May 5, 1953 O. YADOFF 2,637,408

METHOD AND APPARATUS FOR TREATING FLUID MEDIUM

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Fig. 2.

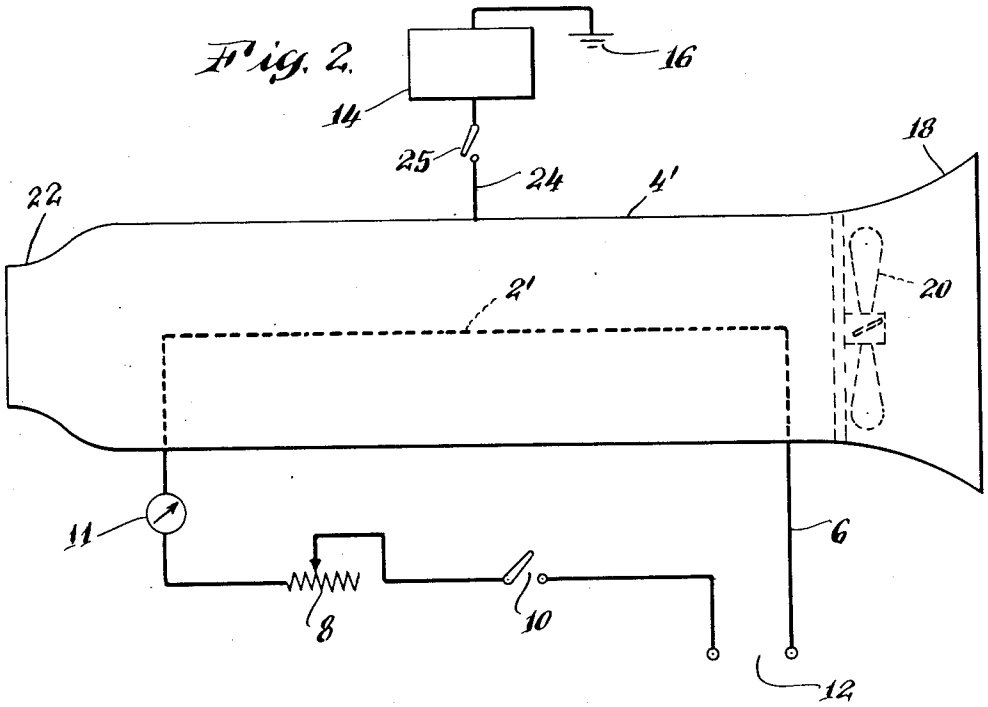
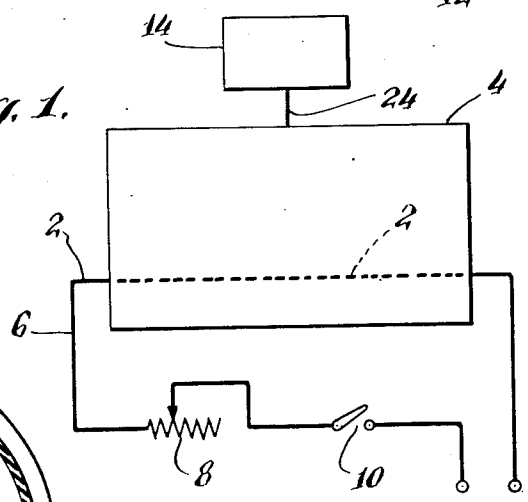


Fig. 1.



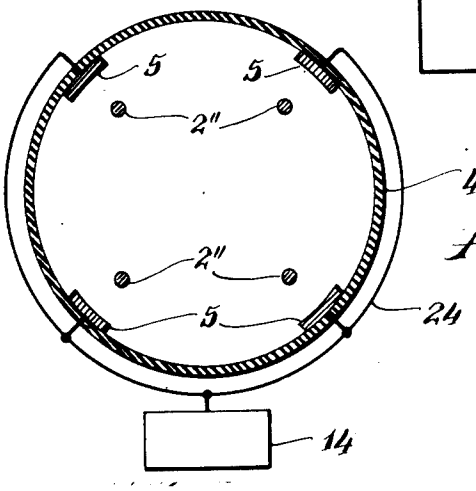


Fig. 3.

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METHOD AND APPARATUS FOR TREATING FLUID MEDIUM

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The present invention relates to a method of obtaining an interaction between an electromagnetic field resulting from the flow of a current through an electrical conductor and an electrical field in which the conductor is located, and to apparatus for carrying out the method.

More particularly, the invention relates to a method of treating a fluid by applying thereto a novel principle involving the interaction between an electromagnetic field set up by a flow of current through a conductor and an independently generated electrical field established around the conductor. Such interaction between the electromagnetic and electrical fields may manifest itself in the form of a change in the conductivity of the conductor and hence in its resistivity to the flow of current therethrough. The magnitude of such a change is a function of the intensity of the electrical field, of the relationship between the fields, and of the condition of the fluid medium, which may be static or in a state of motion, and the effect of the interaction may be observed with the naked eye.

A principal object of this invention is to apply the novel principle of interaction between electrical and electromagnetic fields to a fluid body. This principle may be applied to influence the condition of the body and of matter carried therein.

It has been found that when a gaseous medium, for example air, is subjected to the influence of this interaction, there is set up in the medium a system of electrical vortices, as a consequence of which molecules of the medium, in their vortex movement, come into contact with the conductor and exert thereon an electro-mechanical effect.

Hence it is a further object of this invention to influence the electrical properties of a conductor by subjecting a fluid medium surrounding the conductor to the interaction of a current flowing through the conductor with an electrical field established in the medium, causing the fluid medium to exert an influence upon the conductor.

In accordance with these and other objects, the present invention may be applied in practice, for example, to the treatment of gases for the purpose of removing therefrom such contaminating bodies as smokes, fumes, aerosols, dust and similar particles. It may also be used for killing and eliminating from air or other gases living organisms such as airborne bacteria and bacilli, and even gnats, mosquitoes and beetles.

Furthermore, the present invention may be put to practical use in such apparatus as flowmeters, where the velocity of a stream of fluid passing

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through a space in which there is established the interaction as hereinbefore described may be recorded by instruments responsive to the conductivity of a conductor located in the fluid stream.

With these and other objects in view, the invention comprises the method of establishing an interaction between an electromagnetic field and an electrical field which comprises establishing an electromagnetic field in a conductor which extends through a predetermined zone and which is included in a closed circuit, and imposing a static electrical charge of relatively high voltage upon a pole which defines at least in part the extent or said zone and which is included in an open circuit separate from and independent of said closed circuit.

The present invention further comprises apparatus for establishing an interaction between an electromagnetic field and an electrical field, comprising first circuit means including an electric conductor disposed in a predetermined position and a first source of electromotive force for passing an electric current through said conductor, container means defining an interaction zone about said conductor at said predetermined position thereof, said container means comprising at least one pole spaced from said conductor, a second source of relatively high static voltage entirely separate from and independent of said first source, and second circuit means separate from said first circuit means for connecting said second source to said pole.

The invention will be more readily understood from the following description, reference being made to the accompanying diagrammatical drawings, which show, purely by way of illustration and without in any way limiting the scope of the invention, some forms of apparatus in which the method of the invention may be carried out.

In the drawings:

Fig. 1 is a diagrammatical illustration of a first form of apparatus in accordance with the present invention, and by which the method thereof may be carried out;

Fig. 2 is a view, similar to Fig. 1, of a more deta led form of apparatus embodying the invention; and

Fig. 3 is a view in transverse section of another apparatus embodying the invention.

Referring to the drawings, there is shown in Fig. 1 a conductor 2, which may be of any desired shape or cross-section. For example, the conductor may be an elongated rod, of round or polygonal cross-section, or it may be a thin me-

tallic wire. The conductor 2 may be made of other electrically conducting materials, for example carbon.

The conductor 2 is located inside a container 4, which is usually, but not necessarily cylindrical, and is electrically insulated therefrom. The conductor 2 may be located along the axis of symmetry of the container as shown for the corresponding conductor 2′ and container 4′ in Fig. 2. Alternately, it may be eccentrically located, as shown in Fig. 1 and also at 2″ in respect to the container 4″ in Fig. 3, according to the desired propagation of interaction.

To the ends of the conductor 2 (or the corresponding conductors 2′ or 2″), is connected a first circuit 6, which may include a series-connected rheostat 8 and a switch 10. The circuit 6 includes a source of current 12 which may be, for example, the commercial electrical power supply or any other suitable source such as a battery.

This current source may be either alternating or direct, and the usual domestic voltage of 110 volts has been found satisfactory. The conductor is not supplied with the full current available from the source, but only with sufficient current to establish an electromagnetic field around the conductor when the other field, hereinafter described, is not in operation.

In one example of apparatus, the conductor is a platinum wire of $\frac{1}{10}$ mm. diameter. In another example it is a wire of same diameter 90% platinum and 10% iridium. Other metals have been found satisfactory, but they have a tendency to oxidize earlier than platinum and may be found unsatisfactory for continuous use for that reason.

The container 4 is made, at least in part, of a conducting material, preferably metallic. This container, or an electrically conductive part thereof, is electrically connected by a second circuit separate from circuit 6 to one side of a source of electricity 14, which is preferably a generator of relatively high voltage, the other side of which may be left open or grounded as at 16.

A container usable with the examples of wire referred to above may be a brass cylinder of the same length as the conductor, for example 15 centimeters, the diameter of the container being 8 cm. In another apparatus which has been successfully operated, the conductor 2 was 20 cm. long and the container had a diameter of 10 cm.

The field generated by the source 14 in these examples (using apparatus as shown in Fig. 2) is of the order of 5000 volts/cm., the distance being measured radially from the container wall to the conductor. Accordingly, the container of 8 cm. diameter is connected to a 20,000 v. source, and that of 10 cm. diameter to a 25,000 v. source, but satisfactory results have been obtained with lower voltages.

The ends of the container may be open or closed, according to the conditions of use of the apparatus. In the one form of apparatus shown in Fig. 2 for treating a moving stream of gaseous matter, for example air, one end of the container may be flared as at 18 and provided with a fan 20 (rotated by any suitable means, not shown) for causing the gas to flow in at that end. The other end may, if desired, be partly restricted as at 22 to increase the resistance of the apparatus to the flow and thereby to increase the contact of the fluid with the walls of the container 4′ and with the conductor 2′ or conductors therein.

The apparatus shown in Fig. 1 may also be employed to treat a moving stream of gas if placed vertically. The apparatus may then be started by first warming up the conductor to set the stream of gas in motion by convection; and as soon as the desired motion is obtained, the field from source 14 may be applied.

Furthermore, when the apparatus operates by forced draft, as in Fig. 2, it may be appropriate to shape either or both of the flared and restricted ends with suitable aerodynamic profiles to insure maximum efficiency. This is particularly so when the apparatus is used in accordance with the object of exerting an electro-mechanical effect on the conductor, for example when recording the speed of the stream of fluid in terms of variations in the electrical state of the conductor.

It has been found that when current is supplied to conductor 2, 2′ or 2″ through the circuit 6, it is possible so to influence the conductor or the current passing therethrough as to decrease the effect of the current on the conductor merely by establishing an electrical field originating from generator 14. The power required from the source 14 for influencing the conductor is dependent upon the distance of such conductor from the wall of container 4, 4′ or 4″, upon the condition (i. e. movement or static condition) of the fluid surrounding the conductor 2, and upon the intensity of the current flow in the circuit 6. It has been observed, for example, that if sufficient current is supplied to the conductor 2 from the source 12 to establish incandescence of the conductor, the glow may be extinguished by operating the generator 14 with an appropriate voltage across its terminals. This phenomenon is clearly observable with the naked eye. When the glow is extinguished as above described, it may be re-established by decreasing the rate of flow of the gas, or by increasing the supply of current in the circuit 6 by adjusting the rheostat 8. The magnitude of the influence exerted by the electrical field energized from the source 14 on the conductor 2 may be measured by connecting an ammeter 11 in the circuit 6. In this manner it has been found that the interaction between the two fields aforesaid is still present in a vacuum as well as with pressures at or in excess of normal atmospheric pressure.

From a theoretical point of view, it is believed that the electrical field has a purely electrical effect upon the electromagnetic field, since it is observable under conditions of near vacuum, and that the fluid medium has an electro-mechanical or electro-convectional effect on the conductor. This is borne out by the observation that the effect is less in a near vacuum than at normal atmospheric pressure and that slight changes in pressure are scarcely noticeable, while the effect of movement of the medium is very noticeable.

In the examples of apparatus given above, if the conductor will glow when supplied from a source of D. C. current at 110 volts, with an intensity of 2 amperes, it has been found that a field of 5000 volts/cm. will extinguish the glow until the rheostat is adjusted to increase the intensity to 2.4 amperes. When the source is 110 volts, A. C., 50–60 cycles, the corresponding figures are respectively 2 and 2.2 amperes. In other words the field energized by the source 14 has a greater effect upon a conductor carrying D. C. current than upon a conductor carrying A. C. current.

Now it has been found that when solid, liquid or gaseous particles are introduced into the container in suspension in or admixed with a fluid medium, they appear to be immediately disintegrated as soon as they enter the interaction

space. For example, when an atmosphere saturated with bacteria or bacilli is introduced at 18, pure air is discharged at 22. When a gas containing suspended particles or smoke is passed through apparatus built and operated in accordance with the present invention, the solid particles are removed from the gas. If the apparatus is closed at both ends and filled with a heavy smoke, which is then permited to become static before connecting the source 14 to the container 4, the smoke will disappear as soon as the electrical field is established as aforesaid. In both cases the solid particles of the smoke will settle in what appears to be an atomic or molecular form, mainly on the walls of the container 4. The same result was obtained with air streams polluted with dust and other particles in colloidal and other forms and even with air carrying such living organisms as bacteria, gnats, mosquitoes and small beetles. The dust and other particles immediately settled on the container walls and the bacteria, flying gnats and mosquitoes were instantly killed upon entry into the interaction space. The insects were not, however, disintegrated, but were found dead, although not apparently burnt by contact with the conductor.

For this reason, the hereinbefore described interaction of fields is believed to have a physiological effect upon living organisms, even upon certain bacteria, which are readily destroyed in apparatus according to the invention, but which are otherwise extremely resistant to sterilization even at temperatures up to as much as 200° C.

In known apparatus of the "Cottrell" type, which comprises a single closed circuit including an ionizing electrode and a collecting electrode, and which is used for extracting dust or the like from the atmosphere, reliance is made on relatively high potential differences, a part of the particles being charged with one sign, for example negatively, and attracted to the positive pole; and another part positively, and attracted to the negative pole of the apparatus. In the apparatus according to the present invention, however, all the particles appeared to settle upon the container walls, none being found on the conductor.

From the theoretical point of view, it is believed that the particles are all charged with the same sign as the pole of the source 14 which is connected to the container (considering the source 14 as a D. C. source). If the source 14 is essentially oscillatory or A. C., similar results are obtained, although the theoretical explanation thereof is not thoroughly understood.

It is immaterial, for the purposes of the present invention, whether the container is connected to the positive or the negative pole of a D. C. source 14; and to whichever pole it is connected, the other pole may be left open or grounded. Furthermore, the nature of the electrical field from the source 14 may be varied. A purely electrostatic field is preferably used. Alternatively, the field from the source 14 may originate from a source of alternating voltage of suitable frequency. The source 14 may be connected to the container by direct contact with the selected terminal, or at a distance through a suitable lead 24, in which may be inserted a switch 25. Moreover, the motive power necessary for operating the generator or source 14 may be derived from an independent source or from the same source as the current circulating in the circuit 6 and conductor 2, but in the latter instance the connection between the two sources exists purely through the supply network.

The preferred source of energy is any well known electrostatic rotary machine with two wheels, although a converter of the "kenotron" type or a high tension mercury vapor rectifier may also be used, deriving the motive power, respectively the current to be rectified, from source 12.

In any event, when the generator 14 produces a D. C. field, the container is preferably connected to the negative pole, rather than the positive pole, in order to avoid hysteresis. On the other hand, the apparatus is fully operative, but at a somewhat lower efficiency, if reversely connected.

It has been found, however, that the field may be derived from a source of high frequency energy, for example, with a frequency of the order of 15,000 cycles per second or more. The low limit of frequency is believed to be about 15,000 cycles as aforesaid, but the upper limit may apparently be anything thereover as far as is determined by many tests which have been made.

In the form of apparatus shown in Fig. 3, the container 4'' may be formed as a duct of insulating material, on the interior surface of which are mounted one or more conducting strips 5. In this form of apparatus, there may be a plurality of conductors 2'' which may be paired with strips 5 as shown in Fig. 3. Similarly, a desired number of conductors may be used in the forms of the invention shown in Figs. 1 and 2.

In view of the fact that the electrical properties of the conductor 2, particularly the conductivity of the current flowing therethrough, are noticeably sensitive to movement of the medium through the container, the apparatus may also be used, as hereinbefore stated, for measuring the speed of flow of a stream of fluid, for example air or gas, through the apparatus. In such apparatus it may be convenient to calibrate the ammeter 11 in velocities of the fluid stream in order to obtain a direct reading.

The examples hereinbefore described are merely illustrative of some of the forms of apparatus in which the invention may be carried out and should not be interpreted as in any way limiting the invention, the full scope of which is more clearly defined in the appended claims.

What I claim is:

1. Apparatus for treating material by subjecting it to the effect of an interaction between an electromagnetic field and an electrical field, comprising first circuit means including an electric conductor and a first source of electromotive force for passing an electric current through said conductor of sufficient voltage to establish an electromagnetic field in and around said conductor, container means defining an interaction zone about and surrounding said conductor in spaced relationship therewith, said container means comprising at least one pole spaced from said conductor, a second source of relatively high static voltage approximately of the order of 1 kilovolt per centimeter of distance between said conductor and said one pole separate from and independent of said first source, and second circuit means separate from and electrically independent of said first circuit means for connecting said second source to said one pole.

2. Apparatus in accordance with claim 1 wherein the container means and pole comprise a hollow metal cylinder.

3. Apparatus in accordance with claim 1

wherein the container means and pole comprise a hollow metal cylinder and wherein the conductor comprises a straight wire located substantially concentrically within the cylinder.

4. Apparatus in accordance with claim 1 wherein the container means and pole comprise a hollow metal cylinder and wherein the conductor comprises a straight wire located substantially along a longitudinal axis of the container, the ratio of the internal diameter of the cylinder to the length of the wire being substantially 1:2.

5. Apparatus in accordance with claim 1 wherein the container means comprises a hollow cylinder of insulating material and wherein the pole comprises at least one metal strip mounted longitudinally on the interior surface of the cylinder.

6. Apparatus in accordance with claim 1 wherein the container means comprises a hollow cylinder open at both ends.

7. Apparatus in accordance with claim 1 wherein the container means comprises a hollow cylinder open at both ends and further comprising an outwardly flared extension at one end and a converging restriction at the other end.

8. Apparatus in accordance with claim 7 further comprising fan means for circulating a fluid medium through the container means.

9. Apparatus in accordance with claim 1 wherein said second source comprises an electrostatic machine.

10. Apparatus in accordance with claim 1 wherein said second source comprises a converter.

11. Apparatus in accordance with claim 1 wherein said second source comprises a mercury vapor rectifier.

12. Apparatus in accordance with claim 1 wherein said pole is connected to the negative terminal of said second source.

13. Apparatus in accordance with claim 1 wherein the other terminal of said second source is grounded.

14. Apparatus in accordance with claim 1, said conductor comprising a thin platinum wire, said container means and pole comprising an open-ended hollow brass cylinder concentrically surrounding said wire and having an internal diameter of the order of one half the length of the wire and of same length, and said first circuit means being connected to a source of 110 volts supply and including a series-connected rheostat thereby to enable the passage of an adjustable amount of current through the wire.

15. The method of establishing an interaction between an electromagnetic field and an electrical field which comprises passing an electric current through a conductor thereby to establish an electromagnetic field around said conductor included in a closed circuit, and imposing a static electrical charge of relatively high voltage upon a pole which is in spaced relationship with said conductor and which is included in an open circuit separate from and electrically independent of said closed circuit.

16. The method of subjecting a fluid medium to the interaction of an electromagnetic field and an electrical field which comprises passing an electric current through a conductor which is included in a closed circuit thereby to establish an electromagnetic field around said conductor, imposing a static electrical charge of relatively high voltage upon a pole which is in spaced relationship with said conductor and which is included in an open circuit separate from and electrically independent of said closed circuit, said voltage being approximately of the order of 1 kilovolt per centimeter of distance between said conductor and said one pole, and passing the fluid medium through the space between said conductor and said pole.

17. Apparatus in accordance with claim 7 further comprising means for circulating a fluid medium through the container means.

18. The method of disintegrating material by the interaction of an electromagnetic field and an electrical field which comprises passing an electric current through a conductor which is included in a closed circuit thereby to establish an electromagnetic field around said conductor, imposing a static electrical charge of relatively high voltage upon a pole which is in spaced relationship with said conductor and which is included in an open circuit separate from and electrically independent of said closed circuit, said voltage being approximately of the order of 1 kilovolt per centimeter of distance between said conductor and said one pole, and passing the material through the space between said conductor and said pole.

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