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Method of and Means for Producing Electrified Jets of Gas

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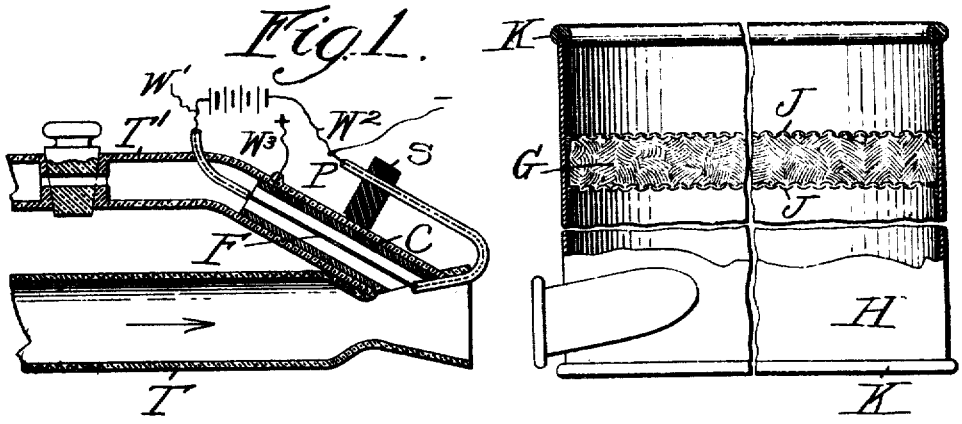
METHOD OF AND MEANS FOR PRODUCING ELECTRIFIED JETS OF GAS.

APPLICATION FILED OCT. 4, 1917.

1,363,037. Patented Dec. 21, 1920.

Fig. 1.



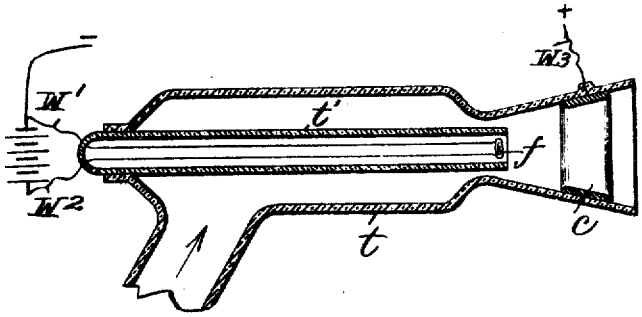


Fig. 2.

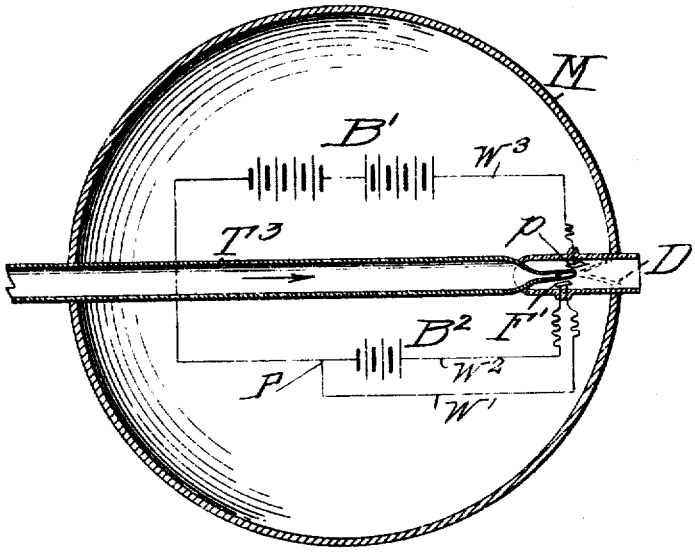


Fig. 3.

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METHOD OF AND MEANS FOR PRODUCING ELECTRIFIED JETS OF GAS.

1,363,037. Specification of Letters Patent. Patented Dec. 21, 1920.

Application filed October 4, 1917. Serial No. 194,785.

To all whom it may concern:

Be it known that I, ROBERT H. GODDARD, a citizen of the United States, residing at Worcester, in the county of Worcester and State of Massachusetts, have invented a new and useful Method of and Means for Producing Electrified Jets of Gas, of which the following is a specification.

This invention relates to the production of an electrified jet of gas or vapor for any desired purpose such as the production of high potentials, and the principal object thereof is to provide for accomplishing this result in such a way that the electrified jet may be of substantially constant character, independently of its velocity, and that change in the velocity will not seriously affect the result of the process; and, in short, to produce such a jet of gas in a highly efficient manner.

According to this invention I introduce into the jet charged particles or ions of one sign from a space not within the current of gas. In this way no direct action of the current affects or modifies the introduction of the stream of charged particles. If a stream of air or other gas were impregnated with particles or ions by a means existing in the stream itself the effectiveness would be greatly limited. For example, if the ions were produced by a hot filament an increase in the velocity of the gas would seriously cool the filament and if a discharge from points were employed, friction and eddies in the gas would increase rapidly with any increase of velocity. These difficulties are done away with by my invention, because if the ions or charged particles are produced in a space through which the current does not pass they are out of the way of the direct action of the jet of gas and it may have any desired velocity or may contain any vapor or erosive solid particles and yet not interfere with the production of ions for introduction into the jet. Further objects and advantages of the invention will appear hereinafter.

Reference is to be had to the accompanying drawings, in which—

Figure 1 is a sectional view of a form of apparatus for carrying out this invention;

Fig. 2 is a similar view of a modified apparatus for charging the gas, and

Fig. 3 is a view of a complete modified apparatus, diagrammatic in form, and showing a modified utilizing apparatus in section.

In the form of the apparatus shown in Fig. 1 a high velocity air blast is forced through a main tube T. The ions are supplied to the jet by a comparatively low-velocity blast in a side tube T_1, the ions being produced by a hot platinum filament F, connected by wires W_1 and W_2 to any suitable source of current, such as a storage battery, or the secondary of a small transformer. The current in the filament should be such as to heat it to incandescence while the air is flowing. The filament may consist of a fine platinum wire covered with oxids of the alkaline earths, or of porcelain, as in the Nernst glower, or of any other substance which may be readily rendered incandescent in the gas passing through the tube T_1.

The ions are caused to pass from the filament into the stream of air in the tube T while passing through a metal cylinder C. This is connected by a wire W_3 to a positive source of potential; some point of the heating system as P being connected to a negative source of potential. Experiments show, however, that an alternating source of potential will work equally well at any air pressure. With even a moderate velocity of air in the tube T_1, practically no ions will pass to the cylinder C. The position of the cylinder or anode C in Fig. 1 and corresponding parts in the other figures is such that a strong field is produced which, if the jet of gas is absent, draws the ions from the filament to the cylinder. However, when a jet of gas is maintained the ions are found to be swept away in the jet before they reach the anode C. In short, the cylinder C serves to draw the negative ions from the filament, but the jet of gas sweeps the ions away before they can reach the cylinder or anode.

This apparatus is preferably constructed from glass tubing, the wires W_1 and W_2 being protected by small, thin, glass tubes, one of them being supported by a piece of insulating material S. A high velocity can be used in the tube T_1 without cooling the filament F, for the reason that the filament F is not in the tube T through which the high velocity jet to be electrified passes, but is in the side tube T_1 in which there is only a moderate speed of flow of gas; just sufficient to carry the ions produced in the tube T_1 into the main jet in the tube T. Further, a spray, as of water or mercury, may be

present in the jet in the tube T, or even solid particles, without interfering in any way with the production of the ions in the tube T_1. It is to be understood, of course, that the method is not restricted to the supplying of negative electricity to the stream of gas in the tube T, because the filament can be heated to such a temperature as to be charged positively and the cylinder C can then be charged negatively. Such positive currents will, however, usually be small.

Briefly, then the method involves the introduction of ions or charged particles of a given sign into a stream of gas, said ions being produced in a space adjacent to, but out of the direct path of, said stream.

Having thus described the method of and means for producing the electrified jet, attention is called to certain applications of the jet so produced. There are various applications, depending upon how the jet containing the electric charges is changed or modified. For example, the ions may be filtered from the stream of charged gas, much as dust is filtered from air on passing through cotton wool. In this case an important practical result is obtained, as hereinafter explained in connection with the form shown in Fig. 1. Again, the jet of charged gas may be made to issue from a metallic casing or envelop which contains all the apparatus necessary for producing the charged jet, the charges not being filtered nor withdrawn from the jet. In this case other and entirely different useful results can be obtained, as hereinafter explained in connection with the form shown in Fig. 3.

In particular, regarding the first application, such a jet can be used as the essential part of an electrostatic machine. For example, if from a storage battery 110 volts difference of potential is applied between a 0.2 millimeter platinum filament, 15 millimeters long, and the brass cylinder C 3 millimeters in diameter, and a blast of air is forced through the tube T under 10 lbs. pressure, and this is passed into a metallic receiver in which the ions are caught, a potential of thousands of volts will be produced in the receiver. Also, as long as the blast continues, a small current can be taken from this high potential receiver. Such a receiver is shown in Fig. 1. The blast is shown as entering tangentially, and slightly obliquely, through an inlet from the tube T into a cylindrical receptacle or can H, one end of which is closed. The air in the can passes out helically toward the open end through a large plug of silvered glass-wool G, held in place by disks of wire gauze J—J. In this way most of the charged ions are continually filtered from the air, producing a high potential in a manner analogous to the high hydrostatic pressure produced in a hydraulic ram, on the stopping of the flow of water. The passage of the air itself is impeded but little. Sharp corners of the receiver are covered with wax or other insulating substance K to prevent leakage of the charge. The current available from the receiver is small, exceeding a milliampere, for the above specifications, only when the space in which the ions are produced is a fairly good vacuum. Nevertheless, such currents are useful for any purpose where a small current at high potential may be employed, as for example in the operation of X-ray and other vacuum tubes.

A modification is shown in Fig. 2 in which the blast passes through the tube t, the metallic cylinder or anode c being located at the mouth thereof with the leading-in wire w_3. The filament is in the form of a coil of platinum, or piece of foil f, stationed near the open end of a smaller tube t_1 and connected with leading-in wires w_1 and w_2. In this way it is not necessary to have a current of air passing through the inner tube t_1, which is inclosed entirely within the larger tube. It is possible to use a sharp metallic point for the filament lying along the axis of the tube in place of the foil, but the foil is preferred as the ions can be produced with lower potentials.

In Fig. 3 the invention is shown in a form in which the blast enters through a tube T_3, and spreads out as shown by the dotted lines D. In a comparatively quiet region outside these dotted lines is placed the filament F' and the anode consisting of a metallic plate p. The discharge tends to pass through, and is carried away by, the blast. This method is operative at any pressure, but when used for an electrostatic machine, pressure about 10 the receiver should be about atmospheric or higher, or extremely low; for with a moderate vacuum the charge on the receiver leaks away rapidly. For example, under low pressures a blast of mercury should be used for the jet, practically a mercury diffusion pump. In this case, the jet does not come in direct contact either with the filament or the anode. The form shown in Fig. 3 is also well adapted for a purpose entirely different from the production of small currents at high potentials. This second application depends upon the fact that like charges repel each other. Thus, if the jet issues from a conductor which is kept charged to a high potential of the same sign as the charges in the jet, by any well known means, then these latter charges will be strongly repelled. Hence the velocity of the issuing jet will be increased, inasmuch as the charged particles will push along with them the gas in which they are contained. All the metallic parts of the apparatus shown in Fig. 3 are inclosed in a substantially spherical charged conductor M which is kept at a very high

potential. The sign of the charge on the conductor M is the same as that of the ions in the jet. The potential battery is indicated at B_1 and the filament battery at B_2. The speed of the issuing jet is limited only by the power of the apparatus, which keeps M charged, to supply electrical energy and thus maintain the potential, which would otherwise fall owing to loss of charge in the jet.

The production of extremely high potentials, in this way, is of importance in, for example, jet propulsion. I have shown and described in my United States Patent No. 1,102,653, propulsion by gaseous jets produced by chemical means, in which velocities were attained double those produced by steam turbine nozzles. These velocities are the greatest that have yet been produced in any way with masses of gas of appreciably large magnitude, but are much less than are possible by the method herein described, for the reason that the potential of the container M, which produces the high velocity, may be as high as desired.

Attention is called to the fact that the high potential, in this case, is produced by some external means and does not result in any way from the electrified jet. It is to be understood that the two applications shown are only illustrated and that the several forms of producing apparatus are not limited to the applications herein shown in connection with them.

It should further be understood that these applications involve the use of a high velocity jet of electrically charged gas; and that such a jet can be produced effectively only by the means herein described, whereby the ions are produced in a space outside of but adjacent to the direct action of the jet.

Although I have shown and described only three forms of the invention I am aware of the fact that other modifications can be made therein by any person skilled in the art without departing from the scope of the invention as expressed in the claims. Therefore I do not wish to be limited to all the details of construction or the specific combinations herein shown and described, but what I do claim is:—

1. The method of producing an electrified jet of gas which consists in conducting a current of gas along a course, producing a stream of charged particles independently thereof, and introducing the same into the jet to be electrified, thus preventing the jet from previously influencing the charged stream.

2. A method of electrifying a jet of gas which consists in conducting a current of gas along a course, and producing ions adjacent to, but out of contact with, the current of gas, and directing the ions into the current, whereby the current will take them up substantially at their source and be charged by them.

3. The method of producing and utilizing an electrified jet of gas which consists in introducing charged particles of one sign from an external source into a jet of gas, causing said gas to pass along in a helical course and removing the electrified particles from the gas.

4. The method of producing an electrified jet of gas which consists in introducing a stream of charged particles into the jet from a space through which the jet does not pass, and subjecting the jet to the influence of electricity of the same sign as that of the ions in the jet.

5. In an apparatus of the class described, the combination of a tube adapted to conduct a gas, a tube outside said tube separated therefrom except at one point near the point of production of the jet, a filament located at said point and constituting part of an electric circuit, and a charged tube within the last named tube connected with a source of potential.

6. In an apparatus of the character described, the combination of a tube for conducting a jet of gas, and means located out of contact with the gas passing through said tube for producing ions and directing a stream of them into the jet.

7. In an apparatus of the character described, the combination of a tube for conducting a stream of gas, with an auxiliary tube leading into said tube at a point near the mouth thereof and adapted to conduct a current thereto, a filament in said auxiliary tube heated by a source of electricity, and a metallic member connected to a positive source of potential, a point connected with the filament also being connected with the negative pole of the same source of potential, whereby charged particles will be produced and introduced into the jet.

8. In an apparatus of the character described, the combination of a tube for conducting a jet of gas, means located out of contact with the gas passing through said tube for producing ions at a point from which they will be introduced into the jet, and means for directing said jet in a sinuous course to conduct the charged particles from it.

9. In an apparatus of the character described, the combination of a tube for conducting a jet of gas, and means located out of contact with the gas passing through said tube for producing ions in a stream and introducing the stream into the jet, with a charged metallic conductor inclosing the stream of ions.

In testimony whereof I have hereunto affixed my signature.

ROBERT H. GODDARD.