

Nov. 2, 1926.

1,605,484

C. E. THOMPSON ET AL

METHOD OF AND APPARATUS FOR TREATING EXHAUST GASES

Filed Nov. 6, 1925

4 Sheets-Sheet 1

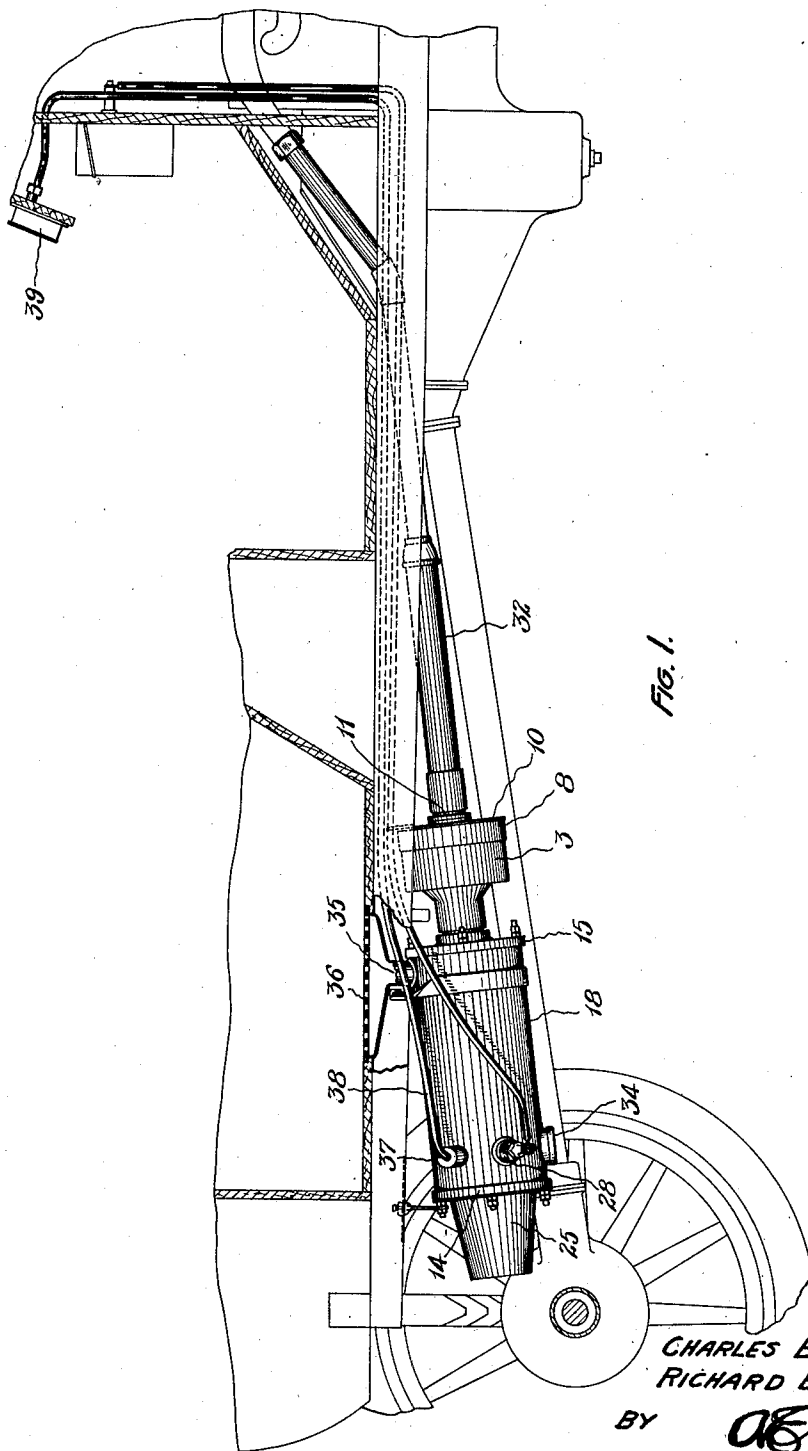


FIG. 1.

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4 Sheets-Sheet 2

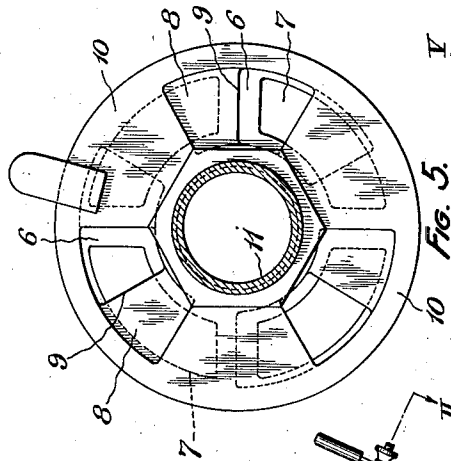


Fig. 5.

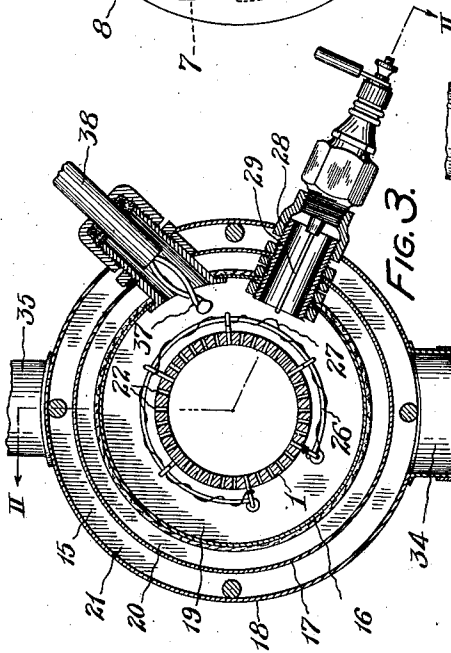


Fig. 3.

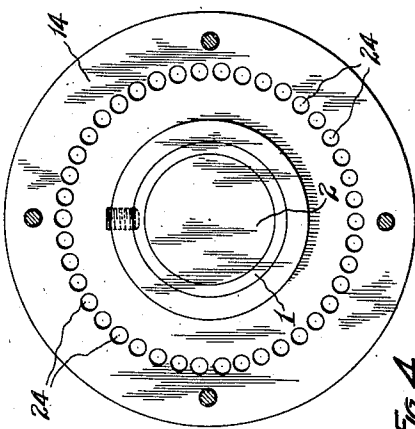


Fig. 4.

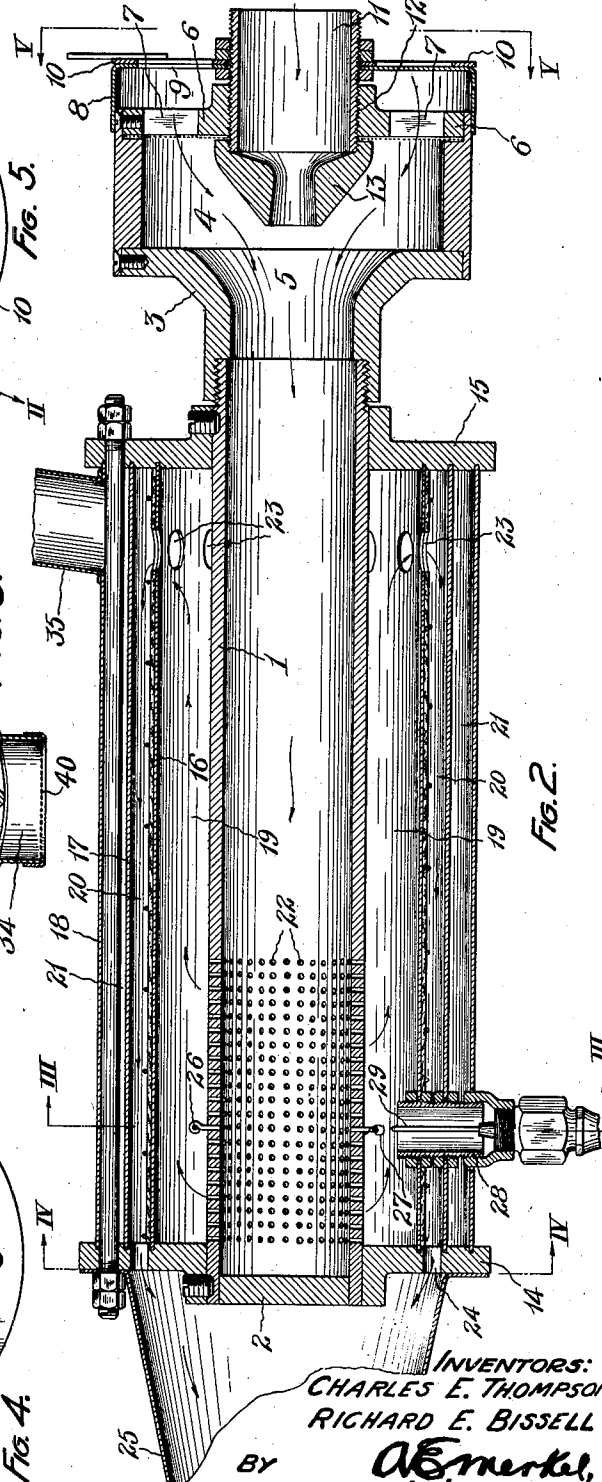


Fig. 2.

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4 Sheets-Sheet 3

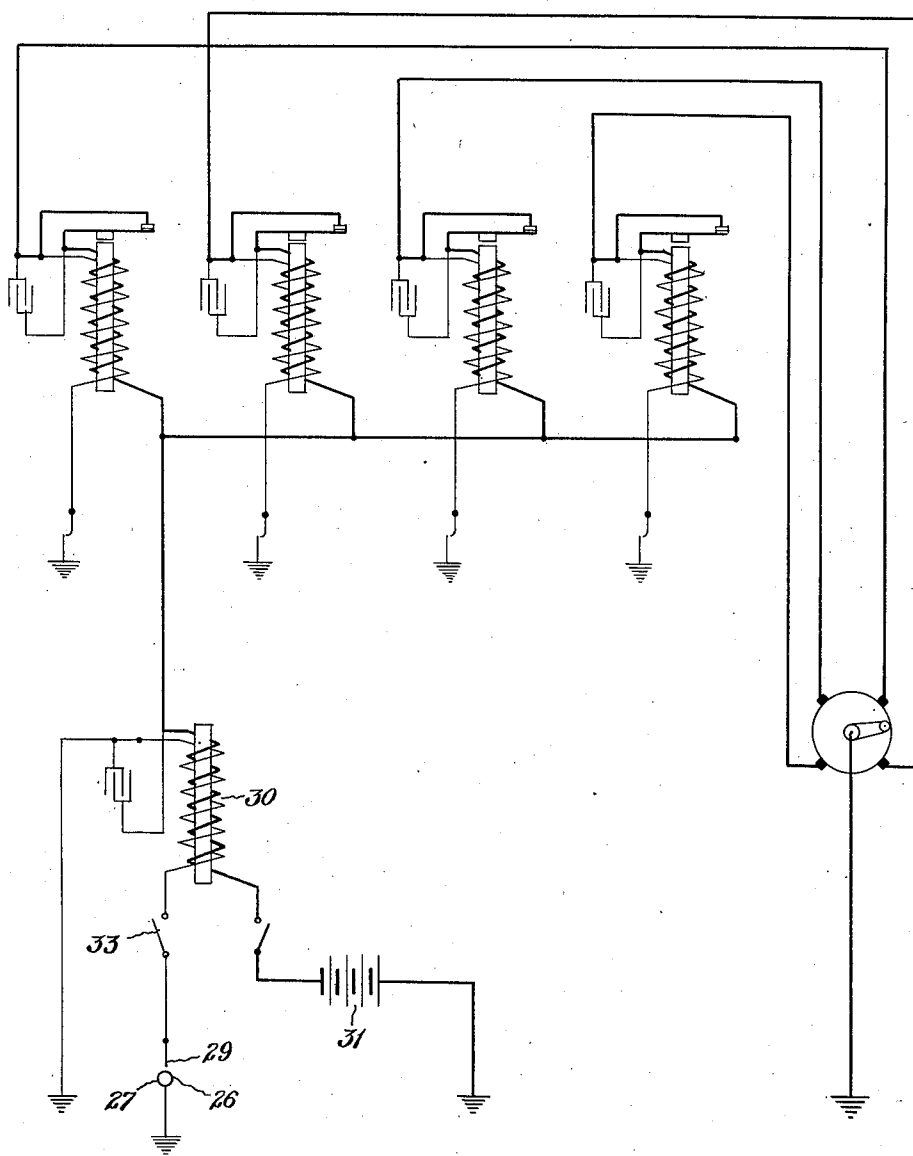


FIG. 6.

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4 Sheets-Sheet 4

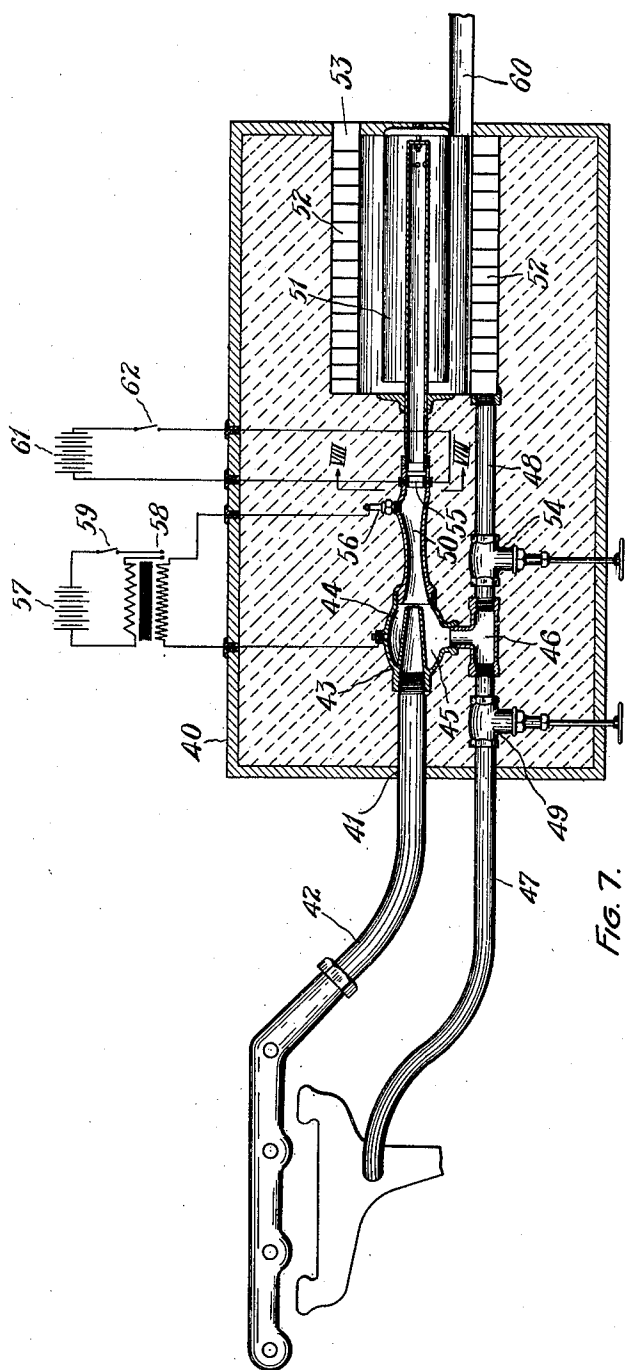


FIG. 7.

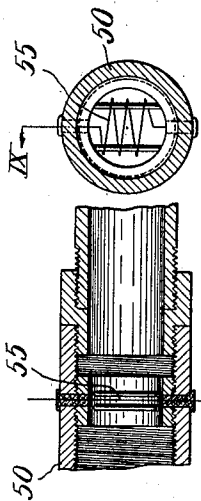


FIG. 8.

FIG. 9.

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UNITED STATES PATENT OFFICE.

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METHOD OF AND APPARATUS FOR TREATING EXHAUST GASES.

Application filed November 6, 1925. Serial No. 67,377.

This application is a continuation in part of pending application filed by the applicants herein December 17th, 1924, and bearing Serial Number 756,481.

Our invention relates to methods of and apparatus for treating the products of combustion emanating from a combustion chamber, its object being to either eliminate or modify the well-known toxic or obnoxious character of the products of combustion due to the incomplete primary combustion of the fuel in such chamber, or utilized the potential heat of the combustible elements of such products, or both.

The invention may be applied with particular advantage to the exhaust gases produced in the operation of internal combustion engines, which, as is well known, contain a considerable amount of the highly toxic carbon monoxide together with obnoxious elements such as methane gas and oil vapors.

In applying our invention to a multiple cylinder internal combustion engine, we have found the best results to be obtained by effecting secondary combustion under uniform conditions, that is under conditions in which the exhaust gases from each cylinder are commingled with an oxidizing agent, the oxidizing character of which is substantially identical with that of the oxidizing character of the agent commingled with the exhaust gases of each of the other cylinders.

We have also found it preferable to effect the combustion in a zone beyond the igniting influence of any flame which may result from the primary combustion, and effect the secondary combustion by means independent and separate from such flame.

As specifically applied to an internal combustion engine, the process consists broadly in commingling the exhaust gases with a gaseous oxidizing agent, initiating combustion of the commingled gases by a source of heat other than the gases themselves, and continuing active combustion by the heat derived from the burning gases. More specifically, the process contemplates the utilization of catalyzing means to promote combustion. For effecting this process we have devised novel apparatus including means to cause the commingling of the gaseous oxidizing agent and the exhaust

gases, a means to initiate combustion of the commingled gases, and a catalyzing means to promote combustion.

The annexed drawings and the following description set forth the process and certain means for carrying it out, the disclosed means, however, constituting but merely examples of the manner in which the principles of our invention may be employed.

In said annexed drawing:

Figure 1 represents a longitudinal section of a motor vehicle showing a device for carrying out our invention applied thereto;

Fig. 2 represents a longitudinal axial section, upon an enlarged scale, of the said device;

Fig. 3 represents a section taken upon the plane indicated by line III—III in Fig. 2;

Fig. 4 represents a section taken upon the plane indicated by line IV—IV in Fig. 2;

Fig. 5 represents an end elevation taken upon the plane indicated by line V—V in Fig. 2;

Fig. 6 represents a diagram of the electric circuit which may be used in the application of our invention to a four cylinder motor vehicle engine;

Fig. 7 is a view partly in elevation and partly in section of another form of the device for carrying out our invention;

Fig. 8 represents, upon an enlarged scale, a detailed section taken on line VIII—VIII of Fig. 7;

Fig. 9 represents a section taken on line IX—IX of Fig. 8.

In the particular apparatus illustrated by Figs. 1 to 6 of the drawings, a central metal tube 1 is provided having its one end closed by a disk 2, and its open end connected with a casing 3 provided with the air chamber 4 and the bell-mouthed duct 5 connecting said chamber and tube.

In the outer end of casing 3 is a disk 6 provided with a plurality of air inlets 7. Surrounding the casing end is a shell 8 provided with a plurality of air openings 9 whose areas may be varied by rotatable disk valve 10 as will be understood.

A sleeve 11 is threaded into and through a central opening 12 in the disk 6 and has secured to its inner end an outwardly flaring nozzle 13 which discharges into the bell-mouthed duct 5, Fig. 1.

Mounted upon the tube 1 are two end plates, 14 and 15 respectively, and secured between these plates are three concentric cylindrical shells, 16, 17 and 18 respectively. These cells form three annular chambers, 19, 20 and 21 respectively.

The end portion of tube 1 adjacent to plate 14 is provided with a plurality of small perforations 22 and the end portion of shell 16 adjacent to plate 15 is provided with the larger perforations 23.

Communicating with the chamber 20 is a plurality of outlet openings 24 formed in plate 14, Figs. 1 and 4. Secured to the outside of said plate is a discharge nozzle 25 communicating with the openings 24.

Mounted upon and electrically connected with the tube 1 and substantially midway of the perforated portion there is a wire support 26 which carries a platinum wire 27 out of contact with said tube, as shown in Fig. 3. The said support and platinum wire almost completely surround the tube 1.

Passing through all three of the shells 16, 17 and 18 and so as to make a gas-tight joint therewith, is a sleeve 28 through which passes an electrical spark terminal 29. The end of the terminal is adjacent to the wire support 26 and platinum wire 27, so that when the terminal is connected with a suitable source of current, a spark will pass from the terminal to the wire and thence to the tube 1, which latter acts as a ground connection.

Said source of current and the electrical connections which may be used when the device is applied to a four cylinder motor vehicle engine, is shown diagrammatically in Fig. 6, in which an additional induction coil 30 is connected with a well-known arrangement shown for producing the sparks for a four cylinder engine, and energized from the same battery 31 which supplies the current for the spark plugs of said cylinders.

This additional coil, as shown by the diagram, is in series connection with each of the spark coils of the cylinder spark plugs and a spark will hence be caused to pass from the terminal 29 to the support 26 whenever a spark is made in any of the cylinders, that is each time the timer makes a connection.

Further description of these connections will be unnecessary, as the diagram will make plain to anyone skilled in the art just how such connections may be made.

The sleeve 11 is connected with the exhaust pipe 32 which leads from the exhaust manifold of the engine, and, as shown in Fig. 1, the above-described device is placed conveniently beneath the rear end of the vehicle body, thereby removing the device some distance from the exhaust outlets of the engine and hence any flame emanating therefrom.

The above-described device operates as follows:

Let it be assumed that the engine is started. The exhaust gases will all be discharged into the exhaust pipe whence they will pass out of the nozzle 13, through the bell-mouthed duct 5 and so into the tube 1. At the same time, the sparking circuit will cause a succession of sparks to jump across the gap between the terminal 29 and the platinum wire 27 and support 26.

The valve 10 is opened so as to afford communication with the atmosphere, and as a result air will be drawn into the chamber 4 and passed through duct 5 and effectively commingled with the exhaust gases. The form of the nozzle 13 and duct 5 is such that a very complete carburetion of the air with the exhaust gases is produced. It will be observed at this point that all of the exhaust gases are mixed with an oxidizing agent uniform as to its oxidizing character, and that therefore all of the combustible material is subjected to a uniform combustion and is hence all transformed into the non-toxic or unobnoxious products to the same degree, as will hereinafter appear.

This carburetted air passes through the tube 1, through the perforations 22, into chamber 19, through the openings 23, into the chamber 20, through the openings 24 into the discharge nozzle 25 and thence into the atmosphere. There are a multiplicity of small perforations 22 arranged at the rear end of the tube 1, forming a screen to confine the flame to the combustion chamber 19 after the principle of a miner's lamp. The cylindrical band of perforations serves to evenly distribute the mixed gases and cause the even burning thereof, thus lowering the temperature of the mass of gases in the vicinity of the catalyzing wire 27 below that which would otherwise occur.

After the said gases have reached a given temperature they are ignited by the spark and burn in the chamber 19 which hence forms a secondary combustion chamber, and the products of such secondary combustion pass out of the chamber 19 into chamber 20 and are eventually discharged into the atmosphere.

As a result of such combustion, the platinum wire becomes heated, reaches a given temperature and hence becomes activated to form a catalyzer which induces the combination of oxygen and carbon monoxide or methane and other gases and vapors of the carburetted air, thus converting such monoxide to the innocuous dioxide, and converting the methane and gasoline vapors to less obnoxious compounds.

The openings 23 in shell 16 are at the forward end thereof, whereby the hot gases are conducted along the outer surface of the tube 1 to pre-heat the commingled gases in

the mixing chamber. The hot gases are thereafter conducted along the interior wall of the shell 17 to the exit openings 24, thereby effectively heating the air in the chamber 21.

In operation, the heat of secondary combustion ordinarily maintains the catalyzing wire 27 at a temperature high enough to cause it to promote chemical union of the gases (about 612° F.), so that combustion of the gases will be effected continuously although there may be times when the heat of secondary combustion will not alone suffice to continue active complete combustion. The electric spark is a convenient means for initiating combustion of the mixed gases and building it up to the point where the catalyst will assist or promote combustion and until combustion may continue from the heat of secondary combustion, but it is absolutely necessary only at the initial stage of operation or when the temperature of secondary combustion becomes too low for combustion to continue automatically when assisted by the catalyst; a suitable switch 33 is provided by which the spark may be cut out when desired. So, while the electric spark is not necessary for continuous combustion, it is considered more convenient to permit its operation at all times.

Inasmuch as the chemical union of carbon monoxide and oxygen, or methane and oxygen is exothermic in character, the heat resulting therefrom is available and may well be used for heating purposes.

Such heat may therefore be readily applied to the heating of the interior of closed types of vehicles such as motor busses.

To this end the outer chamber 21, which has no connection with the path of the gases in the apparatus, and acts as an exterior insulating chamber, may be provided with an air inlet 34 at the bottom and an air outlet 35 which may be connected by a suitable duct with a heat register 36 in the floor (as shown) or in any other suitable part of the interior of the vehicle which may be advantageous. Inlet 34 may be provided with a suitable screen 40.

For the purpose of enabling the operator to know whether or not the apparatus is working and to what degree, we provide an indicating pyrometer which may be in the form of a thermocouple 37, Fig. 3, projecting into the secondary combustion chamber and connected by suitable wiring 38 to an indicating dial 39 preferably located upon the dash board of the vehicle, as shown in Fig. 1.

In Figures 7, 8 and 9 we show a different embodiment of our invention, which is not considered as practical in form, as a whole, as that shown in Figs. 1 to 6, but which discloses a feature of our invention not specifically embodied in the apparatus as

disclosed in Figs. 1 to 6, namely, means to provide additional fuel to assist the combustion of the exhaust gases.

In this form a casing 40 is provided with an opening 41 through which projects the exhaust pipe 42 connected with the exhaust outlet (not shown) of the cylinder or cylinders of an internal combustion engine. The end of this pipe projects into a casing 43 and has its inner end tapered as shown. The tapered end projects into an interior bell-mouthed portion 44. The latter is also provided with an inlet opening 45 at the bottom of which is connected a T 46, whose two inlets are connected respectively with pipes 47 and 48. Pipe 47 is connected with the manifold intake of the engine and is provided with a valve 49. Pipe 50 leads to a secondary combustion chamber 51, which conveniently may be the muffler, and the latter is surrounded by an air-chamber 52 communicating at its outer end with the atmosphere by means of a suitable opening 53 and at the inner end with pipe 48. The latter is provided with a valve 54.

It will be seen from the above, that the casing 43 and connected parts form an ordinary inspirator or "air-lift" by means of which the air from the chamber 52 or combustible mixture from the manifold intake may be drawn into the exhaust duct as a result of the passage through the latter of the exhaust gases from the engine, according as the valves 49 and 54 are opened or closed.

Interposed transversely in the pipe 50 or portion 44, and secured in any suitable manner, is a member 55 composed of a material, such as platinum for example, which will act or may be caused to act as a catalyzing agent in effecting the union of carbon monoxide and oxygen to form carbon dioxide, or methane and oxygen to form water vapor and carbon dioxide or such other reactions as are well known in the chemical arts with gases and conditions present.

Also interposed in the pipe 50 is a spark plug 56 included in an electrical circuit including also a source of current such as a battery 57, and interrupter 58, and a switch 59.

The muffler 51 is provided with the usual tail-pipe 60 discharging into the atmosphere.

Instead of relying upon the heat of secondary combustion to heat the catalyst to the point of activation, it may be desirable in some cases to employ a battery 61, with a circuit of which the catalyst forms a part, which may be closed by switch 62.

In order to conserve the heat it is preferable to embed the above-described apparatus in suitable insulation confined in the casing 40 as shown.

The operation of this form of apparatus will be obvious from the above-description

of the operation of the preferred form. The principal difference between the two forms is that in the form shown in Figs. 7 to 9, a source of additional fuel is employed to ignite the exhaust gases. As shown, the additional fuel supply is drawn from the intake manifold by opening the valve 49, which may be closed when additional fuel is not found to be necessary or desirable.

While we have shown the exhaust gases from all of the cylinders of the engine as being discharged into a common duct before being mixed with the air and then burned, it will be readily seen that the apparatus might be so modified as to mix the products of combustion from each cylinder separately with air, and all of such mixtures then led into a common duct communicating with a transformer such as is above described, without departing from the principle of our invention.

It will also be apparent to those skilled in the art that the principle of our invention may be utilized for treating products of combustion emanating from furnaces or the like whereby the obnoxious character of the smoke emanating from chimneys may be destroyed or modified and the heat of the secondary combustion utilized for any suitable purpose.

While we have described two specific embodiments of the principles of our invention, these specific embodiments are not, in all their features, our joint invention but the sole invention of one of us. For this reason a number of patentable features herein disclosed are not claimed, the claims herein being confined to the broad aspects of the process and apparatus.

What we claim is:

1. The process of treating gases resulting from the combustion of fuel in an internal combustion engine which consists in commingling such gases with a gaseous oxidizing agent, igniting the mixed gases by an external source of heat, and thereafter continuing active combustion by the heat derived from the burning gases.

2. The process set forth in claim 1 in which the heat to ignite the mixed gases is produced by electrical means.

3. The process set forth in claim 1 in which the igniting means consists of an electric spark.

4. The process set forth in claim 1 with the additional step of heating the gaseous oxidizing agent prior to mixing it with the exhaust gases.

5. The process set forth in claim 1 in which the gases are mixed by the injector method.

6. The process of treating gases resulting from the combustion of fuel in an internal combustion engine which consists in commingling such gases with a gaseous oxidizing

agent, igniting the mixed gases by an external source of heat, and thereafter continuing active combustion with the aid of a catalyst.

7. The process of treating gases resulting from the combustion of fuel in an internal combustion engine which consists in commingling such gases with a gaseous oxidizing agent, initiating active combustion thereof when the temperature of the mixed gases is below that at which a given catalytic agent would promote combustion, and thereafter continuing combustion in the presence of such catalytic agent.

8. The process of treating gases resulting from the combustion of fuel in an internal combustion engine which consists in commingling such gases with a gaseous oxidizing agent, initiating active combustion thereof when the temperature of the mixed gases is below that at which a platinum catalyzer would promote combustion, and thereafter continuing active combustion in the presence of a platinum catalyzer.

9. Apparatus for treating gases resulting from the combustion of fuel in an internal combustion engine, comprising, in combination, an engine having an exhaust duct, a mixing chamber connected with the exhaust duct and into which the exhaust gases are thereby conducted, means for admitting thereto a gaseous oxidizing agent and commingling the same with the exhaust gases, and an igniter fixed in position and heated from an external source adapted to ignite the mixed gases to cause active combustion.

10. Apparatus for treating gases resulting from the combustion of fuel in an internal combustion engine, comprising, in combination, an engine having an exhaust duct, a mixing chamber connected with the exhaust duct and into which the exhaust gases are thereby conducted, means for admitting thereto a gaseous oxidizing agent and commingling the same with the exhaust gases, and means for igniting the commingled gases comprising a source of fuel supply independent of the exhaust gases.

11. Apparatus for treating gases resulting from the combustion of fuel in an internal combustion engine, comprising, in combination, an engine having an exhaust duct, a mixing chamber connected with the exhaust duct and into which the exhaust gases are thereby conducted, means for admitting thereto a gaseous oxidizing agent and commingling the same with the exhaust gases, and means for igniting the commingled gases comprising a source of fuel supply independent of the exhaust gases, and an electrical sparking device.

12. Apparatus for treating gases resulting from the combustion of fuel in an internal combustion engine comprising, in combination, a mixing chamber into which the exhaust gases are conducted, means for admit-

- ting to the mixing chamber a gaseous oxidizing agent, means for commingling the same with the exhaust gases, an igniter heated from an external source adapted to ignite the mixed gases to cause active combustion, and a catalyst to promote active combustion.
13. The combination specified in claim 12 in which the igniter consists of electrical means.
14. The combination specified in claim 12 in which the igniter consists of an electrical spark.
15. The combination specified in claim 12 in which the catalyst consists of a platinum wire.
- Signed by us this 30th day of October, 1925.

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