Oct. 16, 1928. 1,687,550

C. D. EHRET

METHOD OF AND APPARATUS FOR COMPRESSING FLUID

Original Filed Feb. 24, 1922

Fig. 1.

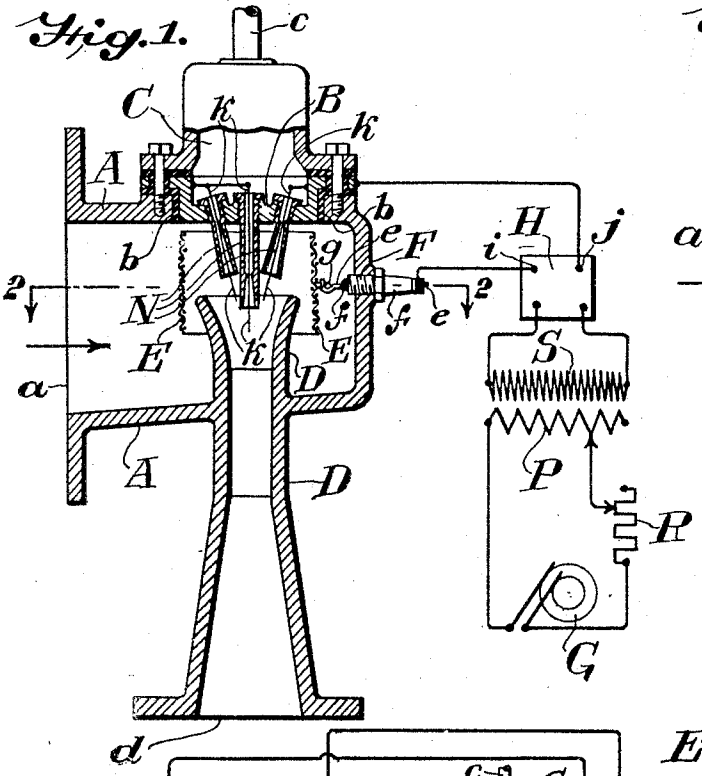


Fig. 2.

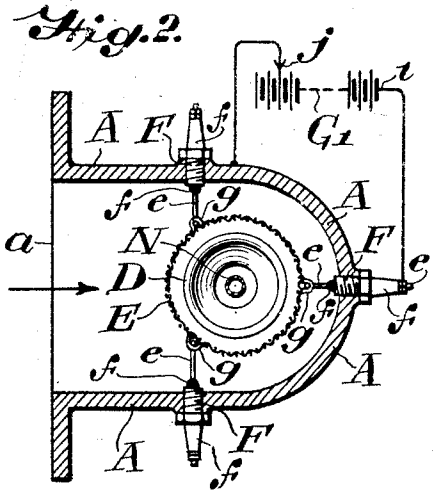


Fig. 3.

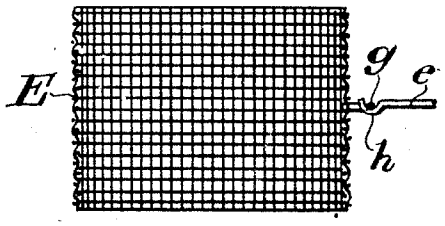


Fig. 4.

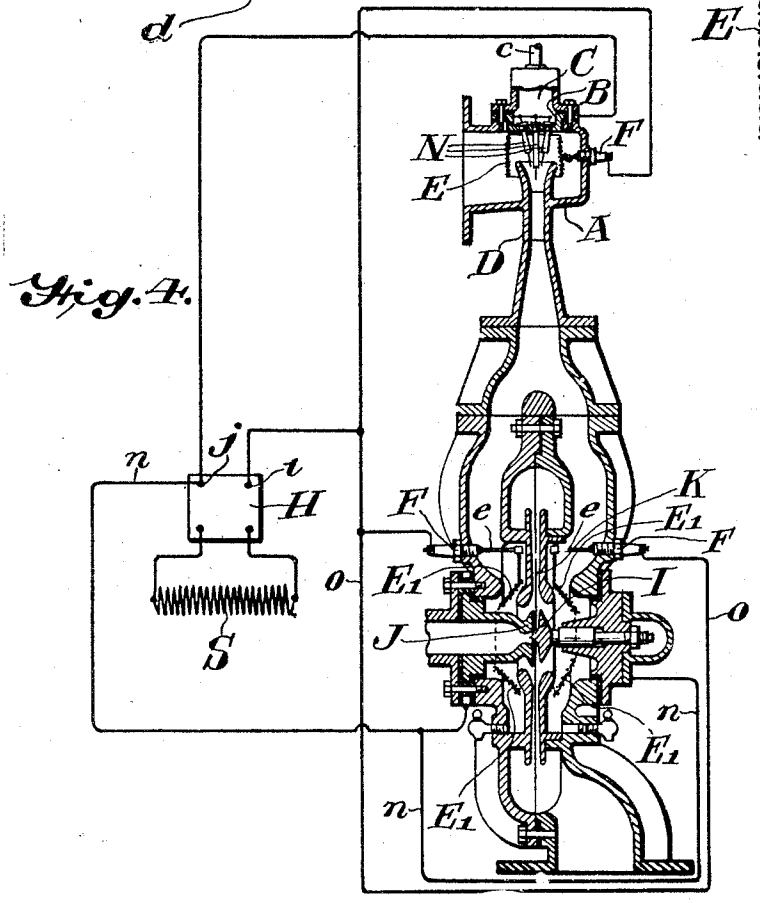
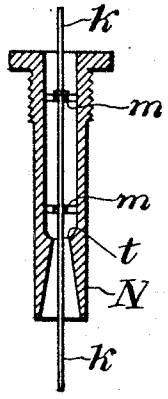


Fig. 5.



INVENTOR.

Cornelius D. Ehret

Patented Oct. 16, 1928. 1,687,550

UNITED STATES PATENT OFFICE.

CORNELIUS D. EHRET, OF PHILADELPHIA, PENNSYLVANIA.

METHOD OF AND APPARATUS FOR COMPRESSING FLUID.

Application filed February 24, 1922, Serial No. 539,043. Renewed February 15, 1928.

My invention relates to a method of and apparatus for effecting improved or increased entrainment or diffusion of a fluid by or into a fluid jet; more particularly, my invention relates to a method of and apparatus for improving or increasing the efficiency of aspiration or ejector action by increasing the entrainment or diffusion of the fluid to be translated or compressed by or into the motive fluid jet.

In accordance with my invention, there is produced by any suitable method or means an electric field traversed by the molecules, particles or masses of or contained in the fluid to be entrained or diffused by or into the jet, the electric field inducing more effective or greater degree of entrainment or diffusion, as by imparting to the molecules, masses or particles electric charges causing them, by increase of velocity or otherwise, further or more effectively to penetrate into the jet.

In accordance with my invention, in connection with aspiration or ejector action, the molecules of or particles in the fluid to be translated or raised in pressure by the motive fluid jet are induced by the electric field to penetrate or diffuse into or become mixed with the fluid of the motive jet to greater degree or extent, whereby for a given amount of motive fluid a greater amount of fluid is translated or compressed, or, for a given amount of fluid to be translated or compressed from one point or pressure to another, less energy as represented by the motive fluid jet is required.

My invention resides in the method and apparatus hereinafter described and claimed.

For an understanding of my method, and for an illustration of some of the many forms my apparatus may take, reference is to be had to the accompanying drawing, in which:

Fig. 1 is a sectional view, partly in elevation, of ejector apparatus with which is associated electric field-producing means, shown diagrammatically.

Fig. 2 is a sectional view on the line 2—2 of Fig. 1.

Fig. 3 is a view of one of the terminals or electrodes and supporting means therefor.

Fig. 4 is a sectional view of double stage ejector apparatus embodying my invention.

Fig. 5 is a sectional view of apparatus embodying my invention.

Referring to Fig. 1, A is the suction chamber of an ejector through whose port *a* enters the fluid to be translated from one point to another or to be raised in pressure. The fluid may be gas, air, vapor, or a mixture of any of them, or may be gas, air or a vapor, or a mixture of any of them, containing in suspension solid or liquid particles.

In an opening *b* in a wall of the chamber A is disposed the nozzle deck B dividing the suction chamber A from the motive fluid chamber C, to which the motive fluid is delivered under suitable pressure by the pipe *c*.

The motive fluid may be inelastic, as water or other liquid, or elastic, as steam, air, etc.

Carried by the deck B is any suitable nozzle structure, of type or character suited to the motive fluid employed. When elastic motive fluid, as steam, is employed, the nozzle structure is of a type to expand the elastic motive fluid, and this is indicated by the flaring nozzles N constituting the nozzle structure. While there is shown a plurality of nozzles, it will be understood that any suitable number of nozzles or a single nozzle may be employed.

The motive fluid is discharged from the nozzle structure in jet form and at high velocity, the jet or jets entraining the fluid entering the chamber A at *a* and translating it or carrying it along, the mixture of fluids being discharged into the diffuser or combining tube structure D, of any suitable type or structure, as well understood in the ejector art. Within the structure D the mixture of motive and entrained fluids loses in velocity, but gains in pressure, with the result that the fluid entering the suction chamber at *a* is raised in pressure and is discharged from the diffuser structure at *d*.

The structure and its mode of operation above described are those well understood in the art, and are not per se my invention.

Suitably positioned in the path of the fluid entering at *a* and passing to or toward the motive fluid jet or jets is disposed a terminal or electrode of any suitable form, structure or size. In the example illustrated, such electrode is indicated at E and consists of a cylinder of metal gauze or mesh, or any equivalent perforated structure, through whose meshes or perforations the fluid entering at *a* may readily pass. The diameter or other dimensions of the electrode E, and the number and size of its meshes, are preferably such that the resistance to flow of the

fluid entering at *a* shall be low and preferably negligible. At the same time, the electrode should be sufficiently spaced from the structure to prevent sparking across of high tension current.

The electrode E may be supported by any suitable means, and, as stated, is insulated from the surrounding parts. In the example illustrated there is threaded through the wall of the chamber A a plug F, similar to a spark plug of an internal combustion engine, having the porcelain or other insulating member *f*, the joint between the plug F and the chamber A and between the insulating member *f* and the plug F being made vacuum or pressure-tight. Extending through the insulating member *f* is a conductor *e*, to whose inner end may be secured the electrode E, whereby the conductor *e* supports it in operative position. In the example illustrated, however, the electrode E has attached thereto several metal wire loops *g* by which it rests upon the hooked ends *h* of the conductors *e* of several plugs F similar to that above described, as indicated in Figs. 1, 2 and 3. The electrode E, before attachment of the deck B and chamber C, may be lowered through the opening *b* until the loops *g* rest upon the hooked ends *h*.

As indicated in Fig. 1, G is a source of alternating current, to which is connected the primary P of a step-up transformer whose high tension secondary is indicated at S. The number of turns of the primary P is adjustable, and in series therewith may be employed an adjustable resistance R, the adjustments effecting adjustment or variation of the potential across the terminals of the secondary S. Connected to the secondary S is any suitable high tension rectifying apparatus H. By way of example merely, it may be stated that the rectifying apparatus H may be a synchronous high tension rectifying switch of any suitable character, such, for example, as described in Letters Patent of the United States No. 954,056. Or the rectifying apparatus may be of the vacuum tube type, as for example, one or more kenotrons.

In any event, across the terminals *i* and *j* of the rectifying apparatus will be produced a unidirectional, or predominatingly unidirectional, high potential difference.

The magnitude of this potential difference will vary greatly with conditions, and may range from a few hundred volts to thousands of volts, or even 100,000 to 200,000 volts, depending upon circumstances and conditions. A principal factor determining the voltage to be employed is the pressure in the chamber A.

The terminal *i*, generally the negative terminal, is connected to the electrode E, in this instance through the conductor *e* of one or more of the plugs F. The other terminal *j* is connected to the nozzle deck B, particularly when, as indicated, the deck B is insulated from the chambers A and C. It will be understood, however, that when the deck B is not insulated, the connection may be made to any conducting or metallic part of the apparatus, and this is indicated in Fig. 2, where the connection is made to the chamber A from the source G^1, which in this case generically represents any suitable source of unidirectional voltage whose magnitude is variable or adjustable.

As indicated in Fig. 1, the nozzle structure is one terminal or electrode of the high tension field and E is the other.

The fluid entering the chamber A at *a*, or particles or masses suspended in the fluid, is charged to a great difference of potential with respect to the nozzle structure and the jets issuing therefrom, with the result that the fluid or/and the particles in suspension therein are accelerated or so otherwise operated upon by the high tension electric field that the entrainment in the jet or jets issuing from the nozzle structure is more effective, with the result that the efficiency of translation or compression of the fluid entering at *a* is increased.

When the motive fluid is liquid, as water, which when not chemically pure or distilled is to considerable degree conducting, the liquid jet is itself in effect a terminal or electrode of the electric field, as well as the metal nozzle structure itself.

When the motive fluid is elastic, as air, gas or vapor, or a mixture of any of them, the jet will again to some degree operate as a terminal or electrode of the field. But in the case of elastic motive fluid, there may extend through the nozzle structure a wire or rod *k* connected to the terminal *j* and projecting beyond the nozzle structure. The wire or rod *k* becomes then an electrode of the field within the jet beyond the nozzle structure.

A mode of supporting such wire or rod *k* is indicated in Fig. 5, where, in advance of the throat *t* of the nozzle N, there are provided spiders or brackets *m* for supporting and directing the rod or wire *k*, the spiders or brackets *m*, however, allowing free passage of motive fluid to and through the throat *t*.

In Fig. 4 is shown a double stage ejector of which the first stage is similar to that indicated in Fig. 1. In the second stage there is provided a radial flow motive-fluid-expanding nozzle comprising the members I, J, with which is associated the surrounding annular diffuser structure K. This type of ejector is of the character disclosed in U. S. Patent No. 1,282,595. In the example illustrated, the nozzle members I and J are insulated from each other but electrically con-

nected by the conductor n to the terminal j of the rectifying apparatus H. In the path of the discharge from the diffuser D of the first stage to the second stage ejector are disposed the conical gauze electrodes E^1, supported by and electrically connected to the conductors e of the plugs F, which are connected by conductor o to the terminal i of the rectifying apparatus H, and at the same terminal is connected the electrode E of the first stage ejector. While in the first stage the nozzle deck B is shown insulated, it will be understood that the insulation may be omitted, as described in connection with Fig. 1. As to the nozzle members I and J, it will be understood that their insulation may be omitted, and they may be in direct electrical connection with the framework of the apparatus.

The mode of operation in each of the stages of Fig. 4 is of the character described in connection with Fig. 1.

As to Figs. 1 and 4, it will be understood that the suction pressure in the suction chamber A may be anything suitable or desirable. It may be atmospheric pressure, or a pressure above or below atmospheric. When the apparatus is employed for producing or maintaining a vacuum in a steam condenser, the suction pressure may be of the order of one inch mercury absolute.

It will be understood that I have illustrated and described apparatus of the ejector type, and more particularly such as may be employed for producing vacuum.

It will be understood, however, that the illustration and description relate also to the broad aspects of my invention consisting in improving the entrainment or diffusion of a fluid or/and parts in suspension therein into a jet of fluid, whether elastic or inelastic.

What I claim is:

1. The method of entraining a fluid by a fluid jet, which consists in causing the fluid to be entrained to traverse an electric field under the influence thereof to the fluid jet.

2. The method of entraining fluid by a fluid jet, which consists in producing adjacent the jet an electric potential differing from the potential at a point remote from the jet, and causing the fluid to be entrained to traverse the electric field between said point and said jet.

3. The method of entraining fluid by a fluid jet, which consists in producing an electric field adjacent the jet, and imparting to the fluid to be entrained a charge causing it to traverse the field to said jet.

4. The method of entraining a fluid by a fluid jet, which consists in passing the jet over an electrode, passing the fluid to be entrained past a second electrode spaced from said first named electrode, and maintaining a potential difference between said electrodes causing said fluid to mingle with said jet.

5. The method of entraining an elastic fluid in a jet of elastic fluid, which consists in passing the jet along an electrode surrounded by the free jet, passing the fluid to be entrained adjacent a second electrode spaced from said first named electrode, and producing a potential difference between said electrodes causing the fluid to be entrained to penetrate into said jets.

6. The method of translating a fluid from one point to another, which consists in producing a motive fluid jet, bringing the fluid to be translated into contact with the jet, and increasing the entrainment by an electrostatic field produced adjacent the jet.

7. The method of raising the pressure of elastic fluid, which consists in expanding elastic motive fluid into a jet of high velocity, producing an electric field adjacent the jet, causing the fluid to be compressed to traverse said field to the jet, and converting the velocity of the fluid mixture into pressure.

8. The combination with jet-producing means, of an electrode adjacent the jet, a second electrode spaced from said first named electrode, means for maintaining a difference of potential between said electrodes, and means for directing a fluid past said second electrode toward the jet produced by said jet-producing means.

9. An aspirator comprising the combination with nozzle structure delivering motive fluid, of an electrode spaced therefrom, means for directing a fluid towards said nozzle structure, and means for producing a difference of electric potential between said electrode and said nozzle structure.

10. An aspirator comprising the combination with a nozzle delivering motive fluid, of a conductor disposed within the nozzle passage and projecting beyond the same, an electrode spaced from said conductor, means for directing a fluid toward said nozzle, and means for producing a difference of potential between said conductor and electrode.

11. Ejector apparatus comprising a tube having a passage of progressively changing cross-sectional area, nozzle structure directing a jet thereinto, a perforated electrode surrounding the jet issuing from the nozzle structure, means for directing a fluid towards said nozzle, and means for producing a difference of electric potential between said electrode and an electrode adjacent said jet.

12. The combination with a nozzle, of an electrode disposed within the fluid jet issuing from said nozzle, means for directing a fluid toward said nozzle, and a second electrode spaced from said electrode and disposed outside of the path of said jet.

13. An aspirator having the combination

with a nozzle having a throat and a diverging passage from said throat to the nozzle outlet, of an electrode disposed within said passage and extending from said throat to the nozzle outlet.

14. An aspirator having the combination with a nozzle having a throat and a diverging passage from said throat to the nozzle outlet, of an electrode disposed within said passage and extending from the nozzle throat to a point beyond the nozzle outlet.

15. An aspirator having the combination with a nozzle having a throat, of an electrode disposed in the nozzle passage and extending through said throat.

16. An aspirator having the combination with a motive fluid expanding nozzle having a throat, of an electrode disposed in the nozzle passage and extending through said throat to a point beyond the nozzle outlet.

17. An aspirator having the combination with a nozzle, of an elongated electrode extending longitudinally substantially in the axis of the nozzle passage.

18. The combination with an ejector comprising a motive-fluid-delivering nozzle, a suction chamber, and diffuser structure, of a foraminous electrode in said suction chamber spaced from the jet issuing from said nozzle, and means for maintaining an electric field between said electrode and a region adjacent said jet.

19. The combination with an ejector comprising a motive-fluid-delivering nozzle structure, a suction chamber, and diffuser structure, of a pair of electrodes, one adjacent the jet issuing from said nozzle structure, another disposed within said suction chamber, and means extending through the wall of said suction chamber supporting said other of said electrodes and effecting electrical connection therewith.

20. Ejector apparatus for producing a vacuum in a steam condenser comprising a suction chamber, diffuser structure, and nozzle structure for expanding steam into jet formation, electrode structure disposed in the path of the fluid to be entrained, a second electrode adjacent said jet, and means for maintaining an electric field between said electrodes.

21. In apparatus of the character described, the combination with nozzle structure delivering motive fluid, of a mesh electrode disposed adjacent the jet of motive fluid and through which fluid to be entrained passes.

22. In apparatus of the character described, the combination with a nozzle, of an electrode disposed within the nozzle passage.

23. In apparatus of the character described, the combination with a nozzle, of an electrode disposed within the nozzle passage, and a second electrode between which and said electrode is maintained an electrostatic field.

24. In apparatus of the character described, the combination with a nozzle, of an electrode spaced therefrom, and means for producing a difference of electric potential between said electrode and the fluid jet of said nozzle.

25. The method of exhausting a steam condenser, which comprises subjecting the air and vapor to be exhausted from the condenser to the action of a motive fluid jet, and effecting diffusion of the air and vapor into the jet.

26. The method of exhausting a steam condenser, which comprises subjecting the air and vapor to be exhausted from the condenser to the action of a motive fluid jet, and effecting diffusion of the air and vapor into the jet by the action of an electrostatic field.

27. Apparatus for producing a vacuum in a condenser comprising a suction chamber connected to said condenser for exhausting therefrom air and vapor, means in said ejector for producing a jet of motive fluid, and means for effecting diffusion into said jet of the air and vapor from the condenser.

28. Apparatus for producing a vacuum in a condenser comprising a suction chamber connected to said condenser for exhausting therefrom air and vapor, means in said ejector for producing a jet of motive fluid, and means for maintaining adjacent the motive fluid jet an electrostatic field for causing the moisture from the condenser to diffuse into said jet.

In testimony whereof I have hereunto affixed my signature this 18th day of February, 1922.

CORNELIUS D. EHRET.