

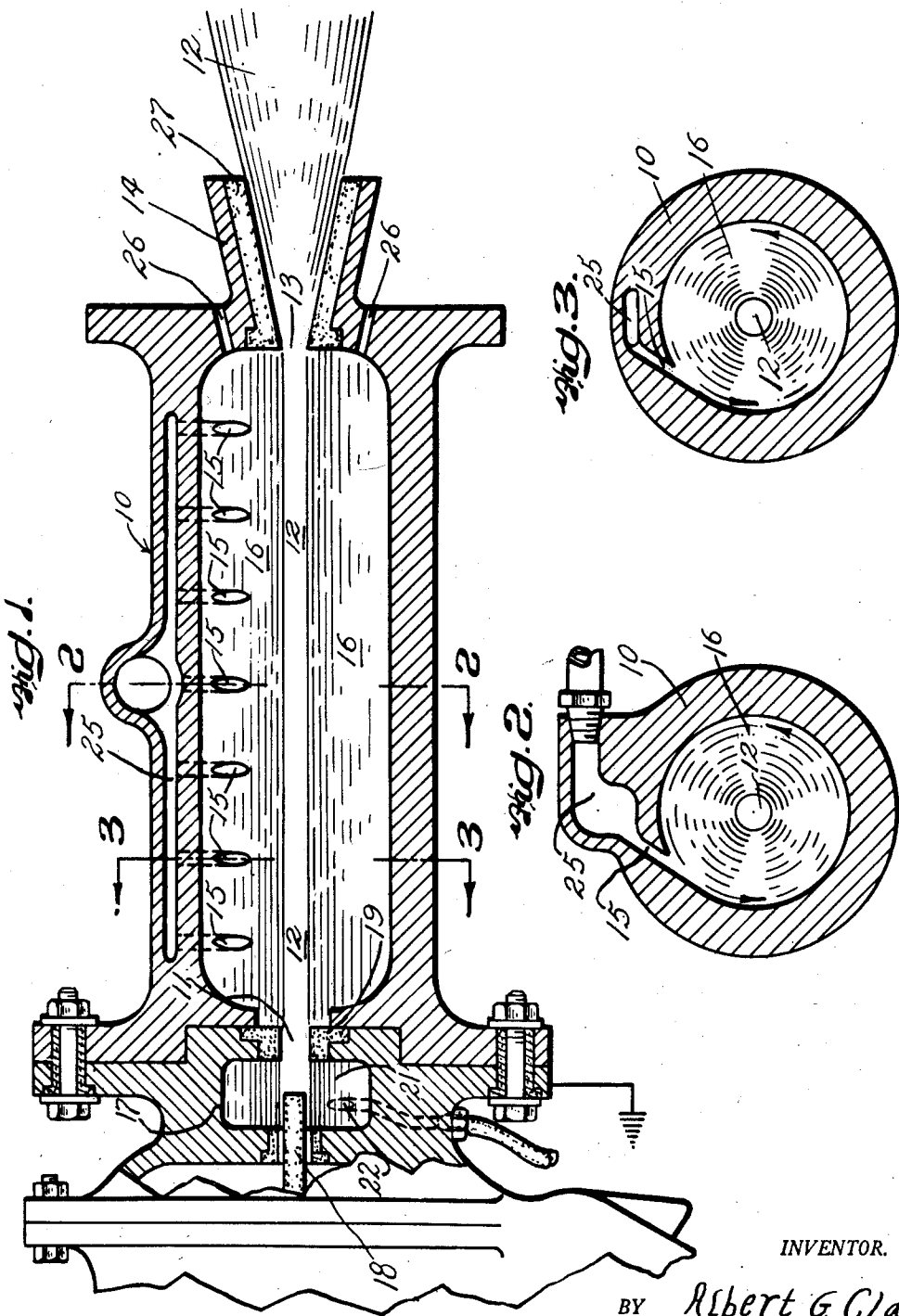
Jan. 7, 1958

A. G. CLARK

2,819,423

PLASMA TRANSMITTER

Filed April 8, 1957



INVENTOR.

BY *Robert G. Clark*

Alfred B. Levine
ATTORNEY

1

2,819,423

PLASMA TRANSMITTER

Albert G. Clark, Wayne, Pa., assignor to General Electric Company, a corporation of New York

Application April 8, 1957, Serial No. 651,468

5 Claims. (Cl. 313—231)

This invention generally relates to improvements in hypersonic flow generators particularly useful for simulating the behavior and environment of movable craft travelling through a fluid medium at hypersonic speed.

In a prior application of Yusuf A. Yoler, Serial No. 645,032, filed March 11, 1957, assigned to the assignee, there is disclosed a unique electrically powered hypersonic generator for propelling fluids at extremely high speeds and great temperatures over a fixed model for the purpose of studying the behavior of the model under these conditions and the fluid environment.

In this and other applications of such a simulating device it may be desired to achieve a denser flow of the fluid without the need for increasing the electrical power consumption, or increasing the electrical arc length requiring a higher voltage. Additionally in some applications, it may be desired to achieve greater variation in the composition of the fluid than may be obtainable by means of the above invention.

These and other advantageous features may be performed by means of the present invention by providing a second stage or second chamber for receiving the extremely hot fluid generated by the simulating device and suitably injecting within the second stage the same or similar fluid in such a manner that portions thereof are absorbed and mixed with the fluid to be later ejected as a denser flow of the same or different composition.

It is accordingly one object of the present invention to provide an improved simulating device for continuously transmitting a fluid of predetermined composition at hypersonic speed.

Another object of the present invention is to provide a simulating device for transmitting fluids at hypersonic speeds containing an improved means for controlling the density and composition of the fluid.

Other objects and many attendant advantages will be more readily comprehended to those skilled in this art upon a detailed consideration of the following specification taken with the accompanying drawings wherein:

Fig. 1 is a side elevational view, in section, depicting one preferred embodiment of the present invention, and

Figs. 2 and 3 are cross sectional views through lines 2—2 and 3—3 of Fig. 1.

Briefly in accordance with one preferred manner of applying the present invention, there is provided a generally cylindrically shaped container 10 having an inlet opening 11 for receiving an extremely hot flow of plasma fluid 12 and having an outlet opening 13 leading to a nozzle 14 whose function is to uniformly expand and greatly increase the speed of the plasma fluid 12 being propelled from chamber 10.

Leading into chamber 10 along its length are a series of tangentially arranged nozzle openings 15 fed from a common fluid inlet 25 for injecting into the chamber suitable gases, powders, or liquids 16 in such a manner that they form a thick whirling column concentrically about the hot plasma 12 as best shown by Figs. 2 and 3. In addition to confining the plasma 13 to a relatively fine

2

stream, as shown, portions of the gas or liquid 16 circulating about the plasma become part of the plasma which are heated and directed to the plasma outlet 13. Observations indicate that the portion of the circulating fluid 16 in proximity to the plasma are heated to the extreme temperature of the plasma and enter this plasma by the force of vapor pressure resulting from the extreme temperature. After entering this plasma, this vapor becomes superheated and then decomposes into molecules and finally into charged ions. Consequently, the plasma leaving outlet 13 is considerably denser by the addition of the constituents of the fluid 16 than plasma 12 entering inlet 11.

It is evident, of course, that since no additional electrical energy or other heating is added to plasma 12 within the chamber, the energy used in decomposing the fluid 16 is derived from the energy contained within plasma 12 and as a result lowers its temperature. In other words, the addition of mass to the plasma results in lowering its temperature as expelled from outlet opening 13. However, since plasma 12 entering chamber 10 may be at temperatures well in excess of 10,000° C. considerable additional mass may be added for many applications where such extremely high temperatures are not needed.

The amount of mass added to plasma 12 or, stated in another way, the density of the plasma expelled from chamber 10 is, of course, a function of the length of this chamber, the pressure and composition of the gas, liquid, or powder 16 added within the second chamber, as well as the temperature of the initial plasma 12 entering the chamber. All of these variables may, of course, be varied within limits as desired to obtain the density and composition as desired for various applications.

The fluid 16 being introduced through tangentially arranged nozzles 15 is preferably continuously injected under suitable pressures to confine the arc plasma 12 to a thin stream as desired, and to enter the plasma and provide the density desired. The fluid not "used" or introduced into the arc is permitted to escape through drain ports 26 which may be forced in the right hand end wall of chamber 10 proximate the nozzle 14, as shown.

A heat resistant lining 27 may be provided about the inside of nozzle 14 to impede rapid erosion of this nozzle surface, if desired.

As disclosed in greater detail in the above mentioned application, the preferred mechanism for generating the initial hot plasma fluid 12 is preferably comprised of a generally cylindrical housing 17, shown as being bolted to chamber 10. A positively energized rod electrode 18 of graphite or the like is concentrically supported within housing 17, and a negatively energized generally ring-shaped electrode 19 is supported within a suitable opening in the right hand end wall of this housing 17. A large source of electrical power (not shown) in the form of a relatively low voltage but extremely high current is applied across these electrodes 18 and 19 to produce arc plasma 12.

To prevent this arc from spreading and confine it within a small enough volume greatly increasing its current density and temperature over that normally obtainable, a suitable fluid such as air, water, or nitrogen, or the like 21 is introduced into housing 17 between the electrodes at high velocity through a tangentially arranged nozzle 22 so as to whirl or circulate concentrically at high speed about the arc. A rotating column of fluid 21 is thus formed about arc plasma 12 confining the arc within a considerably smaller cross sectional area than it would normally occupy in space and greatly increasing its current density and temperature to values in excess of 10,000° C.

In addition to confining the arc and greatly increasing its temperature, portions of the fluid 21 circulating about

the arc become part of the arc which are heated and directed through the central opening of electrode 19 to form arc plasma 12. Further details of this preferred generating means are disclosed in the above mentioned application.

Thus by means of the present invention, there is provided a means for increasing the density of a flame plasma and varying its composition as desired without the need for extending the arc length and hence the energizing voltage. Although but one preferred manner of applying this invention has been disclosed in accordance with the patent laws, it is believed evident to those skilled in this art that many variations may be made in this teaching without departing from the spirit and scope of this invention. Accordingly, this invention is to be considered as being limited only in accordance with the following claims appended hereto.

What is claimed is:

1. The improvement in electrical arc powered plasma generators comprising an elongate chamber to receive the generated plasma, means continuously introducing a fluid into the chamber to confine the plasma in a narrow path along the chamber and form a thick wall of moving fluid about the plasma, and means for ejecting this stream from the chamber and increasing its velocity.

2. In the device of claim 1, said introducing means including a series of interconnected inlets provided along the length of the chamber for conveying a fluid under pressure to circulate about the plasma and confine it in a narrow path.

3. The improvement in electrical arc powered plasma generators comprising an elongate chamber to receive the generated plasma, means continuously introducing

a fluid through a series of tangentially arranged openings along the chamber so as to circulate and form a thick wall of circulating fluid about the plasma, and means for ejecting said plasma and increasing its velocity.

4. A plasma transmitter comprising means for generating an electrical arc, means including a moving body of fluid for confining the arc to a stream of considerably smaller cross section than it would normally occupy in space and introducing said fluid into the arc to form a plasma, an elongate chamber provided with inlet and outlet openings, said inlet opening being positioned to receive the arc plasma from said generating means, means continuously circulating a fluid in said chamber to confine the plasma in a narrow path along the chamber to the outlet and forming a thick wall of moving fluid about the plasma, thereby introducing the chamber fluid into the plasma.

5. In a plasma transmitter, a housing portion, means for generating a high intensity arc within said housing portion, means including a moving body of fluid within said housing portion for confining said arc to a thin stream of smaller cross section than it would assume if unconfined and introducing said fluid into the arc to form arc plasma, an elongate chamber portion, having inlet and outlet openings, and associated with said housing portion to receive the arc plasma stream, said chamber portion being provided with at least one nozzle like opening for introducing a second fluid under pressure into the chamber portion to circulate about the plasma and enter the plasma stream, said second fluid further serving to confine said plasma to a narrow path leading to said outlet.

No references cited.