

Aug. 18, 1970

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3,524,316

METHOD AND APPARATUS FOR COMBUSTING INTERNAL
COMBUSTION ENGINE EXHAUST POLLUTANTS

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2 Sheets-Sheet 1

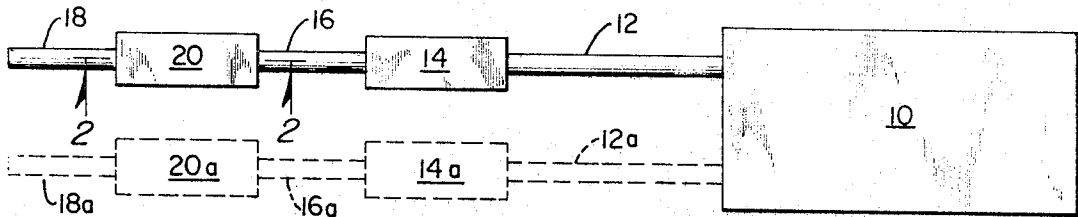


Fig. 1

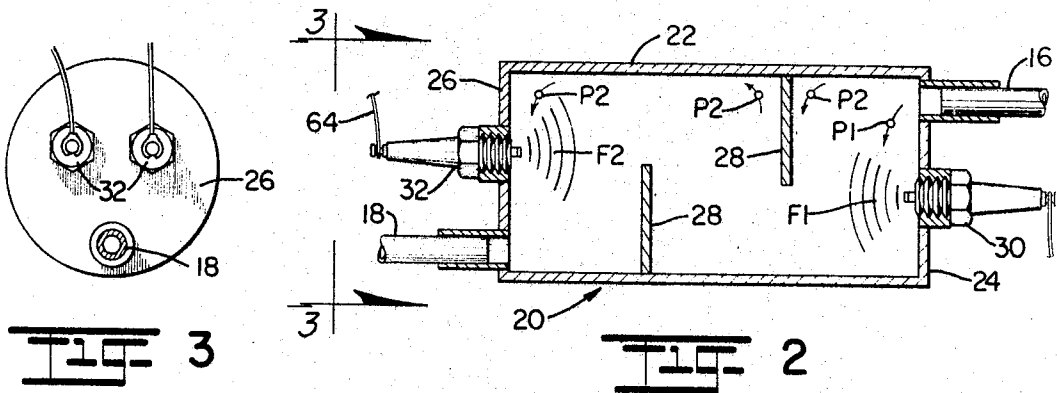


Fig. 2

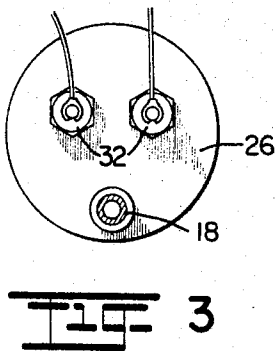


Fig. 3

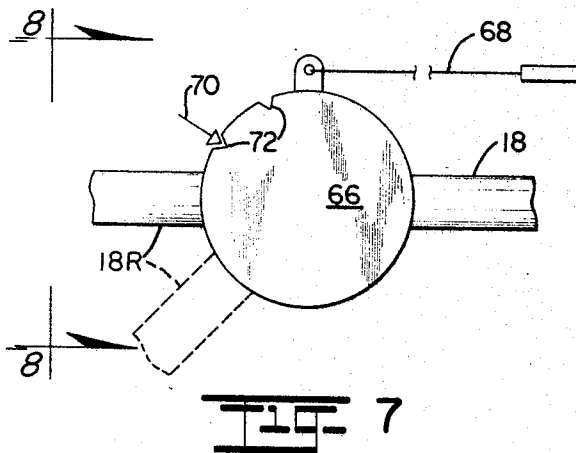


Fig. 7

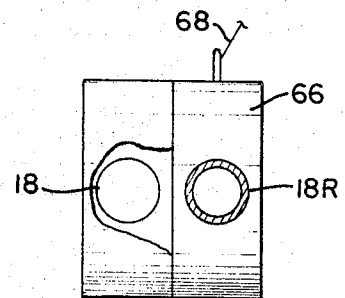


Fig. 8

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2 Sheets-Sheet 2

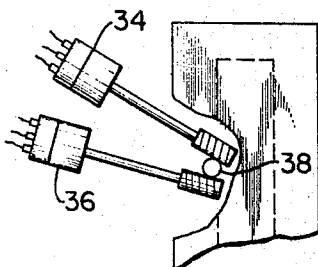
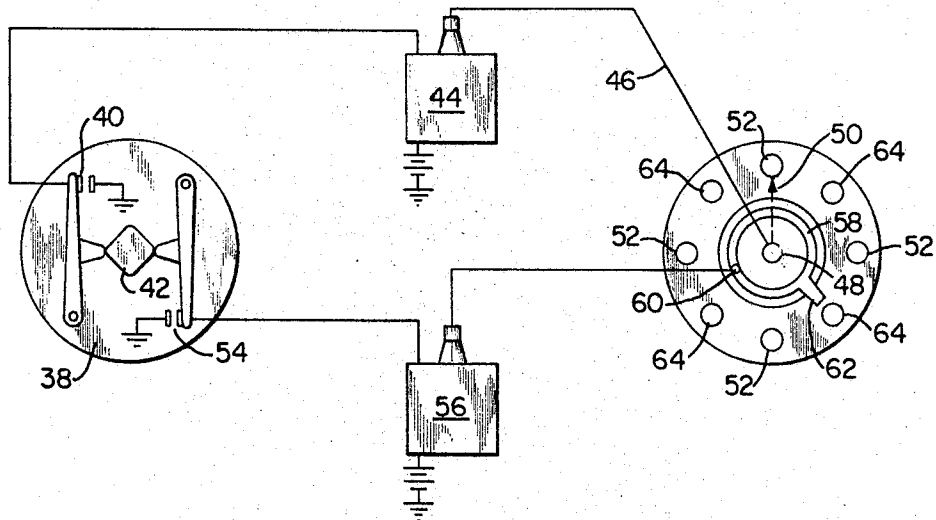


FIG. 4

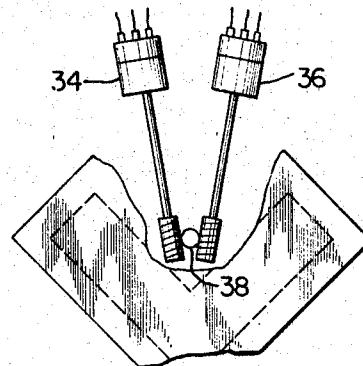


FIG. 5

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METHOD AND APPARATUS FOR COMBUSTING INTERNAL COMBUSTION ENGINE EXHAUST POLLUTANTS

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10 Claims

ABSTRACT OF THE DISCLOSURE

Method and apparatus for combusting the unburned gases in the exhaust of an internal combustion engine in a chamber, such as a muffler or an afterburner in series with a muffler, characterized by the use of a plurality of conventional spark plugs spaced in optimum relation to the chamber and preferably of a number equal to the number of engine cylinders, the various plugs being periodically fired by a separate electrical system operating in synchronism with the engine ignition system. An optional feature includes the provision of a movable tail pipe which may be oriented when desired to a deicing position in which hot exhaust gases may be directed onto snow or ice on a roadway.

BACKGROUND OF THE INVENTION

As is well known, the considerable increase in population density during the past decade or two, and particularly in metropolitan areas, with its attendant increase in the use of automotive vehicles, has created serious air pollution problems which have now reached a point of national concern. This has been further compounded by the continual enlargement of engine displacements which has also increased the quantity of exhaust gases emitted to the atmosphere by each vehicle, which gases contain certain unburned hydrocarbons and other pollutants which are injurious to both health and vegetation. In attempts to minimize the quantity of pollutants which produce what is generally referred to as smog, various devices have been proposed; they are of two general types, one being sometimes referred to as a crankcase device, and the other, an exhaust device. The former is intended to prevent only crankcase fumes and "blow by" from entering the atmosphere which does not prevent other obnoxious exhaust gases from entering the atmosphere, contributing causes of which are faulty carburetion and ignition timing, other engine malfunctions, and improper operator control of a vehicle which all result in incomplete combustion of a fuel-air mixture. The exhaust device, of course, is intended to minimize the emission of obnoxious gases which are contained in the engine exhaust and it is to this type of device that the present invention pertains.

In certain of the various exhaust devices proposed it has been conventional practice to deliver the engine exhaust to a chamber, sometimes referred to as an afterburner, in which a spark plug ignites the unburned gases. It has also been recognized as desirable that the spark plug be fired each time an engine spark plug is fired. Pats. 1,605,484 to Thompson et al. and 2,806,346 to Clayton are exemplary of this technique. Pat 3,058,298 to Morris is similar but employs a special and unconventional spark plug. It is also known that it may be desirable to admit ambient air into the afterburner to support combustion, Pat. 3,201,933 to Baden being exemplary of this technique.

SUMMARY OF THE INVENTION

A plurality of spark plugs, equal to the number of cylinders of an internal combustion engine, are disposed

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at spaced optimum positions relative to an engine afterburner and are fired in a desired sequence by a separate ignition system which operates in synchronism with the engine ignition system.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 diagrammatically illustrates the subject of the invention as it may be applied to an internal combustion engine;

FIG. 2 is a section taken on line 2—2, FIG. 1;

FIG. 3 is a section taken on line 3—3, FIG. 2;

FIGS. 4 and 5 diagrammatically illustrate ancillary equipment required on an internal combustion engine; FIG. 6 illustrates an alternative form of such ancillary equipment;

FIG. 7 is a side elevation of an optional exhaust deflecting device; and

FIG. 8 is a section taken on line 8—8, FIG. 7, a portion being broken away.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawing, and first to FIG. 1, it will be assumed that automotive engine 10 is of the multi-cylinder type having say 4, 6 or 8 cylinders as is presently the practice. In 4 and 6 cylinder "in line" engines it is customary practice to provide a single exhaust pipe 12 connected to a muffler 14 which exhausts through a tail pipe 16, 18. In "V" and "opposed" type engines a second exhaust pipe 12a, muffler 14a and tail pipe 16a, 18a may be provided, these being indicated by dotted lines.

In the single exhaust system, a combustion chamber or afterburner 20 is interposed between tail pipe portions 16, 18 whereas in the dual system a second combustion chamber 20a is interposed in like manner. One of the advantages of disposing the combustion chamber between ends of the conventional tail pipe is that a minimum amount of alteration of the exhaust system is required. Thus, the combustion chamber may be designed to fit within available space rearwardly of the muffler and a portion of the tail pipe cut away, leaving the exhaust pipe and muffler undisturbed and requiring only the accessories of a combustion chamber and certain ancillary equipment to be subsequently described.

Referring now to FIG. 2, combustion chamber 20 comprises a cylindrical shell 22, closed at opposite ends by walls 24, 26 and provided with baffles 28 which produce turbulence in the exhaust gas, aiding in the combustion process, and which also increase the length of its exhaust path within a shorter overall length of the combustion chamber. As will be apparent, by increasing the length of the path, the residence time of any particle of gas within the chamber is increased, this further aiding in the combustion process.

Spark plugs 30 of conventional type are threadably secured to end wall 24 at positions which will produce optimum ignition of the gases passing across their electrode gaps and like plugs 32 are similarly secured to end wall 26, as best illustrated in FIG. 3. While it might appear that only plugs 30 near the entrance end of the chamber are required, it is to be recognized that some particles of gas in the exhaust flow may not be ignited by a combustion front or wave which initiates at a spark plug 30. These uncombusted particles may, however, pass across a plug 32, which initiates another combustion front or wave which travels upstream through the gas despite its general downstream movement. This is illustrated diagrammatically wherein particle P₁ moving adjacent plug 30 initiates a combustion front F₁. A more remote particle P₂, however, may not be effected by front F₁ and may travel through the successive positions shown to a position adjacent plug 32 where it is ignited and starts

a combustion front F_2 which moves upstream, thus providing more complete combustion of the combustible gases passing through the chamber.

As so far described, it has been assumed that the gas entering the combustion chamber contains combustible contaminants and that sufficient oxygen is present to support complete combustion. The gas should thus be at least stoichiometric and preferably somewhat oxygen rich, the oxygen having been admixed with the exhaust gas at a point ahead of the combustion chamber, this technique being well known as previously set forth.

As alluded to, the order of firing plugs 30, 32 in proper order and in synchronism with the firing of the plugs of the engine constitutes an important feature of the invention and further distinguishes it from the prior art in which only a single plug is fired each time one of the cylinder plugs is fired. This may be attained in various ways, depending upon the manner of installation of the system. FIG. 4 illustrates what might be termed a "factory installation" on an in-line engine in which the engine is originally designed to provide a combustion chamber ignition system 36 which is identical to the usual engine ignition system 34 and operated from camshaft spiral gear 38 of the automobile engine camshaft. The additional ignition system contains the conventional breaker points, condenser and is associated with a high tension coil and distributor rotor for producing periodic firing pulses to the plugs of the combustion chamber in synchronism with the firing pulses delivered to the engine cylinder plugs. FIG. 5 is a like installation on a "V" engine.

The dual ignition and distributor systems, just described, are particularly applicable to engines which are factory designed to accommodate them. For presently existing engines, however, an ignition and distributor system for the combustion chamber may readily be provided as an accessory without major changes to the engine. FIG. 6 illustrates such an accessory as applied to a 4-cylinder engine in which the usual breaker point support plate 38 is provided with the usual set of points 40 operated by a lobe cam 42 which opens the primary circuit of coil 44, the secondary output lead 46 of which is connected to a central brush 48 which is constantly in contact with the usual distributing finger or bar 50 which distributes the coil output to four equiangularly spaced wires 52, connected to the engine spark plugs, this system being conventional. The system just described is modified by providing a second set of breaker points 54, which open and close simultaneously with points 40, which likewise control the primary circuit of coil 56, the output of which is delivered to a slip ring 58 by brush 60, the slip ring being connected to a second distributing finger 62, carried by the rotor which delivers the high voltage output of this coil to a second set of wires 64, connected to the plugs of the combustion chamber in a manner to subsequently be set forth. A system of the type just described is identical to "dual" ignition system for a 4-cylinder engine in which two spark plugs are provided for each cylinder, controlled by two sets of breaker points and two coils, the difference being that one set of coil output wires is connected to the combustion chamber plugs rather than to a second set of engine cylinder plugs. As will be apparent from this example, similar modifications may be provided for a 6 or 8-cylinder engine by suitable choice of the number of cam lobes, distributor cap, rotor, and angular spacing of the breaker points with respect to the cam lobes. Other distributing systems may, of course, be employed which require only a single geared take-off from the engine cam shaft to a single distributor shaft, for example, by providing a single distributor shaft with axially spaced cams which operate two sets of breaker points, utilizing "stacked" distributor caps. A still further alternative form (not shown) resides in providing an electronic circuit which is sequentially triggered by the conventional spark plug lead wires but which requires only a negligible cur-

rent to trigger same. In any event, as is apparent, it is desirable to provide a second independent ignition system and high voltage coil so that the spark energy to the engine spark plugs is not reduced.

Referring now to FIGS. 2 and 3, and still assuming that the installation is for a 4-cylinder engine, spark plugs 30 are preferably disposed in the same locus where ignition would be best initiated and plugs 32 should be likewise disposed. To obtain optimum combustion conditions in the combustion chamber, plugs 30, 32 should be fired in a sequence such that a plug 30 fires, a plug 32 next fires, another plug 30 next fires and another plug 32 next fires. This then provides separate timed sparks at two spaced loci in the combustion chamber so that a plurality of plugs 30 initiate combustion fronts from one locus and a plurality of plugs 32 initiate combustion fronts from another locus.

As described hereinbefore, the sets of plugs 30, 32 are disposed at opposite ends of a combustion chamber which is in effect an afterburner for a muffler. Where an installation does not present undue complications and is not economically unfeasible, spark plugs 30, 32 may be disposed in suitable loci in the muffler, such as in opposite end walls thereof. As previously referred to, the exhaust entering the muffler may be admixed with air to provide at least a stoichiometric mixture, but preferably somewhat oxygen rich.

In a dual exhaust system, as illustrated by the dotted lines in FIG. 1, the spark plugs are evenly divided between the two combustion chambers or mufflers. Thus, in an 8-cylinder dual exhaust system each combustion chamber or afterburner is provided with four plugs, two at the front end and two at the rear end when these loci are found to be optimum. The alternate firing order between front and rear sets should be the same as described for a 4-cylinder engine with a single exhaust system.

As so far described, it has been assumed that the engine is of the gasoline type having spark plugs and a conventional ignition distributing system for same. The invention is applicable, however, to diesel engines which do not have spark plugs or an electrical ignition system. In such installations an electrical system for the combustion chamber, whether it be a muffler or a power take-off on the engine, such as one end of the engine crankshaft, by a suitable timing chain or a "cog" belt.

Alternative feature of the invention, and particularly of use in cold climates, is the provision of an exhaust deflecting system as illustrated in FIGS. 7 and 8. In this construction rearmost portion 18R of the tail pipe is connected to its forward portion 18 by a rotary valve 66 which may be disposed in the full line position or rotated to the dotted line position as shown in FIG. 7 wherein the exhaust blast is directed toward the roadway, this in general being at a position slightly ahead of the rear wheels of the vehicle for melting snow or ice which would otherwise render the vehicle immobile. A suitable Bowden wire control 68, operative from the vehicle operator's position, may be provided to selectively position tail pipe 18R which may be retained in selected positions by a detent 70 engaging suitable detent notches 72.

Obviously, many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

I claim:

1. Apparatus for combusting the combustible contaminants contained in the exhaust gas of a multicylinder internal combustion engine, comprising;

- (a) a combustion chamber adapted to receive said exhaust gas,
- (b) a plurality of sets of spark plugs associated with said chamber, each plug adapted to produce a spark therein,
- (c) said sets being disposed at spaced loci relative to

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the chamber and at which optimum ignition of said contaminants may initiate,

(d) a combustion chamber ignition system operated in synchronism with the engine and adapted to deliver high electrical potential to each spark plug and produce a spark thereat,

(e) said combustion chamber ignition system being so timed to produce sparks alternately between the sets, there being one spark in said combustion chamber for each power stroke of the engine cylinders.

2. Apparatus in accordance with claim 1 wherein said combustion chamber is constructed as an afterburner, series connected to a muffler.

3. Apparatus in accordance with claim 1 wherein said combustion chamber is a muffler.

4. Apparatus in accordance with claim 1 wherein said sets are two in number, one being disposed adjacent an inlet end of said chamber and the other adjacent an outlet end thereof, each set comprising at least two spark plugs.

5. Apparatus in accordance with claim 1 wherein said combustion chamber ignition system comprises a set of breaker points, a high voltage coil and a distributor, all operated independently of the firing system for the engine.

6. Apparatus in accordance with claim 5 wherein said engine is of the gasoline type, provided with spark plugs, and an electrical ignition system for same.

7. Apparatus in accordance with claim 6 said engine ignition system including a second high voltage coil and a separate set of breaker points for the engine spark plugs.

8. Apparatus in accordance with claim 5 wherein said

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engine is of the diesel type, devoid of spark plugs and an electrical ignition system for same.

9. Apparatus in accordance with claim 1 including a pair of exhaust pipes and a combustion chamber for each, the spark plugs being equally divided between the two combustion chambers.

10. A method of combusting the combustible contaminants contained in the exhaust gas of an internal combustion engine comprising the steps of;

(a) delivering said exhaust gas to a combustion chamber, and

(b) producing electrical sparks within said chamber alternately at spaced loci relative thereto and whereat optimum ignition of said contaminants may be initiated.

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U.S. Cl. X.R.

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