Aug. 23, 1966 S. T. JUTILA 3,267,859

LIQUID DIELECTRIC PUMP

Filed Feb. 18, 1964

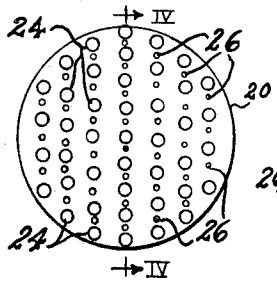

FIG. 3

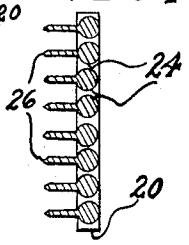

FIG. 4

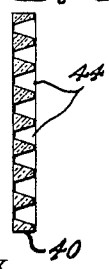

FIG. 6

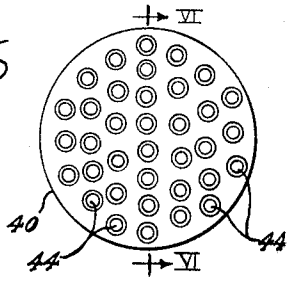

FIG. 5

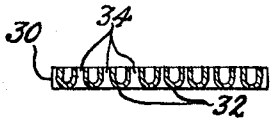

FIG. 8

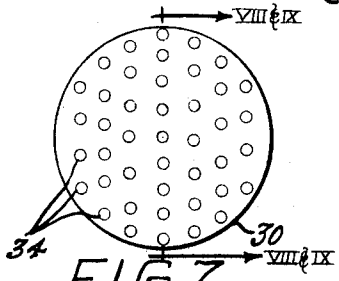

FIG. 7

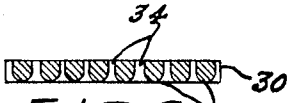

FIG. 9

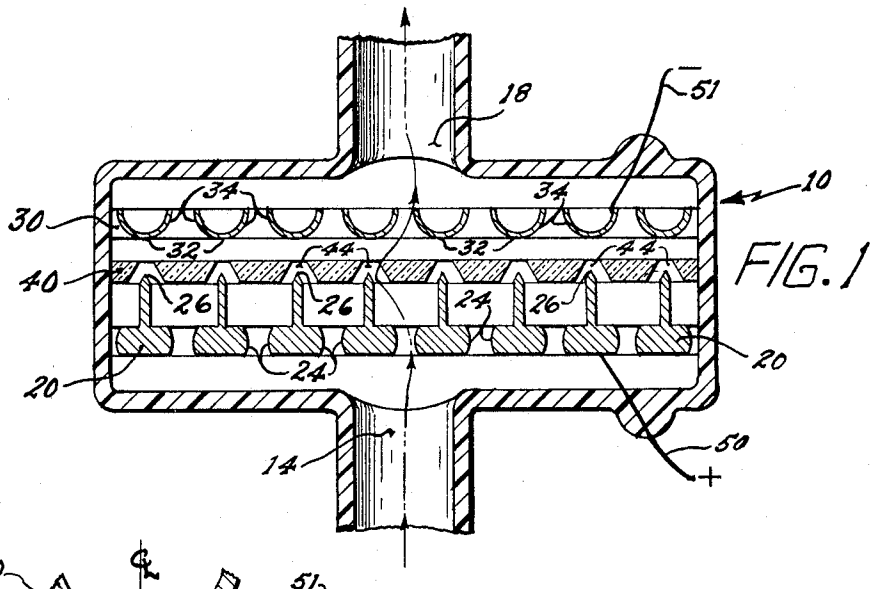

FIG. 1

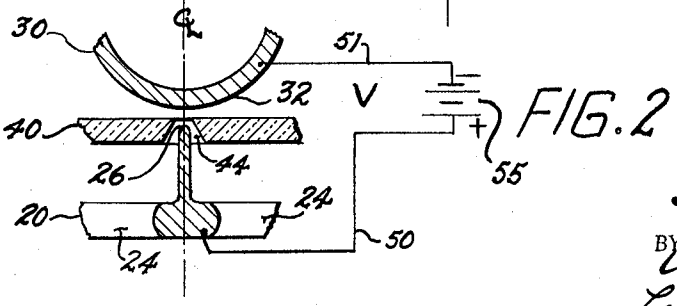

FIG. 2

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LIQUID DIELECTRIC PUMP

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4 Claims. (Cl. 103—1)

This invention relates generally to pumps and more particularly to an improved liquid dielectric pump.

Liquid flow is induced in a liquid dielectric pump by placing a direct current potential between a pair of electrodes immersed in a dielectric liquid. Heretofore, the pumping rate of this type pump has been, in some instances, lower than desired. Now it is known that if an electrically charged conducting surface has a relatively sharp point, a large part of the charge will concentrate at the point to produce a non-uniform electric field having a high electrostatic stress immediately surrounding the point. The invented pump herein, utilizes the aforementioned principle for improved performance.

Thus, it is an object of this invention to improve the performance of liquid dielectric pumps.

It is an object of this invention to induce dielectric liquid flow by non-uniform electric fields causing dielectric deformations and/or by actions of dielectric inhomogeneities in non-uniform electric fields.

Another object is to provide a dielectric pump utilizing an electrode with a plurality of points to produce a non-uniform electric field.

A further object is to provide a liquid dielectric pump which is economical to produce and which utilizes conventional, currently available materials that lend themselves to standard mass production manufacturing techniques.

Other objects and a fuller understanding of the invention may be had by referring to the following description and claims, taken in conjunction with the accompanying drawings, in which:

FIGURE 1 represents a schematic cross-section of the invented pump;

FIGURE 2 is a schematic enlargement of a portion of FIGURE 1;

FIGURE 3 represents a schematic plan view of a pump electrode having sharp points;

FIGURE 4 is a cross-section of FIGURE 3 taken along lines IV—IV;

FIGURE 5 is a schematic plan view of a dielectric barrier disk;

FIGURE 6 is a cross-section of FIGURE 5 taken along lines VI—VI;

FIGURE 7 is a schematic plan view of an opposing electrode disk;

FIGURE 8 is a cross-section of FIGURE 7 taken along lines VIII—VIII; and

FIGURE 9 is an alternate cross-section of FIGURE 7 taken along lines IX—IX.

Referring to the figures, wherein like numerals refer to like parts, the pump casing **10** is a cylinder fabricated of a non-conducting material, for example, glass or a plastic. Liquid flow through the pump is in the direction of the arrows from an inlet **14** toward an outlet **18** which are provided at the opposite ends of the cylindrical casing **10**, as indicated in FIGURE 1.

A first electrode disk **20** is provided within casing **10** at a transverse position between inlet **14** and outlet **18**, normal to the indicated direction of flow. Perforations **24** through disk **20** are streamlined, as illustrated, to facilitate flow therethrough. The uniform pattern of FIGURE 3 is formed by a plurality of points **26** protruding from between perforations **24** in the direction of flow from inlet **14** toward outlet **18**.

A second electrode disk **30** is spaced parallel to disk **20** with surfaces at **32** spaced opposite to points **26**, as shown at FIGURES 1 and 2. Flow toward outlet **18** through disk **30** is provided for by a plurality of streamlined perforations **34**. The distribution pattern of perforations in the disks **20** and **30** may be identical for the alignment of perforations **24** and **34** directly opposite to each other, thereby assuring that each point **26** is opposed by a surface **32**. Both electrodes **20** and **30** may be formed of a thin sheet or punched out of a solid metal as indicated by the cross-sections of FIGURES 8 and 9, respectively.

A barrier disk **40**, of a non-conducting material, is positioned at a parallel position between disks **20** and **30**. The plurality of conical shaped pressure orifices **44** provides for flow through the barrier disk **40**. The distribution of orifices **44** coincides with that of the points **26** enabling each point **26** to protrude into an orifice **44**, as illustrated.

Electrical conductors **50**, **51**, connect the electrodes **20**, **30** to a source of direct current potential. As indicated, the electrode **20** is connected to the positive terminal.

During operation, the pump is filled with a dielectric liquid and a direct current potential applied to the electrodes **20** and **30**. Electrode **20** is kept positive with respect to electrode **30** to avoid high-field induced breakdown, since experiments have indicated that dielectric breakdown occurs more readily if electrode **20** is negative. The barrier disk **40** with the conical shaped pressure orifices **44** encompassing points **26**, tends to trap and concentrate pressure and give direction to the flow thereby improving performance of the liquid dielectric pump. Since maximum pressures obtainable by the invented pump are limited by the dielectric strength of the liquids pumped, the separation of points **26** from barrier **40** and surfaces **32** are optimized for flow at a safe field of operation.

Although the invention has been described with reference to a particular embodiment, it will be understood to those skilled in the art that the invention is capable of a variety of alternative embodiments within the spirit and scope of the appended claims.

I claim:

1. A liquid dielectric pump comprising: a casing having an inlet and an outlet for liquid flow therethrough; a pair of spaced parallel grid electrodes within said casing between said inlet and outlet, one of said electrodes having a plurality of points protruding in direction of said flow from said inlet toward said outlet, and other of said electrodes defining surfaces spaced opposite to said points; a non-conducting barrier between said electrodes, said barrier having for said flow therethrough a plurality of pressure orifices into which said points protrude; and electrical conductors connecting said electrodes to a source of electrical potential.

2. A liquid dielectric pump comprising: a casing having an inlet and an outlet for liquid flow therethrough; a pair of spaced parallel grid electrodes within said casing at a position normal to said flow between said inlet and outlet, one of said electrodes having a plurality of points protruding in direction of said flow from said inlet toward said outlet, and other of said electrodes defining surfaces spaced opposite to said points; a non-conducting barrier between said electrodes, said barrier having for said flow therethrough a plurality of pressure orifices into which said points protrude; and electrical conductors connecting said electrodes to a source of electrical potential.

3. A liquid dielectric pump comprising: a casing having an inlet and an outlet for liquid flow therethrough; a first electrode within said casing at a transverse position normal to said flow between said inlet and outlet, said

electrode having a plurality of perforations and a plurality of points protruding from between said perforations in direction of said flow from said inlet toward said outlet; a second electrode spaced parallel to said first electrode and defining surfaces spaced opposite to said points, said second electrode having perforations aligned with said perforations of said first electrode for said flow therethrough; a non-conducting barrier between said electrodes, said barrier having for said flow therethrough a plurality of shaped pressure orifices into which said points protrude; and electrical conductors connecting said electrodes to a source of electrical potential.

4. A liquid dielectric pump comprising: a cylindrical casing of non-conducting material having at opposite ends, respectively, an inlet and an outlet for liquid flow therethrough; a first electrode disk within said casing at a transverse position normal to said flow between said inlet and outlet, said disk having a plurality of streamlined perforations and a plurality of points protruding from between said perforations in direction of said flow from said inlet toward said outlet; a second electrode disk spaced

parallel to said first disk and defining surfaces spaced opposite to said points, said second disk having streamlined perforations aligned with said perforations of said first disk for said flow therethrough; a non-conducting barrier disk between said first and second disks at a parallel position thereto, said barrier disk having for said flow therethrough a plurality of conical pressure orifices into which said points protrude; and electrical conductors connecting said electrode disks to a source of electrical potential, with said first disk positive in respect to said second disk.

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