

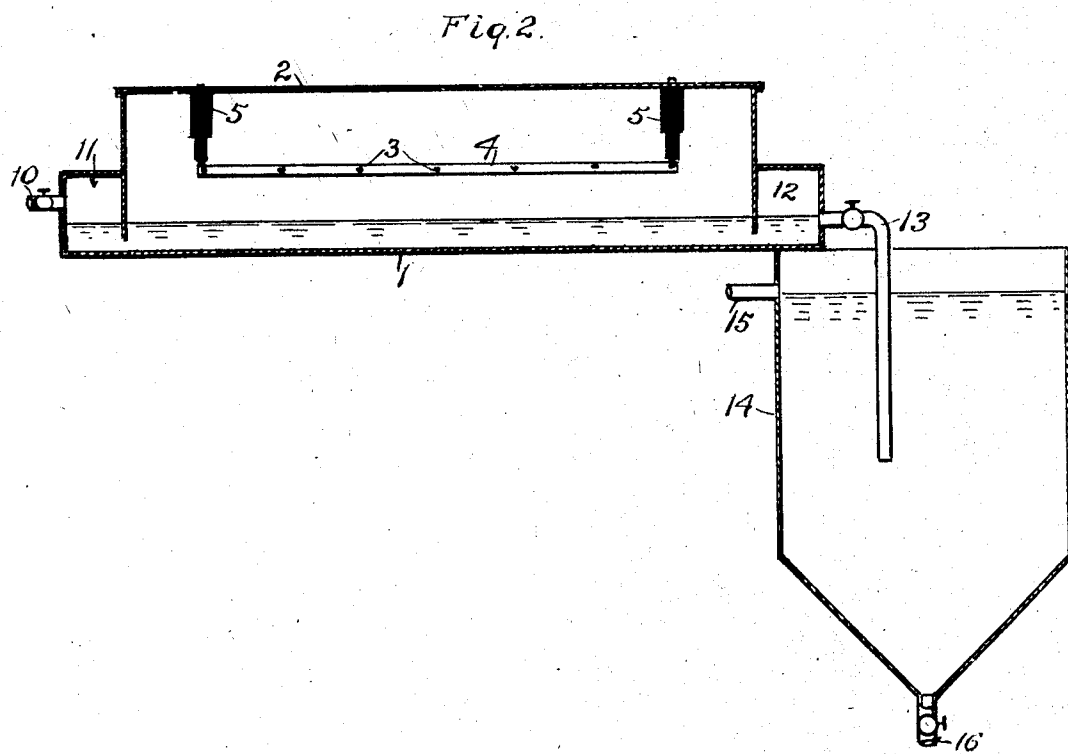
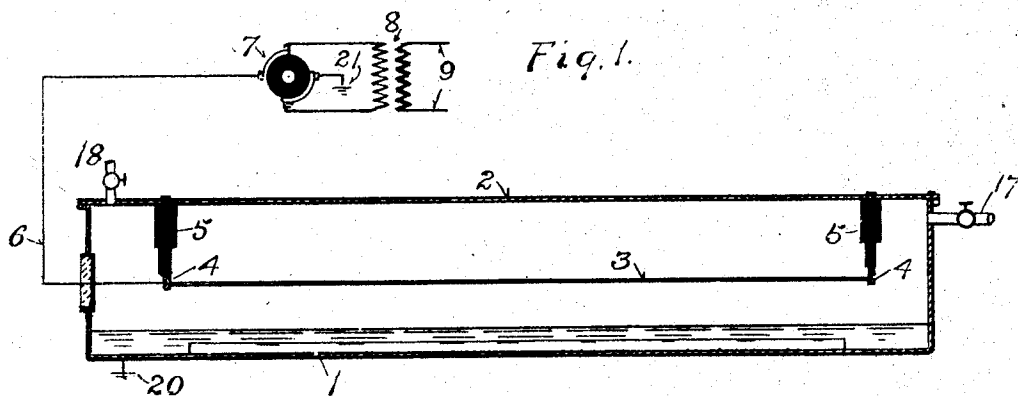
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E. ANDERSON

PROCESS FOR ELECTRICAL TREATMENT OF LIQUIDS

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PROCESS FOR ELECTRICAL TREATMENT OF LIQUIDS.

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To all whom it may concern:

Be it known that I, EVALD ANDERSON, a citizen of the United States, residing at Alhambra, in the county of Los Angeles, State of California, have invented a new and useful Process for Electrical Treatment of Liquids, of which the following is a specification.

This invention relates to a process for subjecting liquids to the action of a silent electrical discharge for the purpose of changing the physical or chemical constitution of such liquids. The invention is especially adapted for treatment of liquids of poorly conducting nature and is particularly designed for the treatment of emulsions of water and oil for the purpose of breaking such emulsions or separating the constituents thereof. In this connection the invention is applicable to various emulsified liquids and particularly to dehydration of emulsions of water and oily or tarry material, for example, emulsions produced in gas manufacture and consisting of crude oil or products thereof containing petroleum or other hydrocarbons emulsified with water.

De-emulsification or dehydration of petroleum emulsions has been effected successfully in many cases by the application of an electrical field. Difficulty however has been encountered in applying this method to dehydration of some emulsions, particularly where the emulsion is of an unusual thick or heavy nature, or where the emulsion, by reason of its high water content, or for other reasons, is of such conducting nature as to interfere with the production of the requisite high electrical potential difference required for the maintaining of an effective electrical field therein. My invention is particularly adapted to cases of this nature as it provides for the maintenance of an electrical field of sufficiently high potential difference to carry out the de-emulsifying operation without undue liability of short circuiting or breaking down the electrical field.

An important object of the present invention is to provide for subjecting the

emulsion to be treated to an electrical field maintained between electrodes in such a manner that a gaseous medium forms a part of the electrical field, thereby preventing or resisting the tendency to break down or disruptive discharge or short circuit which would exist in case both of the electrodes were in contact with the emulsion. A further object of the invention in this connection is the provision in an electrical dehydrating apparatus of an electrode constituting a discharge electrode maintained in contact with a gaseous medium included in the electrical field so as to facilitate the production of ions by discharge from the discharge electrode, and the ions so produced contributing to the effective action of the electrical field in the breaking and separation of the emulsion.

My invention may also be applied to electrical treatment of poorly conducting liquids for other purposes, for example, for changing the chemical constitution of such liquids by the action of a silent electrical discharge either by polymerization or by reaction with a gaseous medium in contact therewith to form addition or substitution products.

The accompanying drawings illustrate an apparatus suitable for carrying out the invention, and referring thereto:

Fig. 1 is a tranverse section of such apparatus.

Fig. 2 is a longitudinal section thereof.

The apparatus shown in the drawing comprises a tank or container 1 formed preferably as a pan or shallow flat bottomed receptacle of considerable horizontal area, said tank or container being preferably covered or enclosed by a top member indicated at 2. Within the tank 1 is mounted a discharge electrode or electrode system comprising, for example, a series of horizontal wires or rods 3, each of relatively small surface area or of small cross sectional area, stretched between horizontal bars 4 which are mounted on insulators 5 supported on and extending downwardly from the top 2 of the tank. A wire 6 leads from the

discharge electrode system to any suitable means for supplying high tension current, preferably unidirectional. For example, said wire 6 may lead to a rectifier 7 adapted to rectify the current supplied from a step-up transformer 8 which is energized by an alternating current circuit 9. The tank 1 may be grounded as shown at 20 and the current is completed by a ground connection 21 to the rectifier.

Suitable means are provided for supplying to the tank 1 the emulsion to be treated and I prefer to so control the supply of the emulsion to the tank and the flow thereof through the tank as to maintain a relatively shallow layer of the emulsion on the bottom of the tank below the discharge electrode 3. For this purpose an emulsion supply pipe 10 may be provided which supplies the emulsion to a launder 11 for distributing the emulsion to the inlet end of the tank 1. From the opposite end of the tank 1 the treated emulsion or liquid flows through a delivery launder 12 which delivers the liquid through an outlet 13 to a settling tank 14 having an upper outlet 15 for oil or tar and a lower outlet 16 for water. The bottom of the tank 1 may be horizontal or slightly inclined towards the outlet end.

To ensure safe operation it is preferable to carry on the electrical de-emulsifying operation in the presence of a gas which is inert with regard to the hydrocarbons which are present in the emulsion, for example, a hydrocarbon gas obtained by distillation from petroleum or any other inert gas may be supplied to tank 1 by pipe 17, vent valve 18 being provided to enable any air within the tank to be expelled.

My process may be carried out in the above described apparatus as follows:

The oil emulsion or tar emulsion, for example, gas tar containing considerable water emulsified with the tarry constituent, is supplied to the inlet 11 of the tank 1 and flows over the bottom of the tank 1, forming a shallow layer thereon, say from one half to two inches in depth. This layer of emulsion extends below the discharge electrode members 3 and above the bottom of the tank which serves as an opposing electrode and such potential difference is maintained between the discharge and opposing electrodes as to produce a silent electrical discharge or corona discharge from the discharge electrodes and to maintain an electrical field of suitable intensity in the space occupied by the emulsion and by the gas above the same. The lines of force of the electrical field thus produced extend transversely with respect to the surface of the liquid and pass partly through the liquid and partly through the gaseous medium above the same. The potential difference required depends upon the spacing of the electrodes and may be, for ex-

ample, about 25,000 volts with a spacing of two inches between the discharge electrodes and the surface of the emulsion. By reason of the electrical discharge thus produced from the discharge electrodes and of the intense electro-static field maintained between the discharge electrode system and the bottom of the tank forming an opposing electrode, an electrical action takes place within the emulsion causing breaking of the emulsion so that there is an increased tendency of the water constituents thereof to settle out from the tarry constituents which is lighter. The shallowness of the layer of emulsion facilitates or expedites the settling out of the water from the tarry or oily constituent of the emulsion. By controlling the supply of the emulsion in such a manner that the flow of the same through the tank is sufficiently slow the water constituents thereof may be more or less completely settled out by the time the emulsion reaches the outlet 13. In general, however, it is more economical to feed the emulsion with sufficient rapidity to cause it to pass through the tank or over the bottom of the tank in a period of time not greater than that required for the breaking action of the electrical field to become fully effective, the settling operation being performed in the tank 14 to which the liquid passes from the de-emulsifying tank 1, and the water and tar or oil constituents being withdrawn respectively through outlets 16 and 15.

It will be understood that the emulsion, whether of oil and water or of tar and of water, will be heated, if necessary, to a suitable temperature to enable the various operations of flowing through the treating tank, of electrical breaking action on the emulsion and of settling of water from the oil or tar to be effected with the greatest economy. The separation after the breaking action may be effected by gravity or by centrifugal action. In some cases it may be desirable to add a chemical reagent, for example an agent such as soap, capable of modifying the interfacial tension between the oil and water constituents of the emulsion so as to facilitate or expedite the breaking and separating operations.

As it is desirable that the body of the emulsion in the treating tank should be distributed in a rather shallow layer, it will generally be necessary to provide a tank of considerable horizontal area in order to provide for rapid treatment of a large volume of emulsion, and the expression "relatively shallow layer of the emulsion" is therefore intended to mean a layer of small vertical thickness as compared to the horizontal dimensions of the tank. It will however be understood that in order to increase the capacity of the apparatus it is only necessary to provide a sufficient number of units, for

example, arranged one above another or otherwise, the emulsion flowing being distributed into said units by suitable feed means in such a manner that the emulsion passes through the several units, preferably in parallel streams.

An important feature of the present invention is that one of the electrodes herein referred to as discharge electrodes is exposed to a gas, thereby enabling rapid production of ions which serve to effect the breaking of the emulsion. Another feature of the invention is that the layer of gas between the said discharge electrode and the liquid being treated lessens any liability of short-circuiting by reason of conductivity of the liquid. A further feature of the invention is that the emulsion being treated is distributed in a shallow layer thereby enabling most effective action of the electric field therein and also expediting the settling or separation of the constituents in the emulsion which have been broken by the action of the electrical field.

The invention is applicable to the separation of colloidal suspensions in general and in fact to any dispersed system comprising a solid or liquid constituent dispersed in a liquid in which it is substantially insoluble or but slightly soluble.

In applying my invention to the treatment of liquids such for example, as petroleum hydrocarbons for changing the physical and/or chemical constitution thereof, such petroleum hydrocarbon, for example, distillate, may be introduced into the chamber or receptacle, 1, the space above the petroleum or petroleum distillate being occupied by an inert gas, for example, nitrogen or carbon di-oxide or hydrocarbon gas derived from petroleum. Sufficient potential difference is maintained between the electrodes to cause a silent discharge from the discharge electrode 3 accompanied by ionization in the gas surrounding and in contact with said discharge electrode. Such ionization in conjunction with the electrical field maintained between the electrodes causes a change in the physical or chemical constitution of the liquid being treated, for example polymerization thereof. By using instead of an inert gas a gas capable of reacting with the liquid under action of an electrical field, for example, hydrogen or chlorine, various addition or substitution products may be obtained. By treating a vegetable oil in this manner in contact with hydrogen gas hydrogenation of the oil may be effected, or by treating petroleum oil in the presence of chlorine gas various substitution compounds containing chlorine may be produced, or by treating linseed oil, for example, in contact with air or oxygen, oxidation and/or polymerization thereof may be effected.

In general it is preferred to use a uni-directional current of high potential difference for energizing the electrical field in which the above described operations whether of emulsion breaking or otherwise are taking place and in such case the discharge electrode is preferably the negative electrode. In some cases, however, the discharge electrode may be made the positive electrode and in some cases also it may be sufficient to use a high tension alternating current for operating the apparatus so that the electrical field maintained between the electrodes is of an alternating nature.

By reason of the electrical field maintained between the electrodes there is produced, in addition to the ionization effect in the gas exposed to the discharge electrode, a considerable amount of electrical convection or windage, which causes agitation of the liquid and penetration of ions and of portions of the gas into the body of the liquid, resulting in bringing into contact with the liquid the ions that are produced by the electrical discharge, and also in bringing the gas itself into more effective contact with the liquid. The ions introduced in this manner into the body of the liquid may be considered the agencies whereby electrical and chemical actions are exerted on the liquid resulting in the de-emulsification, polymerization or other physical or chemical changes in the liquid.

While I have described my invention as applied in connection with an apparatus adapted to present the liquid to be treated in a relatively shallow horizontal layer on the electrode opposing the discharge electrode, it may be carried out in any apparatus providing for exposure of the two electrodes respectively in contact with the liquid to be treated and with a gaseous medium capable of ionization. For example it may be carried out in an apparatus such as shown in the patent to Burns, 1,250,088, December 11, 1917, the liquid to be treated being in that case caused to flow over the surfaces of the electrode, or electrodes of extended area so as to produce the desired physical or chemical changes, for example, in cases where the liquid is an emulsion the breaking of such emulsion; the constituents thereof being subsequently separated by settling or otherwise. Or the process may be carried out by distributing the liquid to be treated on the inside of a cylindrical chamber by centrifugal action produced by rapid rotation of said chamber, the discharge electrode in that case extending axially within the said chamber and in contact with the gaseous medium contained therein. With such an operation applied to an emulsion of oil and water, the centrifugal action will assist in separation of the constituents of the emulsion. It will be

understood that in this case the opposing electrode will be constituted by the walls of the rotating chamber. The discharge electrode is, in any case, of a relatively limited area and the opposing electrode of relatively extended area so that the discharge is mainly from the said discharge electrode by reason of the stronger field adjacent thereto.

In respect to the operation of the above described process in breaking emulsions it may be stated that in so far as the suspended particles may carry electrical charges the effect of the electrical field and particularly of the ions produced thereby may be to react with such charges, for example, by neutralizing same so as to modify the dispersing effect and assist in agglomeration or coalescence of the suspended particles.

While I have described the process as applied to the treatment of a liquid it will be understood that there may be no especial limitation as to the mobility of the liquid, for example, the process may be applied in some cases to substances of high viscosity, such as heavy tars, bitumens, resins, or other substances which are of a semi-solid nature but which are sufficiently fluid to permit of the operation of the process.

In cases where the process is applied to effect chemical reactions between a gas and a liquid, such reaction may be produced or accelerated by the action of a constituent of the gaseous medium which is produced by the action of the electrical field or discharge on said gaseous medium, for example, in the treatment of linseed oil as above described, the discharge electrode being in contact with atmospheric air and the linseed oil being in contact with the opposing electrode, one effect of the electrical discharge or ionization in the air exposed to the discharge electrode is to produce ozone in the air and such ozone contained in the gaseous medium may be an influential factor in the chemical reaction with the liquid or a constituent thereof.

What I claim is:

1. The process which consists in subjecting a colloidal suspension consisting of a material dispersed in a poorly conducting liquid to the action of a silent electrical discharge produced in a gaseous medium in contact with such liquid to cause separation of the suspended material from the liquid.

2. The process which consists in passing an emulsion through an electrical field maintained between opposing electrodes, said emulsion being in contact with one of said electrodes and being separated from the opposing electrode by a gaseous medium and maintaining sufficient potential difference between said electrodes to produce a silent discharge from the electrode exposed in said gaseous medium.

3. The process which consists in maintaining an electrical field between a discharge electrode of relatively small area and an opposing electrode of relatively extended area, the discharge electrode being in contact with and surrounded by a gaseous medium capable of ionization under the action of an electrical stress and the potential difference maintained between the electrodes being sufficient to produce such discharge, and introducing a liquid to be treated into said electrical field and in contact with said opposing electrode so that said liquid is subjected to the action of the ionization produced in the said gas, and of the electrical field maintained between the electrodes.

4. The process of de-emulsifying a liquid which consists in introducing such liquid into an electrical field maintained between a discharge electrode of relatively limited area and an opposing electrode of relatively extended area, said liquid being in contact with said opposing electrode and said discharge electrode being in contact with and surrounded by a gaseous medium capable of ionization under the action of electrical stress, and maintaining sufficient potential difference between said electrodes to produce an electrical discharge from the discharge electrode with resulting ionization of the gas in contact therewith in such a manner that the emulsion is broken by electrical action.

5. A process as set forth in claim 4 and comprising in addition, subjecting the emulsion after the breaking operation to a separating operation to separate the constituents thereof.

6. The process which consists in subjecting a liquid while in contact with a gaseous medium to the action of an electrical field produced between a discharging electrode which is in contact with the gaseous medium and an opposing electrode which is in contact with said liquid.

7. A process as set forth in claim 6 wherein the said gaseous medium contains a constituent which is capable of chemical reaction with a constituent of said liquid under the action of the electrical discharge.

8. A process as set forth in claim 6 wherein said gaseous medium contains a constituent produced by the action of the electrical field therein, said constituent being capable of chemical reaction with a constituent of said liquid under the action of the electrical discharge.

9. The process which consists in passing a colloidal suspension through an electrical field maintained between opposing electrodes, said colloidal suspension being in contact with one of said electrodes and being separated from the opposing electrode by a gaseous medium and maintaining sufficient potential difference between said electrodes to produce a silent discharge from

the electrodes exposed in said gaseous medium.

10. The process which consists in subjecting a liquid whose surface is in contact with a gaseous medium to the action of an electrical field whose lines of force extend transversely with respect to the surface of the

liquid and pass partly through said liquid and partly through said gaseous medium.

In testimony whereof I have hereunto subscribed my name this 25th day of October, 1923.

EVALD ANDERSON.