

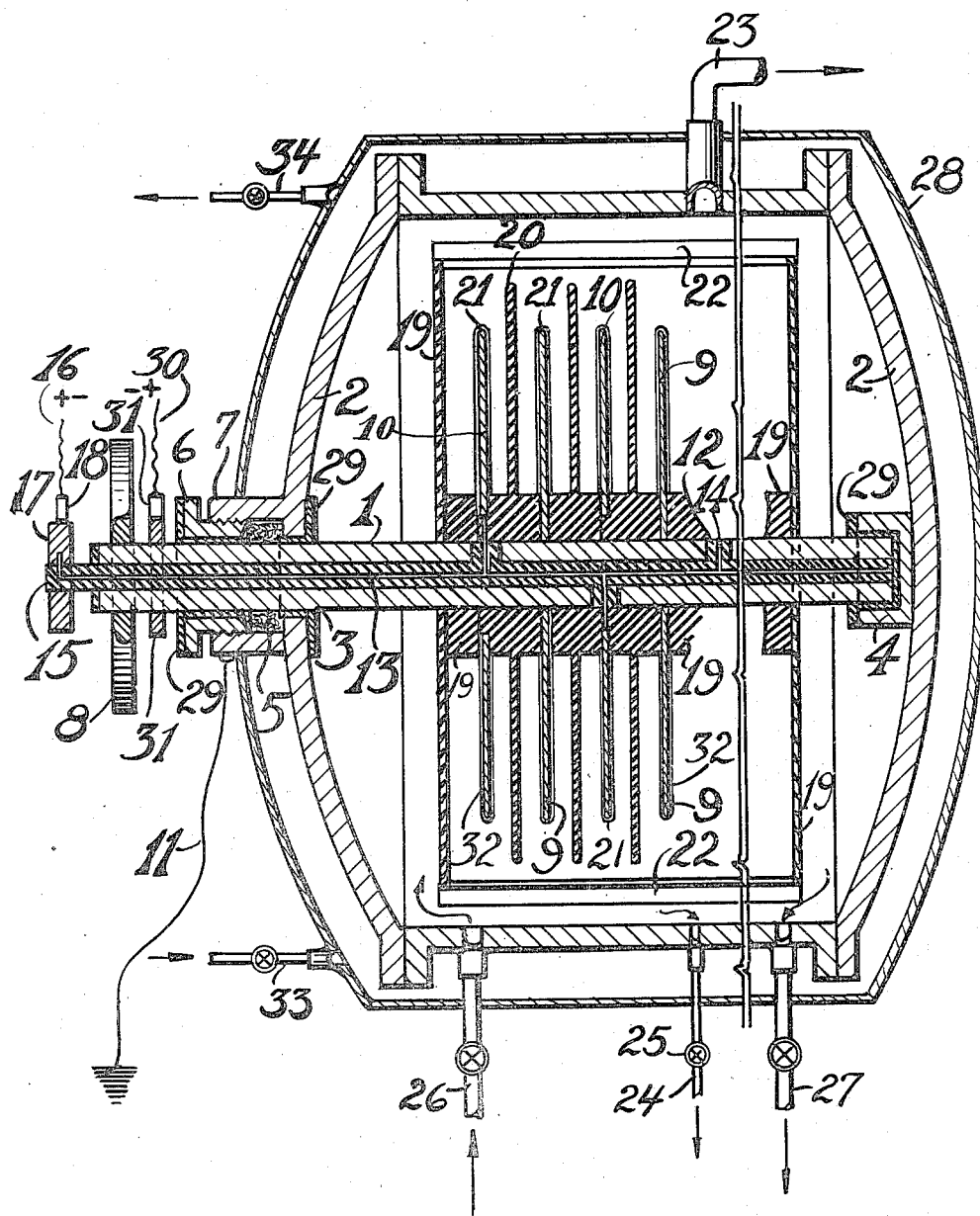
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ELECTRODES FOR VOLTOLIZATION

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ELECTRODES FOR VOLTOLIZATION

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This invention relates to improvements in apparatus for treating carbonaceous materials with silent electric discharges, and more particularly to an improvement in the electrodes of such apparatus.

Electrical treatments of carbonaceous materials, such as fatty and hydrocarbon oils, fats, and waxes, and other organic compounds, whereby such materials are subjected to the action of high frequency electric discharges at high potentials but below those at which sparking occurs have been commonly designated as voltolization processes. The action of silent electric discharges on the organic compounds is complex and varies with factors including pressure, electrical potential, current, and frequency, which are readily controlled, and other factors which can be broadly included in the efficiency of construction and manipulation of the discharge apparatus.

Regardless of how accurately the factors of pressure and electric current are controlled, or of how the carbonaceous materials heated are manipulated, practical difficulties may arise in making the action of the electric discharge uniform and in preventing contamination of the product by parts of the apparatus. A small excess of charge at any localized spot on an electrode forms a nucleus of intensified reaction which in a short time builds up insoluble gels and destroys the uniformity of treatment, causing some of the material to be overvoltolized and some undervoltolized. Also, it has been observed that if bare metal electrodes are used, the resulting product tends to be contaminated with colloidal metal, which frequently is harmful. These difficulties have been successfully avoided in accordance with the present invention by applying to discharge surfaces of each conducting electrode, particularly each metallic electrode, a uniform and continuous adherent coating of a material which prevents contact of the conducting electrode with the material being voltolized, and which is sufficiently thin to maintain a high electrical capacity in the circuit between each pair of consecutive electrodes.

An object of this invention is to provide for more efficiently constructed silent electric discharge apparatus having improved conducting electrodes prepared by applying to the electrodes a thin, homogeneous, and uniform protective coating which particularly resists dissolution by the reacting materials, deterioration by the silent electric discharge, oxidation, moisture, other chemical action, and heat. A more specific ob-

ject is to prepare such improved electrodes with a coating which is easily applied and which remains as an intact even layer on the electrode over a long period of service. Further objects are to provide a form and assembly of conducting electrodes which eliminates irregularities of electrical discharge intensity which may arise from the shape of the electrodes and the manner of assembling the electrodes. These and other objects will become apparent from the following description and claims.

Although it has already been proposed to encase metal electrode sheets with layers of dielectric material, such as porcelain, earthenware, vulcanized fiber, artificial molded resins, glass, wood, oil soaked paper, etc., various difficulties were experienced in trying out these materials. In being relatively thick, such layers of dielectric material lower the amount of electrode discharge and preclude an efficient use of a dielectric plate spaced from and between the electrodes. The very hard materials such as the artificial resins, porcelain, earthenware, ordinary enamels, etc., are too inflexible and are easily cracked. Also, such materials do not adhere well to the metal surface, and even when glued to the metal surface, fissures form readily between the metal and the hard dielectric layer. In general, the shellacs and enamels are unstable under the voltolizing conditions, developing blisters and becoming broken at numerous places.

The stable and adherent protective coating which now has been developed is a clear baking oil varnish which may be applied evenly over the electrode surface by brushing, spraying, or dipping. The thus coated electrode may be used after air drying without previous baking. This varnish, of the China-wood oil and linseed oil or drying oil type, is typified by the following physical characteristics:

Specific gravity at 20° C.	.900 to .910
Viscosity (Stormer) at 20° C.	40 to 80 seconds
Non-volatile matter (minimum)	47%
Drying time (A. S. T. M.) on copper	2½ hours
Life test minimum (A. S. T. M.)	1200 hours
Flash Point, minimum	50° C.

It is not affected after baking and immersion in an insulating oil for 48 hours at 100° C.

The preferred China-wood oil-linseed oil varnishes are known and available products. They generally have a China-wood oil (tung oil) base combined with a relatively smaller amount of linseed oil blended with a resin such as copals,

succin, or coumarone, and a gum, such as dammar, mastic, or the like, and this blend formed by cooking to the desired viscosity is thinned with benzine or other hydrocarbon solvents until the varnish contains about 45 to 55% solids, the remainder being volatile solvent. The ingredients may be used in the following proportions by weight:

	Parts
Resin -----	30
Gum -----	16
Wood oil -----	5
Linseed oil -----	2½

With increased proportions of oil the drying time of the varnish is increased. The cooking is carried out at a temperature of about 300 to 400° F. for a period of 4 to 8 hours. After thinning and filtering of the cooked varnish, a small amount of drier of the soluble organic salt type is generally added, e.g., 0.4% of lead naphthenate. Pigments are preferably omitted.

This type of varnish after being applied to the electrode plates is allowed to dry for about 24 to 48 hours before the varnished electrodes are introduced into the voltolizing apparatus. Temperatures of about 180° F. in the voltolization may bake the varnish to some extent. The varnished electrode may be air dried for a shorter period of 15 to 16 hours followed by baking for a short period before introduction into the voltolizing apparatus if desired.

In some instances, synthetic resins or resinoids are used to replace the natural or fossil resins, and desirable types of synthetic resins which may be thus used are polyvinyl acetal resins, alkyd resins, and some modified resins rather than phenol-formaldehyde resins. A varnish film having a glossy finish and sufficient elasticity for expansion with the metal through the range of operating temperatures is desired rather than a plastic varnish.

The metal surfaces to be varnished are preferably well cleaned before the varnish is applied. The metal surfaces may be polished to a smooth finish before applying the varnish, rather than roughened. With a uniform pore free varnish coating capable of adhering to a polished metallic surface, the oil undergoing treatment tends to spread out over the coating in a thin film ensuring a definite and uniform dielectric gap between the electrodes.

While apparatus in which the improved electrodes may be employed are well known in the art, the following explanations will facilitate understanding of the features in this invention.

Two main types of apparatus used for voltolization are the tube and the trommel types. The latter type, with which the present invention is mainly concerned, is more suitable for large scale operation and can be more ruggedly constructed especially with the use of metallic conducting electrodes.

The trommel type of apparatus comprises a horizontal drum in which is disposed a plurality of separated conducting electrode plates having parallel discharge surfaces. Between pairs of these electrode plates may be interposed one or more non-conducting parallel plates having dielectric surfaces. The conducting electrode plates are spaced apart by dielectric material so that sets of alternate electrode plates may be connected together with sources of alternating current to form discharges between each pair of plates. All or a number of the plates may be

mounted centrally on a rotatable shaft so that they rotate therewith to cause reactant liquid brought upon their surfaces to form thin films thereon. The reactant material may be brought upon the plate surfaces by means of sprays, scoops, or any means which permits the liquid to flow over the surface evenly. The rotating plates may dip into a pool of the liquid reactants at the bottom of the drum so that they pick up liquid as they rotate. A detailed description of some specific forms the trommel type apparatus assumes is given in U. S. Patent 2,071,551, granted February 23, 1937 to George L. Matheson.

In the tube type of apparatus the conducting electrode elements and any intervening dielectric elements assume generally a vertical cylindrical form and are spaced apart by having the cylinders of different diameters and arranged concentrically. The liquid reactant is made to flow in thin films over one or more of the cylindrical surfaces by rotation of such cylinders with their lower parts immersed in a pool of the liquid, by sprays, etc. The conducting electrodes are alternately connected in sets to alternating current sources for producing alternating discharges between pairs of the cylinders.

The general construction of the apparatus especially with reference to the assembly of the electrodes improved according to the present invention will be fully understood with reference to the accompanying drawing, in which:

The figure is a diagrammatic view in sectional elevation of a trommel type of apparatus. To show the details more plainly in this view, space has been economized by omitting an intermediate portion of the trommel, in which there is only a repetition of parts shown. The omitted portion is indicated as coming between the broken lines.

Referring to the figure, which shows a cross-section in detail of an electrode assembly adapted for use in a trommel type of voltolizer, numeral 1 designates a rotatable bored metal shaft or axle projecting horizontally into the shell or drum 2 through a gas tight bearing 3 to socket 4. Bearing 3 may be made gas tight by packing 5 held tightly packed between the threaded nut 6 and the threaded gland 7. The shaft 1 is revolved through a driven pulley 8, or its equivalent. A series of thin conducting electrode disc-shaped plates or sheets 9 and 10 are mounted vertically on shaft 1 to be rotated therewith. The set of alternate metal discs 9 have fixed electrical contacts with the shaft 1, which may simply complete the electric circuit by being grounded through its bearing contact with the trommel drum 2, and ground wire 11. The set of alternate metal discs 10 is electrically insulated from metal shaft 1 by the dielectric plugs 12 and dielectric discs 13, and is connected together with a high tension lead wire 14 by conducting taps 14. Lead wire 14 is insulated from the metal shaft, by the dielectric tube 15 within the bore of the shaft and makes an electrical connection with a high tension alternating current terminal 16 through the revolving slip ring 17 and brush 18. The adjacent electrodes are spaced apart by dielectric discs 19 and preferably have an intervening narrow dielectric disc 20 of which the edge may extend beyond the rounded edges 21 of the electrodes. An oil scoop 22 may be supported by the two outside dielectric discs 19 for lifting liquid reactant material from the pool at the bottom of the drum and letting the liquid drip down on the surfaces of the discs under-

neath. The drum 2 is provided with an upper outlet 23 for leading gaseous material to an evacuating means (not shown), a bottom drain and sampling pipe 24 having a valve 25, valved inlet 26 and outlet 27 for introduction, withdrawal, and recycling of liquids, and a jacket 28 for enclosing a heat exchange medium to heat or cool drum 2 and its contents. The heat exchange fluid is introduced and withdrawn by valved inlet and outlet pipes 33 and 34.

If it is desired to use two high tension sources of alternating current in the circuit, the illustrated arrangement may be modified as shown, simply by insulating the shaft from the drum by insulating sleeves 29 and connecting the insulated shaft to a high tension terminal or bus bar 30 through a slip ring and brush combination 31, which can be placed outside the drum.

An enlarged cross-section is shown of the conducting plates 9 and 10 in their preferred form for avoiding any sharp edges or points at which electricity tends to accumulate. The localized accumulation of electricity may cause metallic sputtering, localized overvoltage, and even arcing, all of which result in a damaged product and power loss. An application of a thicker coating of varnish at the edges remedies this condition to some extent, but rounding of the edges 21 and a uniform coating of varnish 32, is preferable, the varnish being preferably of the stable types described.

The conducting electrode, leads, and taps may be constructed of any suitable conducting material, such as metals, alloys, or mixtures thereof. As suitable examples may be mentioned aluminum, copper, nickel, iron, silver, mercury, tantalum, tungsten, vanadium, platinum, molybdenum, zinc, chromium, cobalt, cadmium, etc. Metalloids such as carbon and the like may also be used.

The conducting electrodes may be in the shape of discs, disc quadrants, etc., and in the form of sheets as thin as foil and thicker or of fine mesh screen. Smooth plane discharge surfaces are, however, particularly desired.

The dielectric material used for spacing the electrodes apart, for insulating them and the leads, and in dielectric plates or sheets interposed between the electrodes may be any suitable insulating material of sufficient strength to stand up under the high tension current and mechanical forces imposed upon them. As examples of suitable materials may be mentioned cellulosic materials and cellulose esters, fiber board, oil soaked fullerboard, vulcanized rubber, synthetic rubbers, artificial and synthetic resins, such as coumarone resins, phenolic resins, etc., made up in single or laminated sheets. Glass, earthenware, porcelain, enamelware, etc., may be used with more precautions taken against breakage. Oil soaked fullerboard is considered one of the most practical materials for use as a dielectric between electrodes because of its durability, high dielectric properties, and low cost.

For improved efficiency it is important to have the protective coating on the electrodes as thin as possible consistent with needs for durability, to enhance the total electrical capacity and energy flow in the circuit between the electrodes. With a more highly effective electrical capacity between the electrodes, the current density, which is proportional to the rate of voltolization, is also relatively high. A desirable protective coating is obtained with a film of the varnish limited to a thickness of about 0.005 to 0.2

mm. However, a coating of this type has such high electrical capacity as to require insertion into the space between consecutive electrodes of a dielectric plate having sufficient thickness to decrease the voltage gradient at the coating and thus prevent breakdown in the coating.

For a suitably balanced circuit between the electrodes having thin protective coatings and interposed dielectric sheets, the consecutive electrodes are spaced apart by about 0.6 to 2.5 cm., and the dielectric sheet having a thickness of about 0.15 to 0.3 cm. is equidistant between two consecutive electrodes. With this arrangement and these dimensions, the protective coating will satisfactorily endure the usual silent electric tensions even though the thickness of the coating be less than 0.2 mm.

The clearance between conductors having opposite polarities should be sufficient to prevent arcing. In a hydrogen environment having a gas pressure of about 0.1 atmosphere, arcing will not occur until the difference of potential between conductors of opposite polarity and separated by a 10 cm. gas gap is about 5,000 volts. A clearance of at least 10 cm., therefore, will be ample in most voltolization work. The usual voltolization process employs an alternating current of about 60 to 10,000 cycles per second, a subatmospheric pressure of about a few centimeters of mercury to about 0.5 atmosphere absolute, and a voltage of about 1,000 to 20,000 volts.

The improved varnished electrodes described, in addition to having the already noted advantages of eliminating contamination of the voltolized product by colloidal metal, permitting more uniform voltolization, preventing sparking, having a durable and inexpensive construction, are considered to be exceptionally efficient in presenting a smooth surface which is self-cleaning and which is readily wetted by the organic reactants. Exposure of continuous even films of reacting liquid to the action of silent electric discharges is one of the most essential requirements for successful voltolization, and the oil wetting property of the drying oil varnishes has been found to be highly conducive to the formation of such films.

With the discharge surfaces of the metal or conducting electrodes entirely covered by a sufficiently thin protective coating which the varnish provides, dielectric plates can successfully be used between pairs of the electrodes with sufficiently high voltage gradients between each electrode and an adjacent dielectric plate to substantially double the amount of reactant film surface treated per unit area of electrode discharge surface, permitting reactant films on the dielectric plate surface to be treated as well as those on the coated electrode.

It will be understood that various modifications may be made without departing from the spirit and scope of the invention, which is not to be limited by any theories of mechanism of voltolization nor any details given merely for the purpose of illustration but only by the following claims which are intended to define all novelty inherent in the present invention.

We claim:

1. An apparatus for subjecting thin films of carbonaceous liquid to the action of silent electric discharges comprising a source of high frequency alternating current, a plurality of separated conducting electrode plates having smooth parallel discharge surfaces, a non-conducting plate interposed between each pair of said elec-

trode plates, means for connecting alternate electrode plates with the source of alternating current to form discharges between each pair of plates, a continuous, uniform, substantially flexible coating film of clear air-dried and baked baking varnish over the discharge surfaces of each of said electrode plates, said coating film having a low electric resistance, and means for bringing the carbonaceous liquid onto said varnish coatings so that the carbonaceous liquid spreads out as an even film over said coatings.

2. An apparatus for subjecting films of carbonaceous liquid to the action of silent electric discharges comprising a source of high frequency alternating current, a plurality of spaced metallic electrodes having smooth parallel surfaces, a stable, substantially flexible, protective film coating of an air-dried and baked varnish having a thickness of less than 0.2 mm. on each of said electrodes to prevent contact of the metal with carbonaceous liquid subjected to treatment, said film having a low electric resistance; a dielectric plate interposed between each pair of consecutive electrodes, with sufficient thickness in the dielectric to prevent breakdown of the film coating, means for connecting alternate electrodes together with the source of alternating current to produce silent electric discharges between the electrodes and the interposed dielectric plate, and means for bringing the carbonaceous liquid onto the protective coating and the dielectric plate so that said liquid spreads thereon as even films which are affected by the silent electric discharges.

3. An apparatus for subjecting carbonaceous materials to the action of silent electric discharges, comprising spaced dielectric members and spaced conducting electrodes adapted to

form thin films of the carbonaceous material on a thin protective coating covering their surfaces, means to prevent arcing between said electrodes, said thin protective coating being a low resistance, substantially flexible coating film of an air-dried and baked varnish composition adherent to said electrode surfaces.

4. An apparatus according to claim 3 in which the varnish composition is a tung oil base, varnish composition.

5. An apparatus according to claim 3, in which said film coating has a thickness of not more than 0.2 mm.

6. In an apparatus of the character described, including a plurality of spaced metallic electrodes having smooth parallel discharge surfaces with interposed spaced dielectric members, an electrode member in which all peripheral discharge surfaces are rounded to provide a substantially continuous discharge surface for said electrode, and a continuous, low resistance, substantially flexible film coating of an air-dried and baked varnish composition as a protective outer coating over the discharge surface of said electrode, said varnish insulating the electrode against surface deterioration.

7. An apparatus of the character described, comprising a plurality of evenly spaced, polished sheet metal electrodes disposed in parallel relation one to another, a plurality of dielectric elements disposed in alternate relation between said electrodes and spaced apart therefrom, and a low resistance, substantially flexible, film coating of an air-dried and baked varnish composition applied to the surfaces of said electrodes.

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