May 18, 1965 R. G. SARGEANT 3,184,575

APPARATUS FOR APPLYING HIGH FREQUENCY ELECTRICAL ENERGY TO LIQUIDS

Filed March 28, 1963

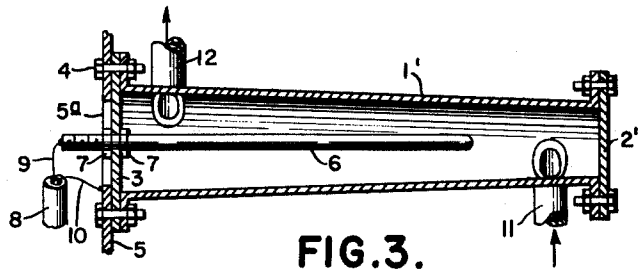


FIG. 3.

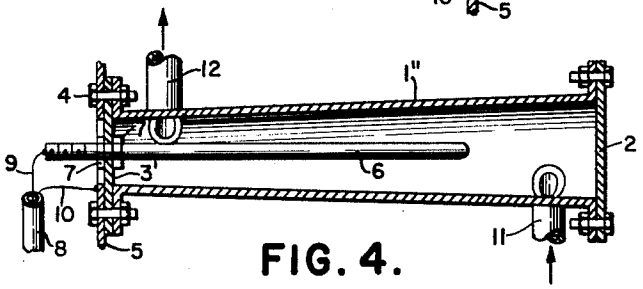


FIG. 4.

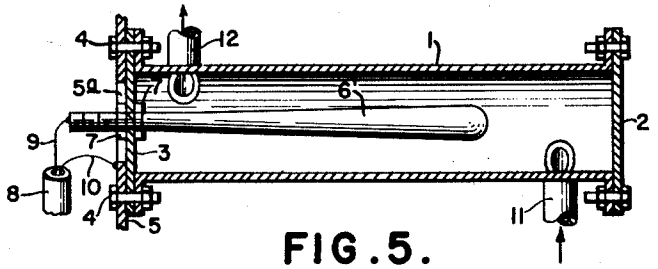


FIG. 5.

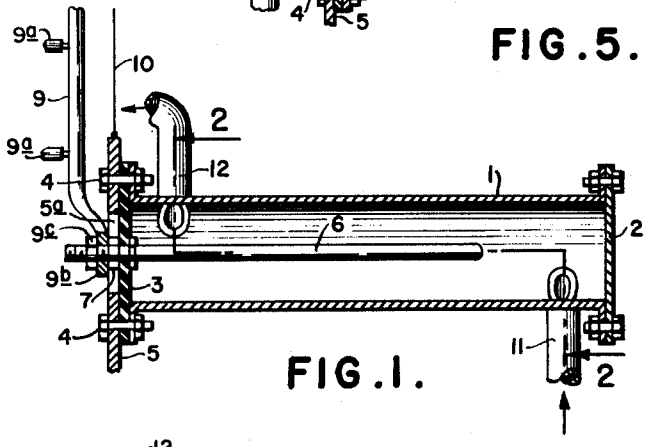


FIG. 1.

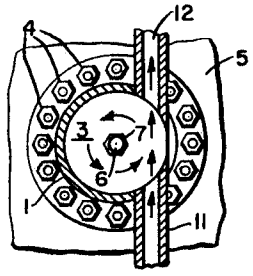


FIG. 2.

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APPARATUS FOR APPLYING HIGH FREQUENCY ELECTRICAL ENERGY TO LIQUIDS

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5 Claims. (Cl. 219—10.65)

This invention relates to apparatus for applying high frequency electrical energy to liquid material, more particularly for the removal of water by evaporation from liquid mixtures containing water and other components.

In my prior Patent No. 3,060,297, issued October 23, 1962, I have shown and described in detail such apparatus and associated equipment, and explained its chief purpose and function.

In said prior patent I disclosed an electrode structure comprising a horizontally disposed cylindrical casing or shell of conducting material through which the liquid mixture is caused to circulate, a central electrode extending axially of this casing, and a high frequency electrical generator having one terminal connected to said casing and the other terminal connected to said central electrode. This central electrode is supported at one end only by means of an insulating disc carried at the end of the casing, and is substantially shorter than the casing.

In said prior patent, the liquid mixture is introduced tangentially into the casing at a point adjacent the end of which said central electrode is supported, and is discharged axially from the other end. It has been found, however, that the inevitable air bubbles which are sometimes introduced into the electrode structure along with the liquid accumulate at a point adjacent the insulating disc. This causes arcing which not only tends to destroy the insulator, but establishes a short circuit which prevents the efficient operation of the electrode structure.

To overcome this disadvantage, I have now produced a modified design of electrode structure which operates even more efficiently than that of said patent.

In this new design, both ends of the casing are closed, and the liquid is introduced tangentially into that end of the casing adjacent the free or unsupported end of the central electrode, and is discharged from the other end of the casing adjacent the supported end of the electrode.

I have also found that in some cases it is advantageous to so construct the device that the radial distance of the central electrode from the walls of the casing, instead of being uniform, varies progressively from one end of the electrode to the other. This may be accomplished either by tapering the casing, or by tapering the central electrode.

In order that the invention may be readily understood, reference is had to the accompanying drawing, forming part of this specification, and in which:

FIG. 1 is a longitudinal section through one form of my improved electrode structure;

FIG. 2 is a transverse section substantially on the line 2—2 of FIG. 1, looking in the direction of the arrows;

FIGS. 3 and 4 are longitudinal sections similar to FIG. 1, but showing the casing as tapered; and

FIG. 5 is a similar longitudinal section, but showing the central electrode as tapered.

Referring to the drawing in detail, and more particularly first to FIGS. 1 and 2, my improved electrode structure comprises an outer cylindrical casing or shell 1 of conducting material, having one end closed by a head or wall

2. At the opposite end is an insulating disc 3, secured by bolts 4 to a radial flange of the casing and to a supporting wall 5 of a suitable housing. Extending axially of the casing 1 is an inner electrode 6, in the form of a rod, passing through the disc 3 and secured thereto as by means of a pair of clamping nuts 7, engaging threads on the end portion of the rod, the wall 5 having a relatively large opening 5*a* providing clearance for the rod. Thus, an open annular space is provided between the casing 1 and inner electrode 6, and this rod electrode is supported at one end only by the disc 3, the other end being free. The rod is substantially shorter than the casing, as shown in FIG. 1. Leads 9 and 10, extending from a high-frequency generator (not shown), are connected respectively with the inner electrode 6 and the casing 1, the latter being grounded. The lead 9, connected with the central electrode, preferably consists of a copper tube, water-cooled by means of hose connections 9^a, as shown in FIG. 3 of said prior patent, the end of the tube being flattened, fitted over the threaded end of electrode 6, as at 9^b, and secured by a nut 9^c.

The construction and arrangement so far described are generally the same as shown in my said prior patent.

In the present invention, however, the liquid mixture being treated is introduced under pressure tangentially into the casing 1 by an inlet pipe 11, located adjacent the head or end wall 2, and beyond the free end of said inner electrode, and is discharged from the casing through an outlet pipe 12, which is also preferably arranged tangentially. This outlet pipe is located near the top side of the horizontal casing at a point adjacent the insulating disc 3, so that the liquid flows from a point beyond the free end of said inner central electrode longitudinally of the casing toward the end where said electrode is supported, the liquid being confined and whirling in said annular space between the casing and the central electrode, as it flows, and being subjected to the action of the high frequency energy while in said annular space. In this new arrangement, the direction of flow, relative to the central electrode, is the reverse of that shown and described in my said patent.

This reverse flow has marked advantages. It insures that the insulator disc 3 will always be fully covered with liquid, so that no air bubbles can be trapped on it to cause arcing which might burn the insulator out. Since the casing is horizontal, any air introduced through the inlet pipe will travel along the top side and be discharged at the outlet 12, before reaching the insulator.

Also, the location of the inlet pipe well beyond the free end of the central electrode results in the maximum turbulence of the liquid taking place in a zone out of range of the electrode.

While in FIGS. 1 and 2 I have shown a structure in which the central electrode is spaced from the outer member or casing a uniform distance through its length, it may be advantageous under some conditions to have this spacing vary progressively along the length of the central electrode. This may be accomplished by tapering the outer member or casing 1′ or 1″, as shown in FIGS. 3 and 4, or by tapering the central electrode as shown at 6′ in FIG. 5. In these figures, I have shown the leads 9 and 10 as embodied in a co-axial cable 8, as in FIG. 8 of said patent, the lead 9 being water-cooled, if desired, as above described in a connection with FIG. 1. The other ele-

ments shown in these three figures are the same as those designated by the same reference numerals in FIGS. 1 and 2.

Regarding FIGS. 3 and 4, it will be seen that the casing 1' or 1'' provides a closed chamber of circular cross-section, as before, while in FIG. 5, the casing 1 is of uniform cross-section throughout.

In FIGS. 3 and 5, the spacing between the central electrode and casing is a minimum at the extreme free end of the central electrode. This produces the greatest and most concentrated transfer of energy, or a "hot spot," at this point, with the energy transfer or heat effect gradually diminishing as the space or gap becomes wider.

What I claim is:

1. In the application of high frequency electrical energy to liquid materials, an electrode structure comprising an elongated, horizontally disposed, hollow chamber having conducting walls of circular cross section, an insulating disc closing one end of said chamber, an end wall closing the other end, a central rod conducting member extending axially thereof, so as to provide an open annular space between itself and said conducting walls, said rod member being substantially shorter than said chamber and supported at one end only on said insulating disc, means connecting said central electrode and said conducting walls with the poles of a high-frequency generator, an inlet pipe delivering tangentially into said annular space at a point adjacent said end wall, and beyond the end of said central rod member, and an outlet pipe extending from the upper side of said annular space at a point adjacent said insulating disc.

2. An electrode structure in accordance with claim 1 in which both the inlet and outlet pipes are disposed tangentially with respect to said annular space.

3. Apparatus in accordance with claim 1 in which the space between said central electrode and the conducting

walls of said chamber varies progressively along the length of said electrode.

4. Apparatus in accordance with claim 1 in which the elongated closed chamber tapers progressively from one end to the other.

5. In the application of high frequency electrical energy to liquid materials, an electrode structure comprising a horizontally disposed outer cylindrical conducting member, one end of said member being closed, an insulating disc closing the other end of said member, an inner rod conducting member extending axially thereof, so as to provide an open annular space between them, said rod member being substantially shorter than said outer member and supported at one end only on said insulating disc, the other end of said rod member being free, means connecting said electrode conducting members with the poles of a high-frequency generator, an inlet pipe delivering tangentially into said annular space at a point adjacent the free end of said rod member, and an outlet pipe extending from the upper side of said annular space at a point adjacent said insulating disc, whereby any air bubbles introduced into said annular space by said inlet pipe are discharged through said outlet pipe and prevented from accumulating at said insulating disc.

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RICHARD M. WOOD, *Primary Examiner.*