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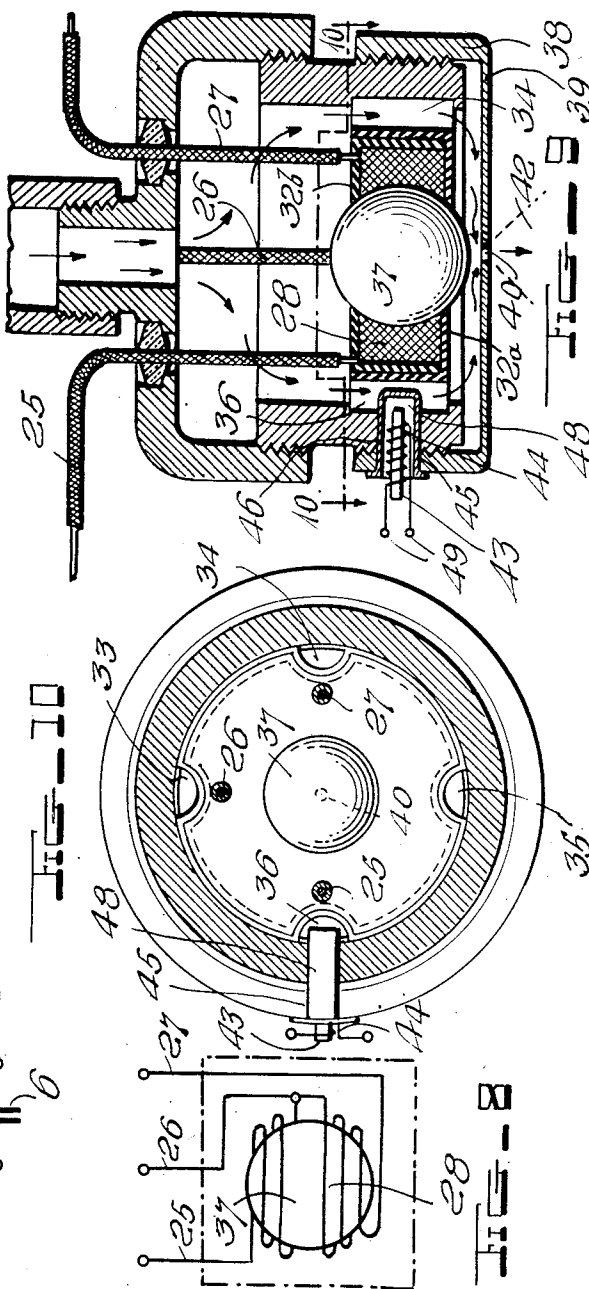
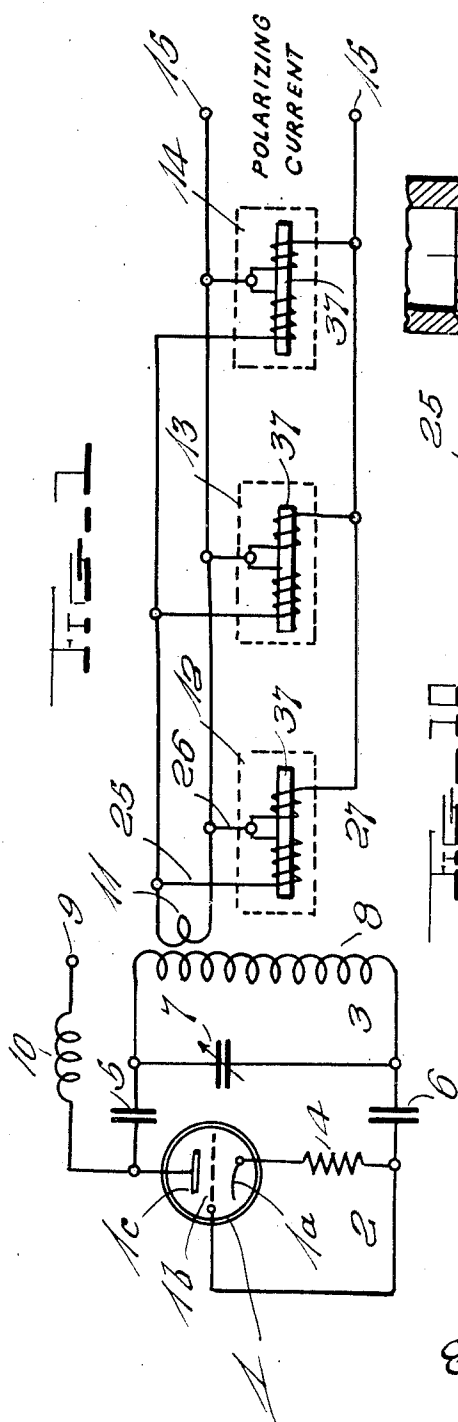
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2,789,008.

ULTRASONIC MAGNETOSTRICTIVE NOZZLE

Filed June 13, 1955

2 Sheets-Sheet 1



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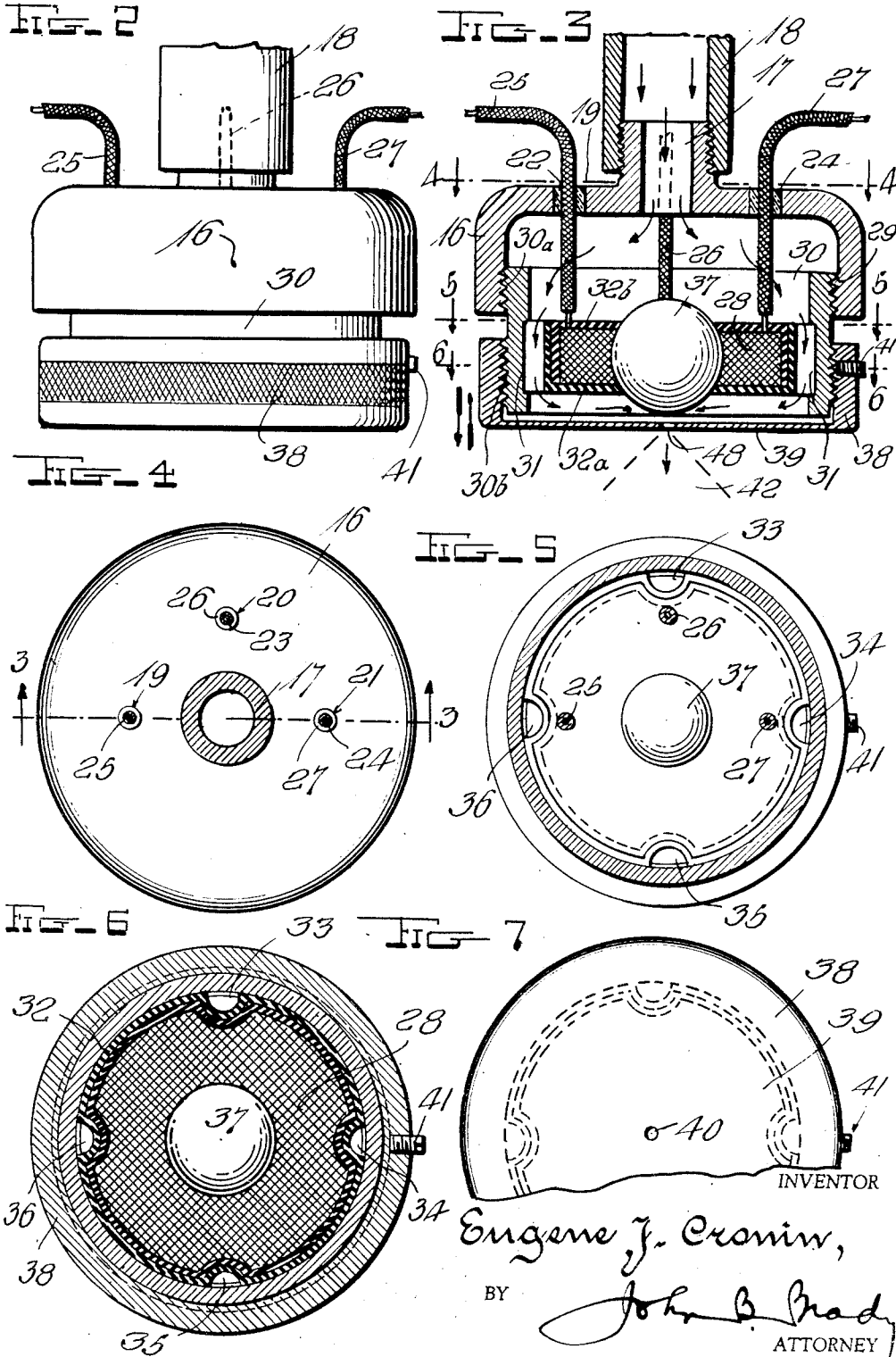
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2,789,008

ULTRASONIC MAGNETOSTRICTIVE NOZZLE

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2,789,003

ULTRASONIC MAGNETOSTRICTIVE NOZZLE

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10 Claims. (Cl. 299—1)

My invention relates broadly to the atomization of fluids and more particularly to the distribution of fluids in an extremely fine spray under control of magnetostrictive pressure.

One of the objects of my invention is to provide a construction of magnetostrictive nozzle operating at ultrasonic frequencies, whereby fluids applied to the nozzle are atomized into extremely fine sprays or mists.

Another object of my invention is to provide a construction of magnetostrictive nozzle which is readily applicable to a fluid outlet and electrically connected to an oscillatory system whereby oscillatory currents in the system control the magnetostrictive operation of the nozzle, generating pressures which break the fluid flow into extremely fine sprays.

Still another object of my invention is to provide a construction of ultrasonic magnetostrictive nozzle which is adjustable to control the distribution of fluid sprays over a relatively wide range of spray conditions varying from an extremely fine mist to a heavier force spray.

Still another object of my invention is to provide a construction of magnetostrictive nozzle operating at ultrasonic frequencies which may be pre-set to deliver a fluid spray of predetermined characteristic and polarized from the source which sustains the generation of ultrasonic frequencies in the nozzle.

Other and further objects of my invention reside in the construction of a ultrasonic magnetostrictive nozzle as set forth more fully in the specification hereinafter following by reference to the accompanying drawings, in which:

Fig. 1 is a diagrammatic view illustrating the circuit connections for a multiplicity of magnetostrictive nozzles embodying my invention;

Fig. 2 is a side elevational view of one form of adjustable ultrasonic magnetostrictive nozzle constructed in accordance with my invention;

Fig. 3 is a vertical sectional view taken through the ultrasonic magnetostrictive nozzle of Fig. 2, substantially on line 3—3 of Fig. 4;

Fig. 4 is a horizontal sectional view taken on line 4—4 of Fig. 3;

Fig. 5 is a horizontal sectional view taken on line 5—5 of Fig. 3;

Fig. 6 is a horizontal sectional view taken on line 6—6 of Fig. 3;

Fig. 7 is a bottom plan view of the ultrasonic magnetostrictive nozzle of my invention, partially broken away;

Fig. 8 is a schematic and diagrammatic circuit of the magnetostrictive nozzle per se and showing the terminal connections thereof which extend to the ultrasonic electrical generating system;

Fig. 9 is a vertical sectional view taken through a modified form of ultrasonic magnetostrictive nozzle embodying my invention; and

Fig. 10 is a transverse sectional view taken on line 10—10 of Fig. 9.

The ultrasonic magnetostrictive nozzle of my invention

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is employed in any fluid spray system where a stabilized constant flow spray is required. Certain of the ultrasonic magnetostrictive nozzles of my invention are adjustable in construction for controlling the character of the spray, while other nozzles embodying my invention are selectively set at the factory for the performance of a predetermined atomization of fluid where viscosity is known and is constant.

I employ a nozzle assembly comprising a coacting housing element with a cap-like structure adjustable thereon and enclosing a magnetostrictive sphere coacting with a centrally apertured diaphragm which may be selectively spaced from the surface of the sphere.

The sphere is formed from a pre-selected magnetostrictive material such as nickel, cobalt, etc., or alloys of such metals. The size of the sphere, that is its axial diameter, determines the frequency at which ultrasonic energy is generated by the magnetostrictive sphere.

The energizing coil surrounding the sphere is of a size compatible to the entire structure but determined by the formula of N turns of wire and a length (l) of one meter and a current of i amperes, that is

$$N \cdot i \cdot \frac{dx}{(l)}$$

(Howe—A Text Book of Electrical Engineering, third edition, Longmans, Green & Co., London, 1912, page 60). The energizing coil is mounted in a suitable material, such as plastic or the like, to provide the required rigidity. The coil fits into a coil sleeve having a threaded exterior over which a coacting cap carrying a diaphragm is adjustable. The distance between the diaphragm carried by the cap and the end of the sphere may thus be accurately fixed.

In the center of the diaphragm of the cap there is an orifice through which fluid under pressure is released to the other side of the diaphragm. Under normal conditions a pressurized system with a small hole would set up a fine spray by a difference in pressure on each side of the hole or orifice. With the addition of the magnetostrictive unit, such as described herein, the pressure differential between the two sides of the diaphragm is increased many fold. Added to the existing pressure of the pressurized system is the ultrasonic force which is of the order of 280,000 pounds per square inch. This results in atomization of the fluid as it is released at the orifice. In other words, if a droplet of oil, for example, is passing through the orifice at the pressure of the system, and then is released instantaneously into the atmospheric pressure, this change disrupts the droplet, breaking it into a very fine spray. By adding the ultrasonic pressure to the droplet on one side of the diaphragm and forcing it into the orifice under this increased pressure, the differential pressure between the two sides of the diaphragm is caused to increase at a very rapid rate, the resultant being the production of a spray which is of a much finer particulate matter than is obtainable by any other means.

Referring to the drawings in more detail, reference character 1 designates an electron tube oscillator including cathode 1a, control grid 1b and anode 1c, connected for generating ultrasonic frequencies in the input and output circuits, designated at 2 and 3, respectively.

The input circuit includes cathode resistor 4 and the output circuit 3 is coupled electrostatically to the anode 1c, through condenser 5, and to the input circuit 2 through condenser 6. The output circuit is tunable by means of condenser 7 for sustaining ultrasonic oscillations through winding 8. High potential is supplied to the anode circuit from source connected to terminal 9 through the radio frequency choke 10. Winding 11 is coupled to winding 8 for transferring the oscillator output therefrom to the multiplicity of ultrasonic magnetostrictive nozzles

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which I have represented at 12, 13 and 14. The windings for sustaining the operation of each of the ultrasonic magnetostrictive nozzles are electrically connected as shown and include connections to a source of polarizing current which connects to terminals 15.

Each magnetostrictive nozzle is constructed as illustrated in Figs. 2-8, or as shown in Figs. 9 and 10. The structure shown in Figs. 2-8 is adjustable so that for different viscosities of fluid which is passed through the nozzle, different degrees of atomization are selectively obtainable. In the form of my invention illustrated in Figs. 9 and 10 the operation of the nozzle is non-adjustable and includes a polarizing coil. This form of my invention is pre-set at the factory for shipment and is intended for use with fluids of known viscosity.

Referring to Figs. 2-8, reference character 16 designates the nozzle housing terminating in the screw-threaded tubular portion 17 to which the fluid distribution pipe 18 connects. The rear of the housing 16 is apertured at 19, 20 and 21 and receives insulated seals 22, 23 and 24 therein which form glands through which the connecting leads 25, 26 and 27 extend from the circuits externally from the nozzle to the magnetostrictive winding 28 disposed interiorly with respect to the housing 16. The interior of the housing 16 is screw-threaded as represented at 29 and receives the externally screw-threaded sleeve 30. The sleeve 30 contains an annular groove 31 therein into which the parts of the insulated casing 32, which surrounds the magnetostrictive winding 28, are fitted. The insulated casing 32 is formed by a pair of telescopically interrelated casing members shown at 32a and 32b which fit over and encase the magnetostrictive winding 28. The parts of the insulated casing 32 are shaped at diametrically opposite positions to provide liquid passages which I have represented in Figs. 5 and 6, at 33, 34, 35 and 36. These grooves or inward projections also serve to center the parts of the insulated casing 32a and 32b, enabling the parts to readily fit together from opposite sides of magnetostrictive winding 28, forming a fluid-tight casing around the electrical winding. The parts of the casing 32a and 32b are both shaped at the center thereof in cooperation with the winding 28 and the magnetostrictive sphere 37 for supporting the magnetostrictive sphere in such manner that the magnetostrictive compressions and expansions and elastic distortions may be effective while the magnetostrictive sphere is retained within the housing 16, as shown. The casings 32a and 32b are each apertured at the centers thereof to form circular seats within which spaced portions of the sphere 37 are confined and between which the magnetostrictive action of the sphere becomes effective. There is sufficient spacing between the inside of the winding 28 and the surface of sphere 37 to allow magnetostrictive action of the sphere without inertia influences of the winding 28. The sleeve 30 is externally screw-threaded as represented at 30a to engage the internal screw-threads 29 in housing 16. The projecting portion of sleeve 30 is also externally screw-threaded as represented at 30b for receiving the internally screw-threaded cap 38, the screw-threads of which adjustably engage the screw-threads 30b. The cap 38 terminates in a diaphragm 39 having a central aperture 40 therein aligned with the curved surface of the sphere 37. The diaphragm 39 is adjustable toward and away from the curved surface of the magnetostrictive sphere 37 by turning the cap 38 on screw-threads 30b. A set-screw 41 in the side skirt of cap 38 engages screw-threads 30b when the cap 38 is adjusted to a predetermined position. Fluid supplied through fluid distributor pipe 18 passes through the tubular portion 17 into the interior central portion of housing 16 and through the passages 33, 34, 35 and 36 into the space between magnetostrictive sphere 37 and diaphragm 39 where the rapid expansion and contraction of magnetostrictive sphere 37 atomizes the fluid and forces the fluid through central aperture 40 into the fine mist or spray, represented at 42. The circuit connections to

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the winding 28 extend through the leads 25, 26 and 27 and through the insulated casing 32b from the generator circuit shown in Fig. 1.

Fig. 8 illustrates schematically the manner in which the winding 28 envelopes the magnetostrictive sphere 37 and connects through the leads 25, 26 and 27.

In Figs. 9 and 10 I have shown a form of my invention which is pre-set at the factory and is not adjustable at the point of installation. In this arrangement a polarizing magnet 43, having an electromagnetic winding 44, extends radially through aligned radially disposed apertures 45 in cap 38 and 46 in sleeve 30 when set in the predetermined selected position. This is accomplished by first selectively fixing the depth of the gap 47 between the curve surface of the magnetostrictive sphere 37 and the aperture 40 in diaphragm 39 and then drilling radial holes through the skirt of the cap 38, and the sleeve 30, through which the cylindrical cup-like liner 48 is introduced and into which the solenoid and winding 43, 44 extends. For purposes of illustration I have shown the holes drilled in a position which is in alignment with passage 36 in the insulated casings 32a, 32b, but it will be understood that these radially disposed holes may be drilled at any intermediate position between the passages in the casing 32 and thus not obstruct the fluid flow through one of the passages. The terminating ends of winding 44, shown at 49, connect with the terminals 15 of the generator shown at Fig. 1 for applying polarizing current which polarizes the magnetic field established by winding 28 with respect to the magnetostrictive sphere 37.

The hammer-like vibration of the magnetostrictive sphere 37 acting in the gap 40 through which the fluid flows around the curved surface of magnetostrictive sphere 37 and through the aperture 40 effects the breaking-up of the fluid to produce the mist or spray at 42.

While I have described my invention in certain of its preferred embodiments, I realize that modifications may be made, and I desire that it be understood that no limitations upon my invention are intended other than may be imposed by the scope of the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States is as follows:

1. An ultrasonic nozzle comprising a fluid housing, a magnetostrictive sphere supported in said housing in contact with the flow of fluid through said housing, means associated with said sphere for sustaining ultrasonic vibrations in said sphere, a closure cap associated with said housing including a diaphragm extending in a plane immediately adjacent the surface of said sphere, said diaphragm containing an aperture in the center thereof of a size sufficient to produce a fine mist from the fluid flowing around the surface of said sphere and means for supplying fluid under pressure through said housing and around the aforesaid means and around the surface of said sphere and along the interior surface of said diaphragm for discharge through said central aperture in said diaphragm under control of the ultrasonic vibration of said sphere.

2. An ultrasonic nozzle as set forth in claim 1 in which said closure cap is associated with said housing through a coupling sleeve wherein said coupling sleeve is externally screw-threaded at one end for engaging said housing and at the other end for adjustably engaging said closure cap whereby the central aperture in said diaphragm may be varied in spacial relation to the surface of said sphere at a position aligned with a diametrical axis through said sphere.

3. An ultrasonic nozzle as set forth in claim 1 in which said diaphragm is adjustable toward and away from the curved surface of said sphere for selecting the spaced gap between the inner annular periphery of the central aperture in said diaphragm and the curved surface of said sphere and correspondingly controlling the atomization of the fluid sprayed through the central aperture in said diaphragm.

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4. An ultrasonic nozzle as set forth in claim 1 in which said closure cap is associated with said housing through a coupling sleeve wherein said coupling sleeve is externally screw-threaded on each end thereof engaging said housing at one end and adjustably engaging said closure cap at the other end for varying the spatial relation between the central aperture in said diaphragm and the curved surface of said sphere, said coupling sleeve being annularly recessed on the internal surface thereof for providing a support for said means for sustaining ultrasonic vibrations in said sphere and wherein said means consists of a winding enclosing casing fitting around said sphere.

5. An ultrasonic nozzle as set forth in claim 1 in which said means for sustaining ultrasonic vibrations in said sphere includes a pair of telescopically engageable closure members each centrally apertured, an electrical winding housed within said closure members, said sphere being disposed within said winding and supported by said centrally apertured closure members.

6. An ultrasonic nozzle as set forth in claim 1 in which said means for sustaining ultrasonic vibrations in said sphere includes a pair of telescopically engageable closure members operative to enclose an electrical winding positioned around said magnetostrictive sphere, said closure members being peripherally recessed at the edges thereof for the passage of fluid from said means for supplying fluid under pressure to the area around the surface of said sphere for discharge through said centrally apertured diaphragm.

7. An ultrasonic nozzle as set forth in claim 1 in which the magnetostrictive sphere supported in said housing is centered axially of said housing by a casing member and wherein said casing member is apertured linearly

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at a multiplicity of spaced positions for the passage of fluid from the means for supplying fluid under pressure through said housing to the space between said diaphragm and the surface of said sphere.

5 8. An ultrasonic nozzle as set forth in claim 1 which includes polarizing means and an electromagnetic winding electrically connected with said polarizing means and directed through one side of said housing toward said sphere.

10 9. An ultrasonic nozzle as set forth in claim 1 wherein an electrical winding is disposed within said housing in a position surrounding said sphere and polarizing means connected with the means associated with said sphere for sustaining ultrasonic vibrations in said sphere, said polarizing means including a magnet directed through said housing toward said sphere.

15 10. An ultrasonic nozzle as set forth in claim 1 which includes a casing mounted within said housing, an electric winding within said housing and surrounding said sphere, a plurality of linearly extending passages for fluid disposed in said casing, a cup-shaped cylindrical sleeve extending radially through said housing and into said casing toward said winding, an electromagnet extending interiorly of said sleeve for developing a magnetic field directed radially through said winding and polarizing means connected with said electrical winding.

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