts on the liquid therewithin to set up compressional sound wave action in the liquid, in a pattern corresponding to the motion of the tub. The gyration frequency of the tub is preferably established at a resonant frequency of the liquid body within the tub, with the tub comprising part of the acoustic circuit, so as to establish a standing sound wave within the water body. One usable pattern is that of the 2nd harmonic resonant frequency, characterized by velocity nodes (regions of minimized velocity oscillation of water particles) located adjacent the side walls of the tub and at the center, with velocity antinodes (regions of maximized particle velocity oscillation) at seven-tenths the radius of the tub out from the center. By going to higher overtone frequencies, as may often be advantageous, the number of antinodes and nodes can be materially increased. For example, at the 2nd overtone, at triple the fundamental frequency, nodes appear at the walls, at the center, at points between the center and the walls, and an antinode will be located between each pair of adjacent nodes.

At the antinodal region or regions, the water oscillates back and forth in conformance to the gyrational standing wave pattern at sonic frequency, typically 2000 cycles per second, and any laundry in the vicinity is thus subjected to forcible liquid surging at that frequency. Because of the gyrational pattern, water surges against the laundry at sonic frequency from every direction in horizontal planes. Cleansing is thereby very materially accelerated.

The process of the invention may be described broadly as involving the generation of a vibration inducing force characterized by a rotating force vector which rotates in a plane substantially normal to a wave coupling surface that is acoustically coupled to the tub water and contents. This force is generated at the relatively high frequency which corresponds to elastic resonance for media to which said surface is coupled. The surface in question can be, for example, the side wall of the tub, or a wave radiation means in the central region of the tub; and the vibration inducing force (rotating force vector) is transmitted from its point of generation to such wave coupling surface, and thence into the liquid and laundry contents of the tub.

A further feature of the invention comprises a means whereby, when the laundering operation is finished, and the liquid drained from the tub, the tub may be freely rotated, and driven so as to operate as a spin-dryer.

The invention will be further understood from the following detailed description of present illustrative embodiments thereof, and wherein:

FIG. 1 is a vertical medial section through one illustrative embodiment of the invention;

FIG. 2 is a detail section taken on line 2—2 of FIG. 1;

FIG. 3 is a detail section taken on line 3—3 of FIG. 1;

FIG. 4 is a view similar to FIG. 1 but showing a modified embodiment of the invention; and

FIG. 5 is a section taken on line 5—5 of FIG. 4.

Referring now to the drawings, and particularly to FIGS. 1–3, numeral 10 designates generally an enclosure having a bottom 11, a cylindrical sheet metal side wall 12 rising therefrom, and turned inwardly to form top 13. This top 13 has a circular opening 14, defined by a downwardly turned flange 15, and closed by a suitable lid 16. Inside and adjacent sheet metal side wall 12 is wall 17 composed of any suitable sound insulation material; and a perforated sheet metal wall 18 extends downwardly and in this case, angularly outward, from the lower margin of flange 15 to a point 19, and thence vertically to bottom 11, where it is suitably secured to the latter. The space so formed in back of the perforated wall 18 is packed with a suitable sound insulation material 20, such as glass fiber or the like.

An electric motor 21 having a vertical shaft is mounted on the center of bottom 11. A universal joint 22 of any suitable type connects the upper end of the motor shaft with the lower end of a drive shaft 23, whose upper end has a ball 24 provided with a vertically splined driving connection 25 with the inside wall surface of a bore 26 terminates in a bearing surface 28 and the roller rides on the ball 24 with surface 28 seating on its spheric top surface. It will be seen that the coacting vertical splines in the side of the ball and in the bore of the roller 27 permit a degree of angular or universal rocking action of the ball and rod 23 with respect to roller 27 while the roller is being rotated through splined connection 25 from drive shaft 23.

Roller 27 is driven as thus described around the periphery of a vertical bore 29 in a relatively stiff annulus 30 mounted centrally on the base of tub 31. Thus tub 31 is constructed of sheet metal, and is located inside and annularly spaced from the wall 18. In this case, the side wall 32 of the tub is inclined outwardly in a downward direction, in parallelism with the wall 18. The walls 18 and 32 could, however, be vertical and cylindrical. The tub is open at the top. The side wall 32 is turned under and inwardly at the bottom, and merges with an upwardly inclined bottom wall 33, whose flat and horizontal center 34 seats on and is secured to the aforementioned annulus 30. The latter has a tubular downward extension 35 to which is tightly fitted a sleeve 36 inside a resilient ring 37, typically composed of rubber, of the type commonly used in vibration mountings. The outside of this ring 37 tightly engages a sleeve 38 mounted for free rotation on a vertical axis through bearing 39 supported by the upper end of tubular stand 40 erected from enclosure bottom 11 around motor 21.

The side and bottom walls 32 and 33 of the tub converge and join to form channel 42, and a water discharge port 43 extends outward from this channel and through a short spout 44. This port is normally closed by a valve element 45 engageable against spout 44. Means are provided by which this valve element is advanced or retracted to close or open port 43, and also whereby the tub is held against spinning on its vertical axis when port 43 is closed. In actual practice, the valve element 45 could be solenoid operated, under control of an electrical cycling system. For simplicity, I here show, somewhat diagrammatically,

an operative control means, according to which the valve element 45 is seated in a cup 46 on the end of a plunger 47 urged inwardly by a spring 48. This plunger is mounted for reciprocation in the walls 12, 17 and 18, as shown, and to its outer end is pivotally connected, as at 49, one arm of a bell crank 50, the other arm 51 of which extends horizontally as a foot pedal. The pivot connection at 49 may be loose, or comprise a pin and slot arrangement (not shown) in order to accommodate the arc of swing of the upper arm of the bell crank.

As seen best in FIG. 3, the valve cup 46 has an extended lip 46*a* on one side, located to engage the side of discharge spout 44 when the valve plunger is in its advance or valve closed position, thus preventing the tub from rotating on its axis.

Extending approximately three-quarters of the way around the channel portion of the tub, as seen in cross section, is a circular trough 60, adapted to receive water discharged from spout 44 in any position of the tub, and a discharge pipe 61 leads downwardly from this trough and then outwardly through the side of the enclosure.

Water may be introduced to the tub through a pipe 64 mounted in the tub enclosure and discharging into the tub. Overflow at the upper rim of the tub runs down the inclined side wall of the tub and is caught by trough 60.

In operation, tub 31 may contain water and articles to be laundered up to a level, say, as indicated by the dashed line in FIG. 1. Soap or detergent may be used in the usual way. Motor 21 is driven, and rotates shaft 23 and therefore roller 27. By reason of centrifugal force, the shaft 23 and roller 27 swing outward, so that roller 27 engages the wall surface of the bore 29, which is somewhat larger in diameter than the roller 27. The roller 27 rocks on ball 24 to permit full side-face engagement with the wall of the bore 29, and, pressed against the latter by centrifugal force, the roller gains traction and rolls around the wall of the bore. This wall thus forms a raceway for the roller 27. The roller 27 is of substantial mass, and the centrifugal force which it develops in rolling about its said raceway is applied to tub annulus 30, acting as a reaction-receiving roller guide. Thus a constantly rotating force vector, turning in a horizontal plane and intersecting the central vertical axis of the tub, acts through annulus 30 on the central portion of the base of the tub, at about the center of gravity of the tub and contents. This rotating force is yieldingly opposed by the rubber ring 37 in which the tub annulus 30 is tightly mounted. No rotation of the tub occurs at this time in view of the tub being at this time locked against rotation by the valve cup lip 46*a* (FIG. 3). Instead, the tub bodily gyrates, all points on the tub describing small circles of uniform diameter, their size depending upon such factors as the number of circuits made per second by the roller 27 around its raceway, the mass of the roller, damping caused by the tub contents, and the yieldability of the rubber ring 37. Incidently, it should be appreciated that the trips per second taken by roller 27 around its raceway 29, the orbital frequency, is a much larger number than the revolutions per second of the roller 27, on its own axis, depending upon the ratio of the circumference of one relative to the circumference of the other. An important step up in frequency is thereby made possible.

Preferably, the tub 32 is made relatively rigid, and in many instances no material elastic wave action occurs therein, particularly at the operating frequencies used. The tub, then, merely gyrates bodily in a small circle, without rotation on its axis.

The action of the gyrating tub on its liquid contents, on the other hand, is such as to set up sonic compressional wave action in the liquid, and by proper selection of gyration frequency, a preferred operation is attained characterized by a resonant sonic standing wave in the liquid. Assuming an average tub diameter of two feet, and taking the velocity of sound in the water to be 4,000 feet per second, the frequency for the second harmonic resonant frequency standing wave, giving approximately a full wave length across the diameter of the tub, is 4,000/2 or 2,000 cycles per second. Accordingly, for a two foot tub, or one having an average diameter of two feet, the roller 27 is driven around its raceway 29 at a frequency of 2,000 circuits per second. This frequency will usually be somewhat less due to the mass of the tub structure adding to the mass of the water.

The tub 31, gyrating at this frequency, and acting laterally against the body of water therewithin, sets up a gyratory form of sonic standing wave in the water. For the second harmonic frequency wave, a velocity node N (region of minimized water particle velocity oscillation) occurs in the water adjacent the side wall of the tub and in the center, and a velocity antinode V (region of maximized water particle velocity oscillation) occurs at 7/10 of the radius of the tub, out from the center. Actually, the water particle velocity oscillation progressively builds up radially inward from the side wall, and radially outward from the center, so that there is a relatively large region within which water oscillation, at 2,000 cycles per second, occurs at relatively high amplitude. This surging water, oscillating at 2,000 cycles per second, occurs with large acceleration, and correspondingly high cleansing factor.

When the cleansing stage has been completed, a rinse period may be carried out by introducing a flow of clean water into the tub through inlet pipe 64 while the gyratory action continues. The introduced water causes overflow over the upper edge of the tub, which is caught by trough 60, as earlier described.

Finally, pedal 51 is depressed and held down, retracting valve 45 from discharge spout 44, and simultaneously releasing the tub for rotation. The motor driven roller, rotating against raceway 29, now rotates the entire tub on bearing 39. The tub rotates while still gyrating at moderate amplitude, because less effort is required for rotation than for gyration against the resistance of rubber ring 37. The tub spins rapidly under these conditions, and liquid is discharged therefrom through spout 44, caught by trough 60, and carried away at 61. When the initial water has been thus removed, further spin drying of the retained laundry takes place.

FIGS. 4 and 5 show a modification, the outside sheet metal enclosure 70 having top opening 71 closed by lid 72, and the tub being designated by reference numeral 73. The tub has side wall 74 and bottom wall 75, which rests on tubular stand 76. Bottom wall 75 is turned down just inside stand 76, and then flanged inwardly, as at 77, and seated in the resulting formation is a yieldable, resilient ring 78, preferably rubber. An annulus 79 secured to wall 75 completes peripheral confinement of ring 78. It will be seen that in this embodiment, the tub is firmly or stationarily mounted.

The ring 78 tightly embraces the lower end of a hollow cylindrical column 80, having a closed upper end 81, and provided with radially projecting sheet metal agitator vanes 82. The column 80 is thus yieldingly or compliantly mounted, while the tub is stationary.

An inertia roller 84 rolls around the inside wall surface or raceway of column 80, serving as a reaction-receiving guide, and is constructed internally and mounted on a drive shaft 85 driven from motor 86 exactly as the corresponding parts in FIGS. 1–3.

The tub is shown to have discharge pipe 88 controlled by valve 89. An inlet pipe is indicated at 90.

The column 80 in the embodiment of FIGS. 4 and 5 is subjected to the same type of bodily gyratory action as is the tub in the embodiment of FIGS. 1–3, and with the roller 84 driven at a speed to make a number of circuits per second around the column 80 approximating the resonant standing wave frequency of the body of contained water for the desired standing wave pattern. Such pattern is developed, with a velocity node N adjacent the

column, another velocity node N adjacent the side wall of the tub and a velocity antinode V in the seven-tenths radius region. It will be seen that in both embodiments, a wall at a boundary of the liquid body gyrates at a resonant standing wave frequency of the liquid body, setting up a corresponding standing wave pattern of elastic sound waves in such body.

In addition, the vanes 82, moving with gyratory action, at a frequency which may again be of the order of 2,000 cycles per second affords very effective sonic frequency agitation.

This application is a continuation-in-part of my prior application entitled Method and Apparatus for Generating and Transmitting Sonic Vibrations, filed July 6, 1959, Serial No. 825,117, now Patent No. 2,960,314.

It will be understood that the drawings and descriptions are merely illustrative of and not restrictive on the broad invention, and that many changes in design, structure and arrangement may be made without departing from the spirit and scope of the invention or of the broader of the appended claims.

I claim:

1. In a sonic laundering process, the method of generating a sonic compressional wave system in a body of water contained in a tub, that comprises: immersing in the axial region of said body of water in said tub a sonic wave radiator means and imparting to said wave radiator means a vibration inducing force having a rotating force vector turning at a frequency which is a resonant frequency of said body of water for a mode of standing wave vibration therein with wave action directed in lateral directions in a horizontal plane.

2. The method of sonic laundering, that comprises: introducing laundry to be cleaned into a body of water, and setting up in said body of water a mode of standing elastic wave oscillation, characterized by at least one antinodal region, by coupling to a surface of said body of water a generator of high frequency force rotating in a plane substantially normal to said surface and operating at a resonant frequency of said body of water for a mode of resonant standing wave vibration therein, whereby the laundry in said antinodal region is subjected to high amplitude compressional wave action in lateral directions in one phase in the water in said region.

3. The process of claim 2, including confining said body of water in a tub, and applying said high frequency rotating force to said tub.

4. The process of claim 2, including confining said body of water in a tub, and effecting the coupling of said generator to said surface of said body of water by applying said high frequency rotating force of said generator to a vibratory wave radiating means located in a central region of said body of water.

5. The process of sonic laundering, using a liquid container tub with a wall comprising a sonic wave coupling surface for coupling to a body of liquid and laundry contents therein, that comprises: generating a vibration inducing force characterized by a rotary force vector which rotates in a plane substantially normal to said wave coupling surface at an elastic resonant frequency for elastic media coupled thereto, whereby to provide a rotary vector source of resonant elastic vibration, and transmitting and coupling said vibration from said source to a point on said coupling surface for transmission into said body of liquid and laundry contents.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,134,990 June 2, 1964

Albert G. Bodine, Jr.

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 6, line 4, for "phase" read -- plane --.

Signed and sealed this 23rd day of March 1965.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents