Sept. 21, 1965 L. MATVAY Re. 25,858

PLASMA FLAME HYPERTHERMAL EXOTHERMIC FURNACE WITH CATALYST AND COMBINATION THEREOF WITH AN INTERNAL COMBUSTION ENGINE

Original Filed Nov. 16, 1959 2 Sheets-Sheet 1

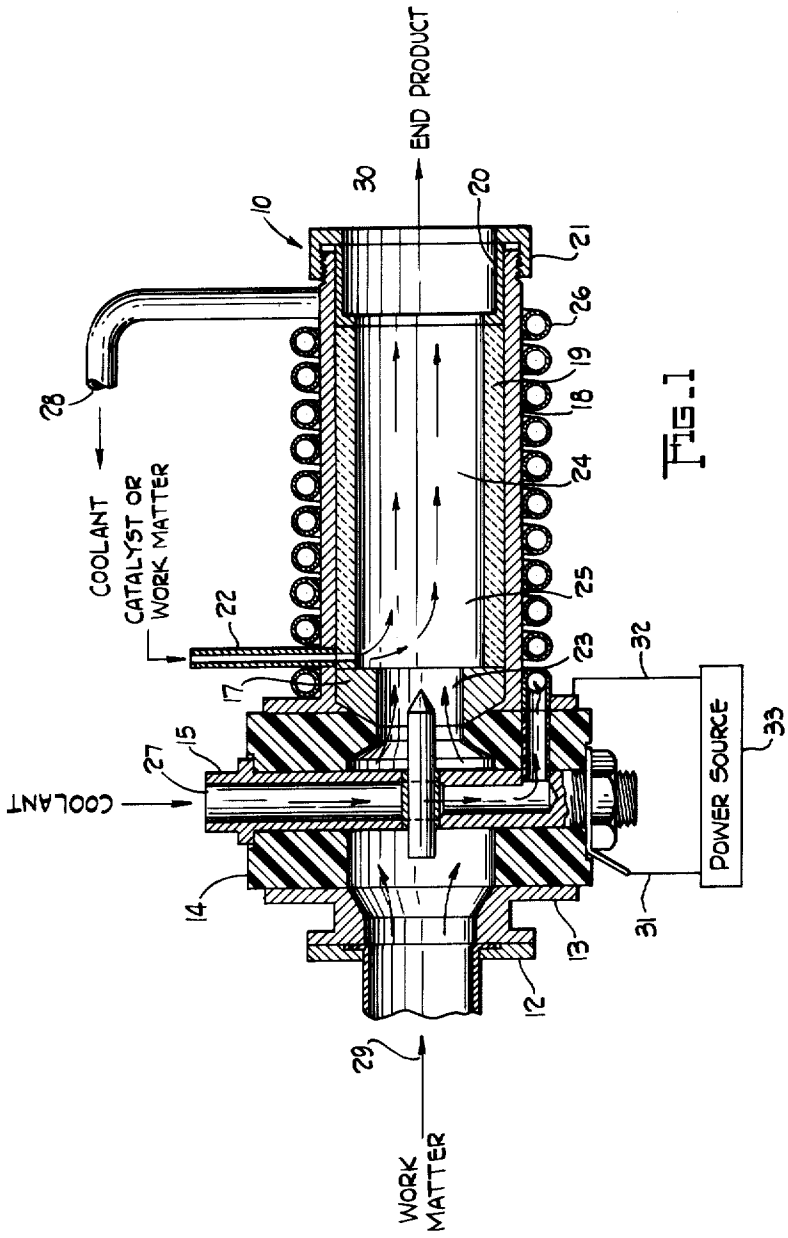

FIG. 1

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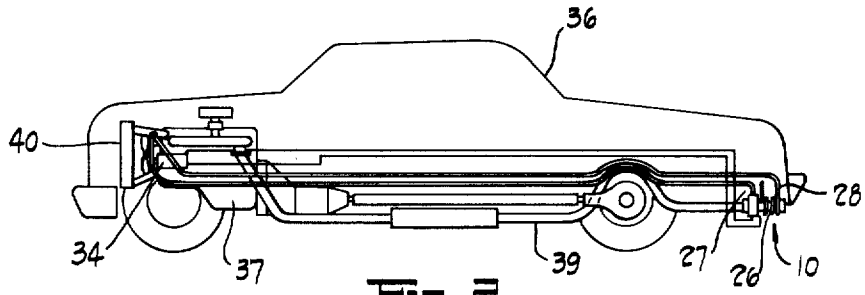

FIG. 2

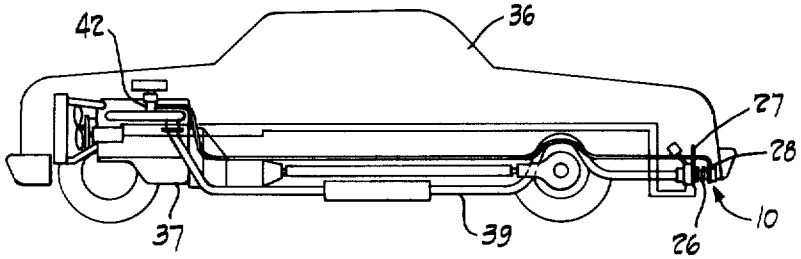

FIG. 3

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PLASMA FLAME HYPERTHERMAL EXOTHERMIC FURNACE WITH CATALYST AND COMBINATION THEREOF WITH AN INTERNAL COMBUSTION ENGINE

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12 Claims. (Cl. 60—30)

This invention relates to plasma flame apparatus and more particularly to a hyperthermal exothermic furnace which also employs the use of a catalytic agent.

It is an object of the present invention to provide a device for operation in the very high temperature range, hyperthermal, using a catalytic agent if required to process or refine or dissociate or decompose the work matter.

Another object of the present invention is to provide a plasma flame device where both electrodes are sufficiently and effectively cooled to make it possible to operate the device on D.C.S.P., D.C.R.P., or A.C.

Still a further object of the present invention is to provide electrodes with large cross section area to carry a high electrical current.

Still a further object of the present invention is to provide a method of introducing the work matter that is to be processed or refined or dissociated or decomposed into the furnace.

Still another object of the present invention is to provide the method of combining a catalytic agent with the refractory to act as both refractory and catalyst.

Still another object of the present invention is to provide a smog elimination device which can be produced, packaged, and sold in large quantities at a comparatively low cost, and which can be conveniently utilized on any make of automobile, truck or motorcycle.

Still a further object of the present invention is to provide a high temperature furnace which can be produced, packaged, and sold at a comparatively low cost and which can be conveniently utilized whenever needed.

Still additional objects, benefits, and advantages of this invention will become evident from a study of the following detailed description taken in conjunction with the accompanying drawing, in which:

FIGURE 1 is a view in axial section of a furnace embodying a preferred form of this invention; FIGURE 2 is a schematic view showing the furnace of FIGURE 1 in combination with an internal combustion engine; and, FIGURE 3 is a schematic view showing a modified form of combination of the furnace of FIGURE 1 with an internal combustion engine.

Briefly this invention comprises providing a plasma flame hyperthermal, exothermic, furnace comprising a housing having one portion, a plasma flame generator, in which two electrodes of opposite charge and large cross-sectional area are disposed and into which work matter introduced to form a plasma flame and a second portion, a reaction furnace, or chamber having a suitable lining such as refractory and a catalyst and being adapted to receive the plasma flame and catalytically disassociated or decompose it. Such a plasma flame furnace is particularly adapted for mounting on an automobile, truck or motorcycle, for example, to receive the engine exhaust to decompose or disassociate the same to eliminate smog resulting therefrom. The furnace is provided with a cooling system using either a liquid or gas coolant, as desired, and is adapted for use with D.C.S.P., D.C.R.P. or alternating current.

The furnace preferably includes one or more Pitot tubes, which communicate with the second portion thereof just downstream of the nearest electrode, through

which catalyst as a liquid, slurry, powder or rod and/or additional work matter may be introduced into the furnace. In addition, and/or alternatively, all or part of the catalyst is incorporated in a suitable refractory lining, such as Aluminum Company of America's XC100 or mineral chromite, formed into the desired shape and used to line the second portion of the furnace.

The furnace is adapted for attachment to the tail or exhaust pipe of any automobile or the like to function as a smog eliminator by exposing the unburned gases, hydrocarbons, olefins, acroleins, formaldehydes, lead and nitric oxide to the high temperature of the furnace to cause them to disassociate and decompose and further to expose this work matter to the catalytic agent to render it harmless to human beings.

Further, when used as a smog eliminator on automobiles, or the like, having internal combustion engines, the furnace is preferably and conveniently provided with a cooling system, which can be interconnected with the existing cooling system of the automobile, etc. or with the existing engine intake manifold to provide either a water or air cooling system for the furnace as desired, and the electrical current for the electrodes is preferably supplied by the generator commonly associated with the engine.

The catalyst is adapted to decompose nitric oxide into nitrogen and oxygen and hydrocarbons into carbon dioxide and water and preferably comprises copper oxide.

The furnace can also be used, inter alia, with a high purity inert gas as work matter entering the first portion of the furnace to provide a plasma flame to process or refine high purity, high melting temperature metals and non-metals, to disassociate ammonia added, through the Pitot tubes, as a second work matter, and be used in an atmosphere produced by adding propane through the Pitot tubes to provide a special atmosphere for the carbonization of desired products; and, with hydrocarbons in any desired form (liquid, slurry, powder or gas), with the inert gas plasma flame, as needed, to crack the hydrocarbons.

Referring now specifically to the drawing, a plasma flame, hyperthermal, exothermic furnace embodying this invention is indicated generally at **10**. The plasma flame, hyperthermal, exothermic furnace **10** is preferably generally cylindrical in shape with a hollow interior and includes a flange adapter **12** by which the delivery piping, through which the inert gas, working gas, vapor or suspended solids in a conveying gas, called work matter **29**, is conducted to the furnace **10**, is attached to the intake adapter **13**.

The electrical and heat insulator **14** has a large cylindrical hole axially aligned with the large cylindrical holes in the flange adapter **12**, intake adapter **13**, washer electrode **17**, furnace jacket **18**, refractory lining **19**, spacer **20**, and end cap **21**.

The electrode chuck **15** is located so as to be well insulated within the electrical and heat insulator **14** to prohibit any electrical short circuiting. The rod electrode **16** is located on the axial center line by the electrode chuck **15** in the center of the axially aligned cylindrical hole of the washer electrode **17**.

The washer electrode **17** is held in place against the inward flange of the furnace jacket **18** by the refractory lining **19**, and the spacer **20**, which in turn are all firmly held in place by the threaded end cap **21**.

The Pitot tubes **22**, one shown, can be located as required to introduce additional work matter **29** or a catalytic agent into the arc region **23** or into the hyperthermal exothermic reaction chamber **24** to be acted upon by the plasma flame **25**.

The helical coolant coil **26** is wound around the furnace

jacket **18** and is welded or brazed to it. The coolant enters at coolant inlet **27** and flows through the coolant passage in the electrode check **15** around the rod electrode **16** next through the coolant passage in the electrical and heat insulator **14** and then through the helical coolant coil **26** and finally out at the coolant outlet **28**.

The operation of this device will now be readily understood. Under pressure inert gas such as argon or helium or other working gases or vapors or suspended solids in a conveying gas, called work matter **29**, enter the plasma flame hyperthermal exothermic furnace **10** through the flange adapter **12** and intake adapter **13**.

The work matter **29** flows through the axially aligned cylindrical hole in the electrical and heat insulator **14**, around the electrode chuck **15**, into the arc region **23**. At this point, the arc region **23**, the space between the rod electrode **16** and washer electrode **17**, the electrical energy is transformed into heat and at the same instant as the work matter **29** passes through the arc region **23** a portion of the work matter **29** becomes ionized and thus becomes a plasma flame **25**.

The plasma flame **25** and the remaining work matter **29** now have been heated. The temperature to which the plasma flame **25** and work matter **29** are raised to is dependent upon a number of physical, chemical, and electrical factors.

The dependent physical factors are such things as the space or gap between the rod electrode **16** and the washer electrode **17** which determine the electrical arc jump distance, impedance. The size of the hole in the washer electrode **17** controls the amount of construction upon the flow of work matter **29**. Therefore the smaller the hole diameter in the washer electrode **17** the greater the constriction of the work matter **29** and thus a greater concentration of heat and electrical energy.

The dependent chemical factors are such things as is the work matter **29** monatomic or diatomic or molecular in structure, is the chemical reaction of the work matter **29** exothermic or endothermic, and is the catalytic agent highly or moderately active. These chemical factors in themselves determine whether the plasma flame, hyperthermal, exothermic furnace **10** will develop temperatures of only a few hundred degrees or temperatures as high as sixty thousand degrees.

The dependent electrical factors are such things as the amount current used and whether the electrical current used is D.C.S.P. or D.C.R.P. or A.C.

In most metals a few electrons in the outer portion of the atom are very loosely bound to the nucleus of the atom Accordingly a metal is defined as a lender of electrons. As a result large numbers of these electrons are free to drift about in the interatomic space. However when the electrons are attached by connecting the conductor to a electrical power source they will accelerate owing to the force of attraction but the speed attained by any individual electron will be relatively small because it will bump into one of the many atoms before it has gone far and bounce off in another direction. The energy which the elector had absorbed by reason of its acceleration is given up to the atom and appears in the form of heat.

It therefore follows from the above electron theory that where a D.C.S.P. circuit is used the electron flow, kinetic energy, is from the negatively charged electrode to the positively charged electrode and also the negatively charged electrode will remain relatively cool in comparison to the hot positively charged electrode. Therefore in a D.C.S.P. circuit the positively charged electrode will require cooling in some manner. However when a D.C.R.P. or A.C. circuit is used both electrodes must be sufficiently cooled to keep them melting and spattering because of the high temperature concentration upon their surface and within them.

The plasma flame **25** and the work matter **29** now enter the hyperthermal, exothermic reaction chamber **24**. Also

at this instant in the hyperthermal, exothermic reaction chamber **24** the heated work matter **29** comes in contact with the refractory lining **19**. The refractory lining **19** itself may be a catalytic agent or composed of a mixture of refractory material and catalytic agent.

Also through the Pitot tube **22** more or another work matter **29** or a catalytic agent may be introduced into the hyperthermal, exothermic reaction chamber **24** or into the arc region **23** to be processed or refined or dissociated or decomposed.

Finally the work matter **29** and other products are expelled out of the hyperthermal exothermic reaction chamber **24** as processed, refined, dissociated or decomposed products, called end products **30**.

The electrical current is supplied to the plasma flame, hyperthermal, exothermic furnace **10** by way of the electrical conductors **31** and **32** from the power source **33**. The power source **33** may be an electric arc welding generator or transformer or when the plasma flame hyperthermal furnace **10** is used as a smog eliminator the power source would be the automobile, truck or motorcycle generator **35**, see FIGURE 2.

FIGURE 2 discloses the furnace **10** mounted on vehicle **36** to treat the exhaust gases, of internal combustion engine **37**, which are conducted to the furnace **10** by suitable piping **39**. Vehicle **36** also includes a conventional generator **34**, which as noted above is adapted to supply power to the furnace **10** and an engine cooling system, indicated generally at **40**, with which the coolant coil **26** of furnace **10** and more particularly the inlet **27** end outlet **28**, respectively, are connected by suitable means indicated generally at **41**.

FIGURE 3 discloses a modified combination of furnace **10** with vehicle **36** and engine **37** in which the coolant coil of the furnace is connected with the intake manifold **42** of the engine and the air is drawn into the manifold through inlet **27**, coil **26**, outlet **28** and interconnecting piping means **43**.

While this invention has been described with particular reference to the construction shown in the drawing and while various changes may be made in the detail construction, it shall be understood that such changes shall be within the spirit and scope of the present invention as defined by the appended claims.

I claim:

1. In combination an internal combustion engine, an engine exhaust system for said engine, an electric current generator driven by said engine, and a plasma flame, hyperthermal, exothermic furnace for treating the exhaust gases from said engine, said furnace comprising a housing having a hollow interior with intake and discharge ends, said intake end of said housing being interconnected with said exhaust system and receiving the exhaust gases from said engine, said furnace comprising a plasma flame generator portion and a reaction chamber portion, said generator portion receiving the gases entering through said intake end, first and second electrode means in said generator portion, means connected with said electric current generator for passing an electric arc between said electrodes to act upon at least a portion of the said gases entering through said intake openings to generate a plasma flame, said reaction chamber portion being disposed intermediate said generator portion and said discharge end and being interconnected with said generator portion and discharge end to receive the plasma flame and gases associated therewith and to discharge through said discharge end, catalyst means disposed in said reaction chamber portion to have functional contact with said plasma flame and gases to disassociate all or part thereof into constituent parts.

2. The combination according to claim **1** in which said plasma flame furnace also comprises means for cooling at least a portion thereof.

3. The combination according to claim **2** in which said

engine has a cooling system and said plasma furnace cooling means is interconnected therewith.

4. The plasma flame, hyperthermal, exothermic furnace according to claim 2 in which said cooling means has a liquid coolant.

5. The combination according to claim 2 in which said engine has an intake manifold, and said plasma furnace cooling means has air as a coolant and is interconnected with said intake manifold.

6. A plasma flame, hyperthermal, exothermic furnace comprising a housing having a hollow interior with an intake end for the introduction of work matter and a discharge end, said furnace comprising a plasma flame generator portion and a reaction chamber portion, said generator portion receiving work matter entering through said intake end, first and second electrode means in said generator portion, means connected with a suitable power source for passing an electric arc between said electrodes to act upon at least a portion of said work matter to generate a plasma flame, said reaction chamber portion being disposed intermediate said generator portion and said discharge end and being interconnected with said generator portion and discharge end to receive said plasma flame and residual work matter associated therewith, and to discharge through said discharge end, and catalyst means disposed in said reaction chamber portion to have functional contact with said plasma flame and work matter to treat at least a portion thereof.

7. A plasma flame, hyperthermal, exothermic furnace as set forth in claim 6 having at least one transversely extending Pitot tube providing access to said reaction chamber portion, at least a portion of said catalyst being introduced into said reaction chamber portion through at least one said Pitot tube.

8. The plasma flame, hyperthermal, exothermic furnace according to claim 6 having at least one transversely extending Pitot tube providing access to said reaction chamber portion in which at least a portion of the work matter to be treated in said furnace is introduced into said

reaction chamber portion through at least one said Pitot tube.

9. The plasma flame, hyperthermal, exothermic furnace according to claim 6 with means for cooling at least one said electrode.

10. The plasma flame, hyperthermal, exothermic furnace according to claim 9 in which said cooling means also cools said reaction chamber portion.

11. The plasma flame, hyperthermal, exothermic furnace according to claim 6 in which said reaction chamber portion has a refractory lining and at least a portion of said catalyst is disposed within and forms a part of said refractory lining.

12. A plasma flame, hyperthermal, exothermic furance according to claim 6 in which said electrodes have a substantially large cross-sectional area whereby to carry a high electric current.

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