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(54) METHODS AND MEANS FOR EFFECTING PHYSICAL PROCESSES OR CHEMICAL REACTIONS IN GASES AND OTHER SUBSTANCES

(57) **Abstract:**

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This invention relates to a method and a device for effecting physical processes or chemical reactions in a mixture of substances in solid or gaseous or liquid states. The method and device are especially suitable for cleaning air and for detoxicating exhaust gases of Otto and Diesel engines and of oil-firing and other combustion systems.

The invention is intended, among other things, to provide an improved method and device for reducing the pollution of the air by smoke, exhaust gas and dusty discharges arising from industry, vehicular traffic, and other sources of atmospheric pollution.

The problem of reducing emission of air-polluting substances from vehicles with Otto and Diesel engines has proved most intractable. Here the exhaust gases concerned are predominantly those containing, among other things, carbon monoxide, unburnt and/or only partially-oxidized hydrocarbons, fragments of hydrocarbons, aldehydes, nitric oxides, sulphur oxides and other compounds.

The invention facilitates substantial detoxication of exhaust gases by chemical reactions, as for instance, by the oxidation of the hydrocarbons to CO_2 and H_2O, oxidation of the carbons, and for instance also of CO to CO_2 (following the well-known combustion equations).

According to the invention there is provided a device for effecting physical processes or chemical reactions in a mixture of substances in solid or gaseous or liquid states, comprising a chamber which is of circular cross-section and is bounded towards the exterior by a surface which appears as two symmetrical continuously-curved lines in a longitudinal section of

the chamber, the said surface being such that the chamber is substantially egg-shaped or heart-shaped or pear-shaped and has a narrower end and a wider end, the said chamber having one or more lateral inlet conduits nearer to one end than to the other end of the chamber for the introduction of one or more of said substances substantially tangentially, and an axial outlet conduit for the products at one end of the chamber, with or without an axial inlet conduit at the other end of the chamber for the introduction of the additional substances, so that substances introduced through the lateral inlet conduit or conduits whirl therein to be eventually expelled through the axial outlet conduit. Advantageously in some instances the lateral inlet conduit or conduits may be nearer to the wider end of the chamber. With further advantage the device may comprise an axial outlet or inlet conduit of tapered form, with its narrower end inside the chamber, extending through more than half the axial length of the chamber. The axial outlet or inlet conduit may have a perforated portion or extension. Further and optional features of the invention appear from the foregoing and following description and are set forth in the appended claims.

In the accompanying drawing five devices in accordance with the invention are illustrated diagrammatically and by way of example,

Figs. 1 to 5 being views of the five devices in longitudinal section, and

Fig. 6 being a diagram of the fluid flow in a device represented in cross-section.

Each of the illustrated devices comprises a chamber which is of circular cross-section and is substantially egg-shaped or heart-shaped or pear-shaped so that it has a wider end and a

narrower end, with a co-axial discharge channel and inlet. The arrows indicate the paths of the substances being treated; these substances enter at E and/or at D and/or at G, F, and leave by outlets A, being caused to whirl with increasing speed of rotation. Figure 3 represents a device with an outlet tube A having a perforated internal extension P. It is to be noted that the outlet conduits A are of inwardly tapered form.

The arrows E represent lateral inlet conduits nearer to the wider end of the chamber for the introduction of one or more substances substantially tangentially.

In Figs. 1, 2, and 4 the axial outlet conduit A is of tapered form, with its narrower end inside the chamber, extending through more than half the axial length of the chamber.

As shown by Figs. 1 to 5, in each of the illustrated devices the chamber is bounded towards the exterior by a surface which appears as two symmetrical continuously-curved lines in a longitudinal section of the chamber.

In Fig. 3 the axial outlet conduit A is of tapered form, with its narrower end inside the chamber, extending through more than half the axial length of the chamber, and the conduit A has a perforated portion or extension P.

In Fig. 5 the axial inlet conduit D is of tapered form, with its narrower end inside the chamber, extending through more than half the axial length of the chamber, and the conduit D has a perforated portion or extension.

Figs. 3 and 5 further illustrate the provision of a nozzle or system of nozzles leading to the perforated portion of the axial outlet conduit A, whereby gaseous substances or liquids or pulverulent substances (represented by arrows G, F) can be

supplied to the emerging substances. For detoxicating exhaust gases, air or oxygen may be supplied through the nozzle or system of nozzles, and water vapour produced by the oxidation of hydrocarbons may be at least partially condensed in the form of water, a further detoxication of the exhaust gases resulting from the action of the water. The said gaseous substances or liquids or pulverulent substances may be entrained or mixed with air or oxygen supplied through the nozzle or system of nozzles.

The oxygen or air may be drawn in through the nozzle or system of nozzles, or out through a perforated outlet conduit, by a suction effect. Alternatively, if it should be necessary in particular cases, the oxygen or air may be blown in.

In Fig. 4 the introduction of substances through a perforated inlet D is represented by the arrows G, F.

In Fig. 5 some arrows G, F represent the supply of substances through a nozzle to a perforated portion of the axial outlet conduit A, and other arrows G, F represent the supply of substances to the axial inlet conduit D which has a perforated portion or extension approaching that of the outlet conduit A.

The internal surfaces of the device may be lined with chemically-active substances, for example substances having a sterilizing effect. A device producing photochemical radiations (not shown) may be provided in the chamber.

The exhaust gases or the like flowing in at a relatively high velocity through the inlet channel (or channels) are "rolled" or whirled in the interior of the substantially egg-shaped or heart-shaped or pear-shaped chamber. This process of movement - with increasing speed of rotation towards the tip or narrower end of the chamber produces physical effects on the one hand and, by

D

interaction with the oxygen or air supply, oxidation processes (detoxication of the exhaust gases) on the other.

In-so-far as the fuels concerned are hydrocarbons, at least partial condensation of the water vapour takes place in the chamber and in the discharge channel, and the water thus continuously forming can in such cases, among other things, absorb any aldehydes still present, take up sulphur oxides, and participate in other processes.

Devices in accordance with the present invention without air or oxygen supply systems produce physical and chemical effects which, for instance, make them superior in various respects to the exhaust or waste-gas discharge systems known heretofore. Thus these devices suffice to reduce congestion in engine exhaust systems, to lower the operating temperature, and to increase the engine output appreciably.

With devices made according to the invention, the well-known electrostatic charging of vehicles - among the various physical effects occurring - is substantially prevented.

If, say, dust discharges are made to rotate at suitable speed in the chambers of devices in accordance with the invention, water and air or, in so far as no chemical reactions have to be caused by introducing oxygen or air or other gases, water alone (or other suitable liquids) may be drawn in or injected, whereby in the interaction between the moving substances and liquid drawn in or injected, a coagulation of any particles present is effected predominantly in the vortex centre and in the discharge channel.

The above-described devices and methods may also be adapted for the treatment of exhaust gases and pulverulent emissions in the iron and steel industries (for example in bottom-

blowing converters), in the power stations of mines, cement works, and in many other industries.

The invention is furthermore adaptable for applications in numerous other fields where similar physical and chemical effects, processes and reactions between gaseous, liquid and solid substances in mixtures and solutions are desirable.

The method and device according to the present invention are also suitable for use, inter alia, in the field of ion acceleration, as well as for the constriction or bundling of hydrogen or other gases with the object of a nuclear fusion, further for the formation of optimally homogeneous fuel/air mixtures, for the production of emulsions and other mixtures, and for employment in jet and rocket propulsion units, and for other uses.

The materials for the individual parts of the device according to the invention must of course be selected to suit the particular chemical and other reactions occurring and to the specific thermal stresses. The internal surfaces of the device according to the invention may be provided, where required, with suitable catalysts, or with substances having a sterilizing effect, or other substances according to the effects required.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEDGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. A device for effecting physical processes or chemical reactions in a mixture of substances in solid or gaseous or liquid states, comprising a chamber which is of circular cross-section and is bounded towards the exterior by a surface which appears as two symmetrical continously-curved lines in a longitudinal section of the chamber, the said surface being such that the chamber is substantially egg-shaped or heart-shaped or pear-shaped and has a narrower end and a wider end, the said chamber having one or more lateral inlet conduits nearer to one end than to the other end of the chamber for the introduction of one or more of said substances substantially tangentially, and an axial outlet conduit for the products at one end of the chamber, with or without an axial inlet conduit at the other end of the chamber for the introduction of additional substances, so that substances introduced through the lateral inlet conduit or conduits whirl in a vortex within the chamber whilst travelling therein to be eventually expelled through the axial outlet conduit.

2. A device according to claim 1, characterised by the lateral inlet conduit or conduits being nearer to the wider end of the chamber.

3. A device according to claim 1 or 2, characterised in that it comprises an axial outlet or inlet conduit of tapered form, with its narrower end inside the chamber, extending through more than half the axial length of the chamber.

4. A device according to claim 1, characterised in that the axial outlet or inlet conduit has a perforated portion or extension.

5. A device according to claim 4, comprising an axial outlet conduit having a perforated portion and a nozzle or system of nozzles leading to the perforated portion of the axial outlet conduit whereby gas mixtures, gases or liquids can be supplied to the emerging substances.

6. A method of detoxicating exhaust gases in a device according to claim 5, wherein said gases are passed in through the lateral inlet conduit and air or oxygen is supplied through the nozzle or system of nozzles, and water vapour produced by the oxidation of hydrocarbons is at least partially condensed in the form of water, a further detoxication of the exhaust gases resulting from the action of the water.

7. A method according to claim 6, wherein pulverulent substances are brought into chemical reaction by being entrained in the supply of air or oxygen through the nozzle or system of nozzles.

8. A method according to claim 6 or 7, wherein the exhaust gases are brought into reaction with other gaseous substances which are mixed with the air or oxygen supplied through the nozzle or system of nozzles.

9. A method according to claim 6 or 7, wherein the exhaust gases are brought into contact with liquid substances which are mixed with the air or oxygen supplied through the nozzle or system of nozzles.

10. A device according to claim 1, wherein the internal surfaces of the device are lined with chemically-active substances, for example substances having a sterilizing effect.

11. A device according to claim 1, wherein a device producing photochemical radiations is provided in the chamber.

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Fig. 1

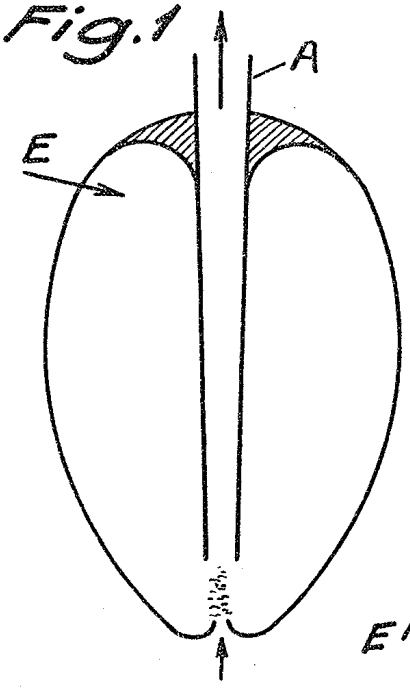


Fig. 2

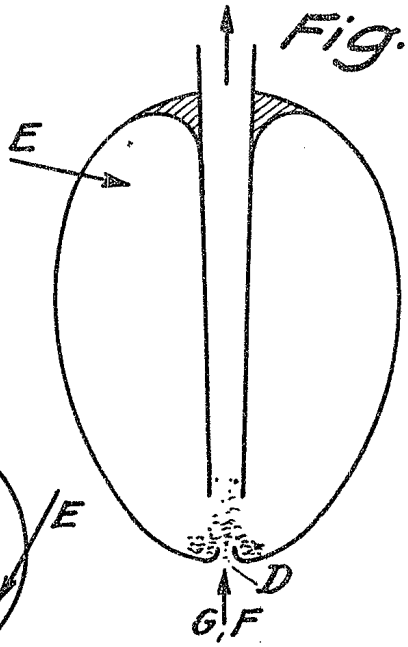


Fig. 6

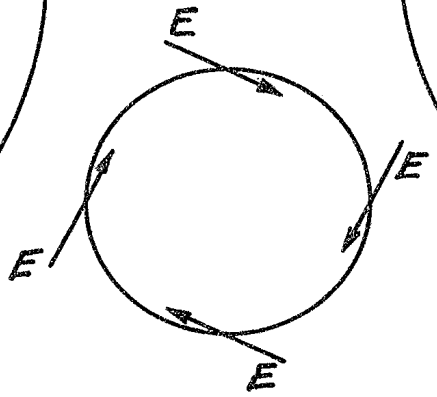


Fig. 3

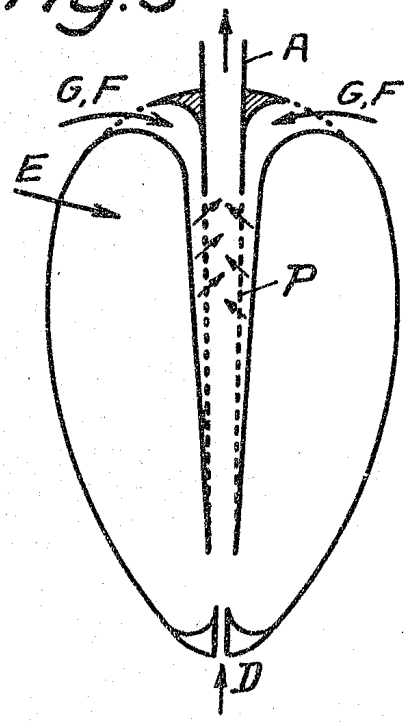


Fig. 4

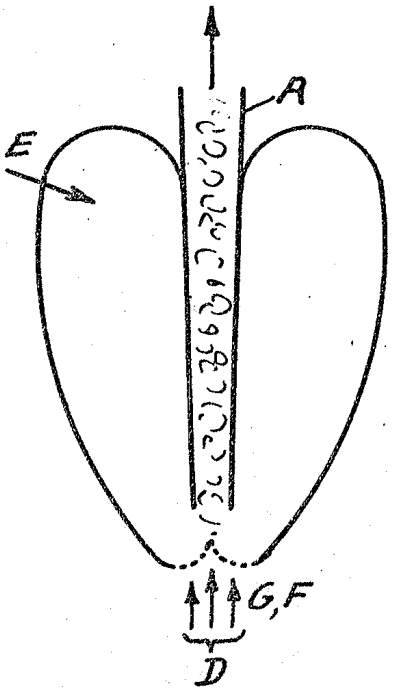
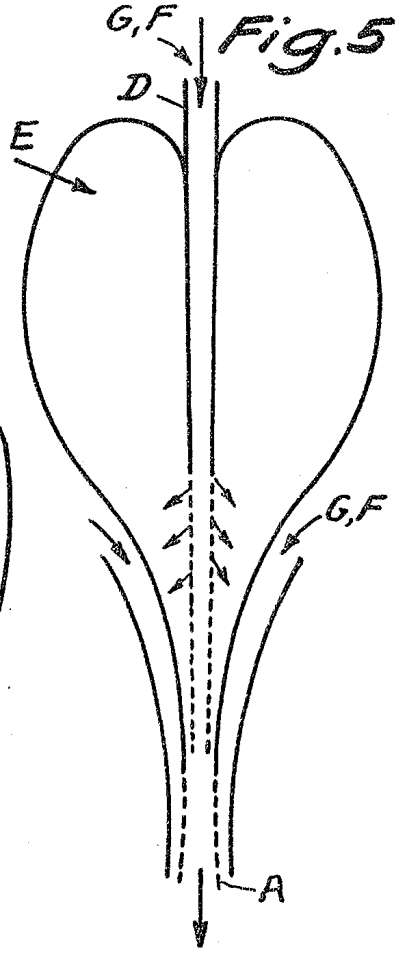


Fig. 5



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