

[54] **DEVICE FOR THE POST-COMBUSTION OF THE UNBURNT SUBSTANCES IN THE EXHAUST GASES OF THE INTERNAL COMBUSTION ENGINE OF A MOTOR VEHICLE**

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 [51] Int. Cl. **F02b 75/10, F01n 3/10**
 [58] Field of Search **60/287, 288, 294, 292; 23/288 F, 277 C**

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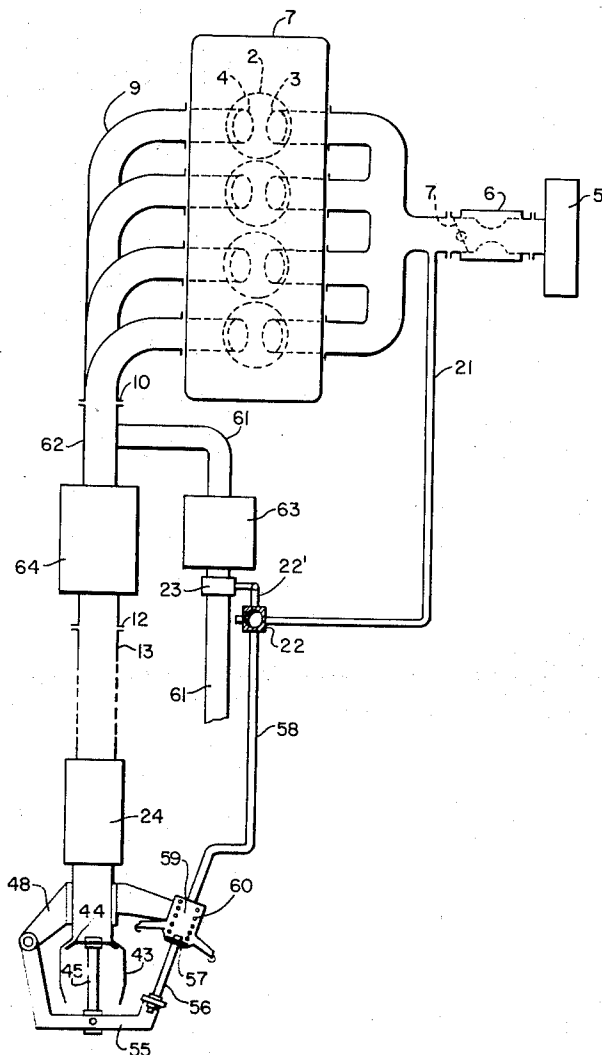
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Primary Examiner—Douglas Hart
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[57] **ABSTRACT**

A post-combustion device for the control of unburnt and polluting substances in the exhaust gases of the internal combustion engine of vehicles, in which there is provided a post-combustion chamber and a shut-off valve of the exhaust pipe, with this valve controlling whether the exhaust gases are conveyed through the post-combustion chamber or the latter is by-passed, the post-combustion chamber being positioned near the engine but the shut-off valve being positioned remote from the engine so as to obtain a particular relationship of the engine temperature with respect to these members.

10 Claims, 8 Drawing Figures



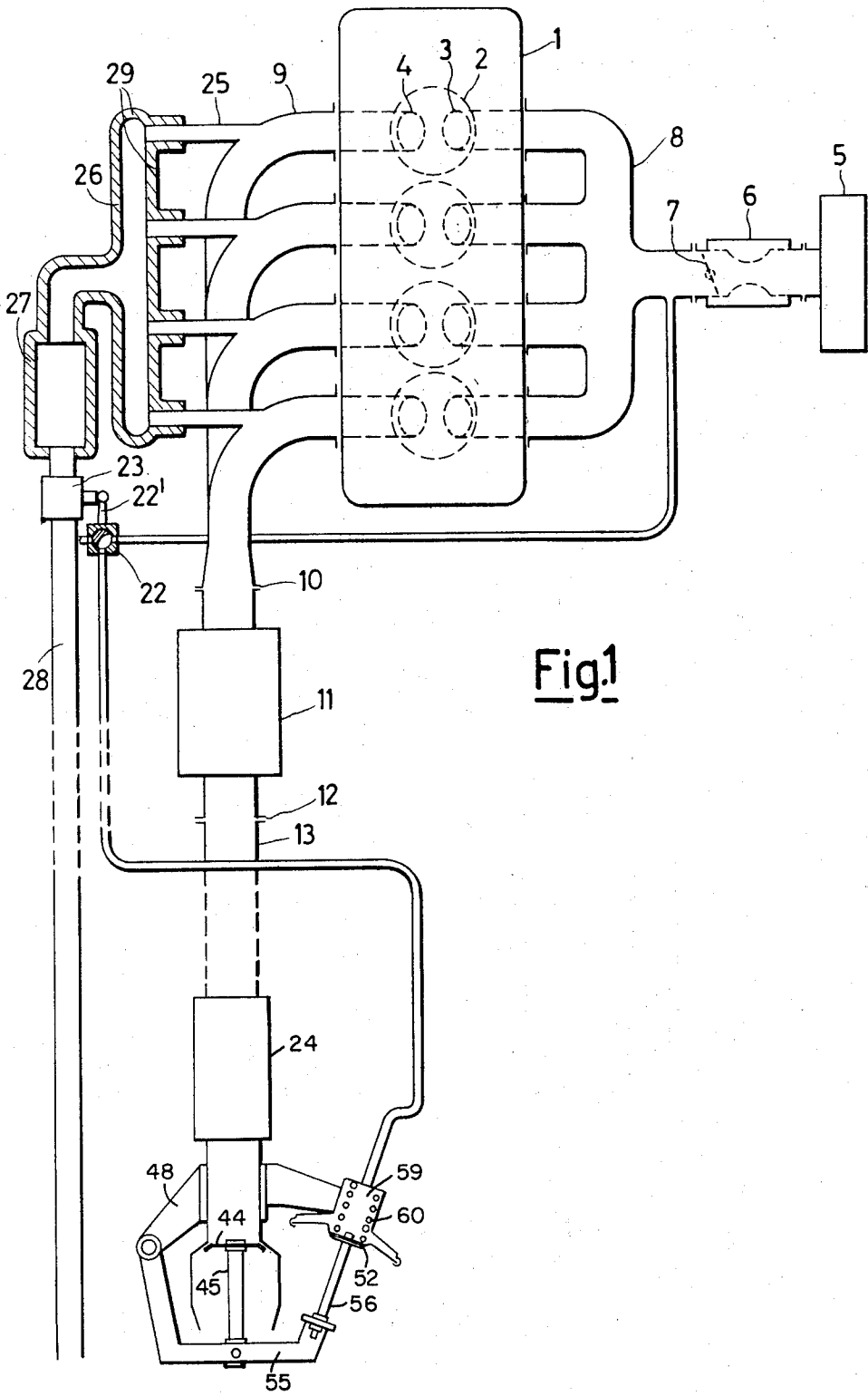


Fig.2

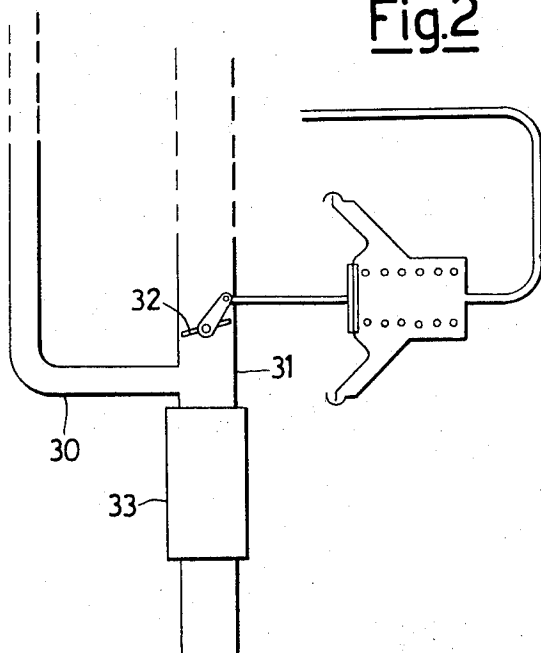
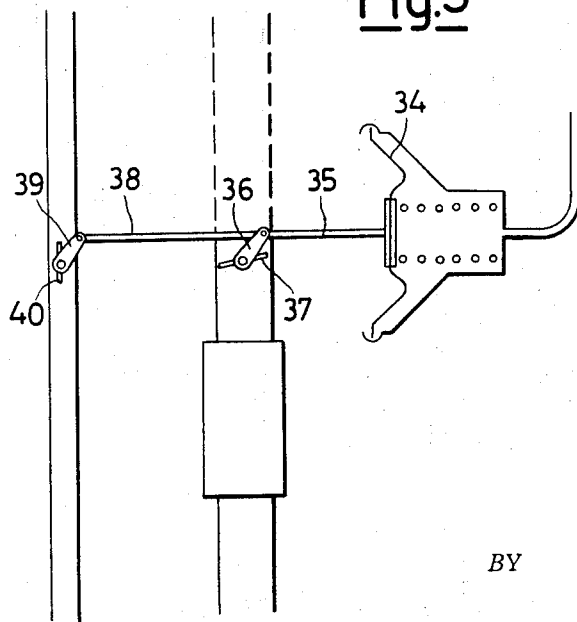


Fig.3



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Fig.4

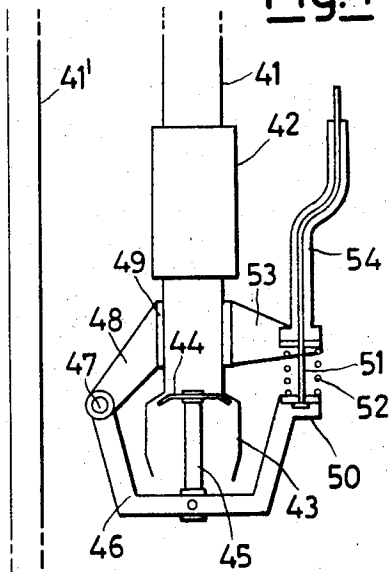


Fig.5

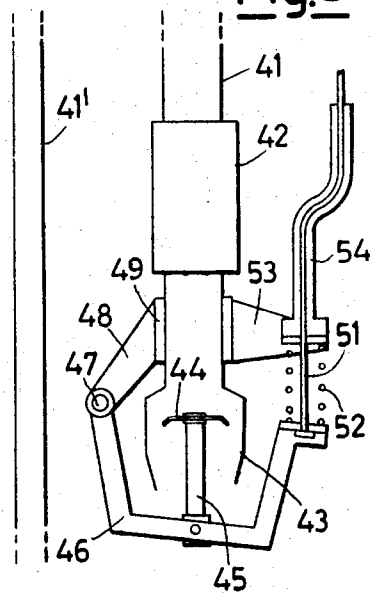


Fig.6

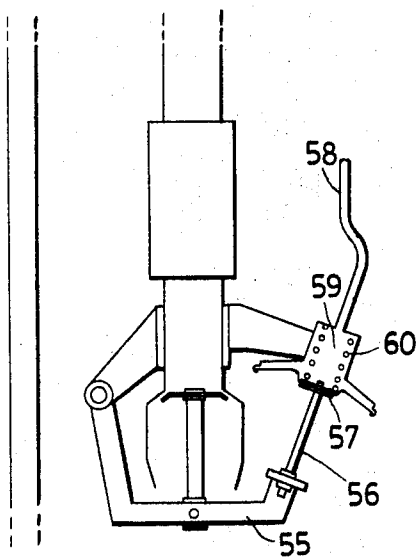
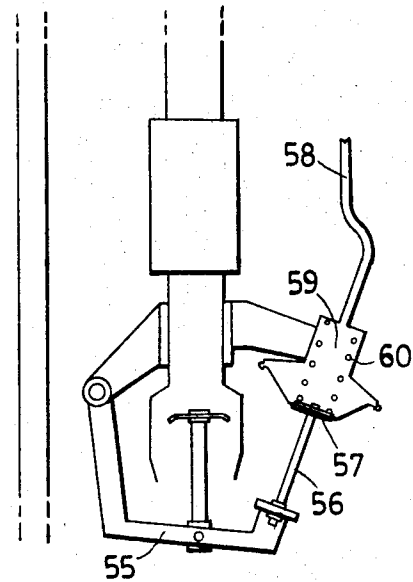


Fig.7



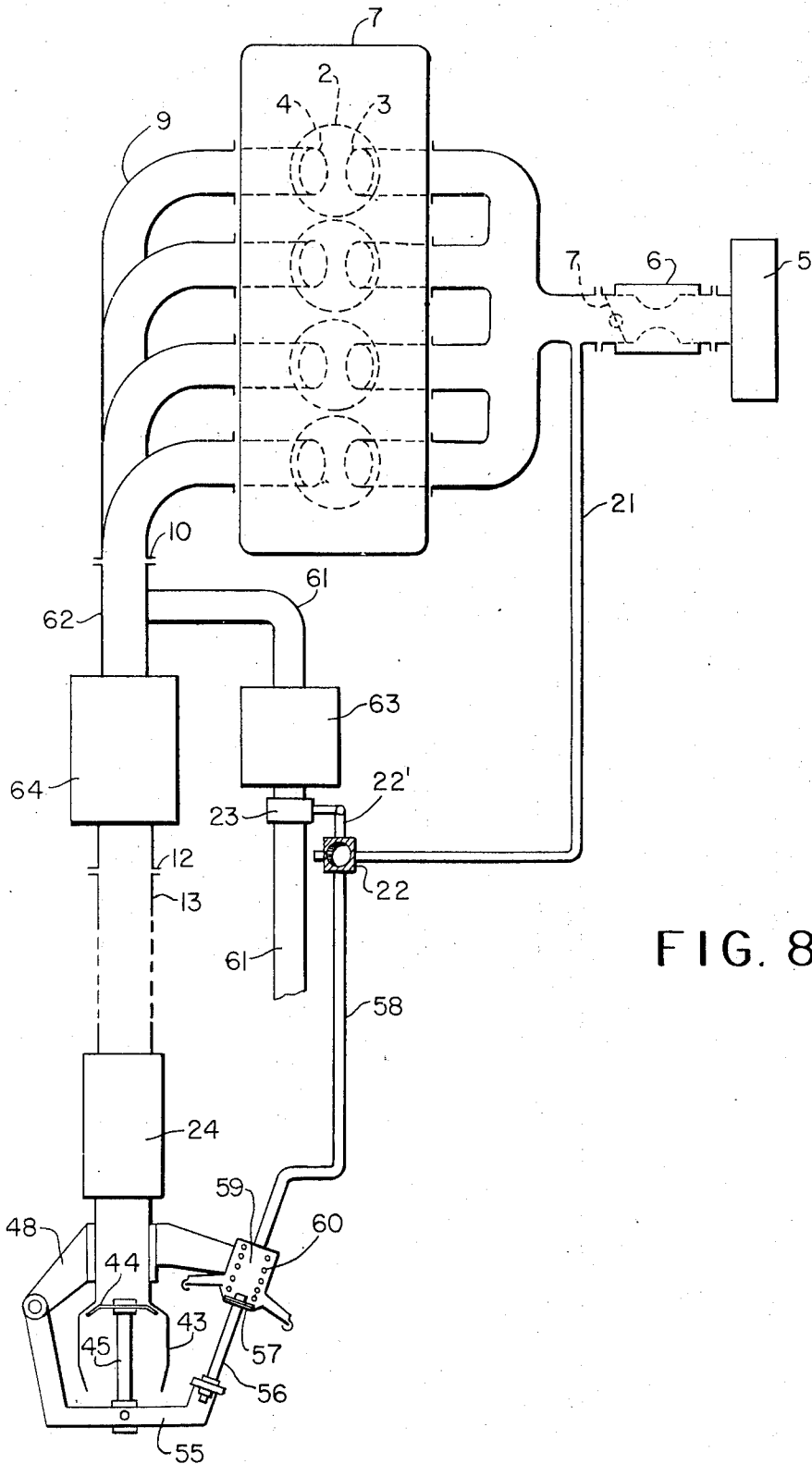


FIG. 8

DEVICE FOR THE POST-COMBUSTION OF THE UNBURNT SUBSTANCES IN THE EXHAUST GASES OF THE INTERNAL COMBUSTION ENGINE OF A MOTOR VEHICLE

BACKGROUND OF THE INVENTION

This invention relates to means for the post-combustion of the unburnt substances in the exhaust gases of an internal combustion engine for a motor vehicle.

PROBLEM AND PRIOR TECHNIQUES

It is well known that the quantity of unburnt and hence polluting gases emitted with the exhaust gases of the internal combustion engine of a vehicle can be reduced by designing and adjusting the motor in such a manner that the combustion inside the explosion chamber, at least during the most important working stages from the pollution point of view, is as near perfect and complete as possible. A further diminution in the unburnt substances emitted with the exhaust gases can, however, only be obtained by recourse to further combustion of the unburnt substances per se in a suitable post-combustion chamber disposed in the exhaust system of the engine, and hence traversed by the gases before discharge to the atmosphere. This solution, however, gives rise to considerable difficulties deriving from the fact that the range of power requirements of the engine when working is very extensive, and hence the flow range of burnt gas emitted by the motor is very wide. A post-combustion chamber sized for maximum flow would be too large for lesser flows, at which its efficiency would be low and the time required for reaching temperatures suitable for post-combustion would be excessive.

The smaller gas flows are also those which correspond to the use of the vehicle in town, where the problem of pollution is obviously much more important.

On the other hand, a small chamber sized for optimum operation at lower gas flows exerts an excessive back pressure, giving rise to excessive power losses when traversed by high gas flows (corresponding to maximum power) and it overheats to the point of becoming damaged and losing efficiency.

Thus the conventional solution was reached which consists of the use of a branch in the exhaust pipe, so that the gas, by means of the automatic operation of a valve, is entirely fed when the engine is working at lower power to the post-combustion chamber, while at greater working power it entirely or largely follows the second path, by passing the combustion chamber. In these conventional solutions, the discharge pipe becomes a single pipe downstream of the zone in which the post-combustion chamber is inserted. These solutions also give rise to considerable difficulties, however. It is known that post-combustion takes place more easily the higher the inlet temperatures of the gases to the chamber. Because of this in the conventional solutions, the chamber is inserted in the exhaust pipe as near as possible to the engine, and thus the valve for the branching of the gas flow is also inserted in a zone in the pipe which is very hot. This situation leads to difficulties regarding the necessity of using materials resistant to heat and hence costly, but more especially to the probability of self-welding, blocking and generally of hardening of the kinematic couplings of

the valve per se, such as pivots, guides, etc., thereby compromising its regular operation.

SUMMARY OF THE INVENTION

The device according to the present invention proposes to obviate these difficulties by disposing the post-combustion chamber in a zone near the engine, in which the high temperatures of the gases favor its operation, while disposing the shut-off valve in a terminal zone of the exhaust pipe in which the lower temperatures permit a less costly construction and reliable operation of the valve.

The device is firstly based on the fact (confirmed experimentally) that along the exhaust pipework there is a considerable dispersion of heat to atmosphere when working, so that the temperature of the gases diminishes decidedly along the pipework.

The device is further based on the consideration that very small passage cross sections of the exhaust gases (and consequently dimensions and weight of pipes) correspond to low working powers, for equal speeds and hence equal pressure drops. It is also based on the fact that at said the low working powers, higher gas speeds in the pipes and hence higher pressure drops are quite acceptable, because power losses due to the lower filling are obviously recoverable by means of a somewhat larger opening of the engine throttle valve. From these double considerations, it has been found possible and advantageous to provide a device comprising a main exhaust pipe and supplementary exhaust pipe disposed parallel to the main pipe, a shut-off valve disposed in the terminal section of the main pipe, while in the supplementary exhaust pipe a chamber is inserted for the further combustion of the unburnt components in the exhaust gas leaving the engine, with the shut-off valve being operated automatically during working of the vehicle in the sense that a high engine working powers and/or high gas temperature in the post-combustion chamber, the valve is open while at lower engine working powers and/or lower gas temperature in the post-combustion chamber, the valve is closed.

In this way the shut-off valve in the main exhaust pipe can be disposed, as stated, in the terminal zone where the gases are already cold, while the post-combustion chamber can be disposed in the supplementary exhaust pipe in the initial zone where the gases are still hot.

In order that the gases arrive at the chamber as hot as possible, thermal insulation, for example in the form of a double wall, is advisable in the section between the motor head and chamber. This insulation, however, complex and costly especially in the initial zone where the individual exhaust pipes from the individual cylinders have not yet joined into a single pipe. A further characteristic of the device according to the invention is the provision of a branch on each of the individual exhaust pipes from the individual cylinders.

These branches, placed close to the head, allow the gas to immediately flow into the main exhaust pipe and supplementary pipe. The individual pipes, of small dimensions, join together downstream of the branches before entering the post-combustion chamber, or directly flow together in the post-combustion chamber itself. Because of the small size of these tubes between the branches and point of merger, and because of the small size of the pipe downstream of the point of merger, the provision of thermal insulation, for exam-

ple, in the form of a double wall is much facilitated. The device according to the present invention also provides a particularly simple and economical solution for the automatic operation of the shut-off valve inserted in the terminal portion of the main pipe (and also where appropriate of a valve inserted in the terminal portion of the supplementary pipe).

According to this solution, the basic impulse for the automatic operation and the energy for the operation per se are derived from the vacuum existing in the feed pipe of the engine by means of a small tube which connects said pipe to a cavity situated at the valve. A mobile wall of this cavity (membrane or piston) subjected to the vacuum and, if required, to the force of a spring mechanically operate the valve by its movement. The temperature of the gases inside and at the exit of the chamber can control a cock inserted in the tube connecting the suction duct to the cavity, and hence avoid any overheating (and corresponding damage) of the chamber.

The characteristics of the invention will be more evident by the description given by way of example with reference to the accompanying drawings in which:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a diagrammatic plan view showing the head of an internal combustion engine and the post-combustion device according to the invention; and

FIGS. 2 - 8 are details illustrating possible variations applicable to the device of FIG. 1.

DETAILED DESCRIPTION OF THE DRAWINGS

FIG. 1 shows an engine head 1 seen from above provided, with explosion chambers 2, suction valve seats 3, and exhaust valve seats 4 of the four engine cylinders shown in broken lines, a filter 5 for the air drawn in by the engine, a carburetor 6 of which a venturi and throttle valve 7 are indicated with broken lines, and a feed manifold 8. The exhaust gas leaving the individual heads flows through various pipes 9 which join together into a single pipe before a flange 10 connecting to a silencer 11. By means of a flange 12 a silencer is connected to the pipe 13 shown in the figure by partially broken lines (its length depends on the length of the vehicle; a further silencer could be inserted therein). In the terminal portion of the pipes 13, in which the gases are considerably cooled, a butterfly shut-off valve 14 is disposed and is rigid with a pivot 15 on which an operating lever 16 is keyed. By means of a rod 17, the lever 16 is controlled by a membrane 18 which moves so as to close the valve 14 when a vacuum in the cavity 19 exceeds the elastic force of the membrane or the membrane and an opposing spring 20 such as in the proposed embodiment. As the cavity 19 is connected by means of a tube 21 to the feed manifold 8, a vacuum exists in the cavity equal to that created in the feed manifold by the effect of the throttle valve 7. Thus, at low working powers and consequently moderate vacuum levels, the valve 14 is closed, whereas it is open at low or zero vacuum levels (high engine working power).

The complex consisting of the pipes 9, the silencer 11, a pipe 13 and where applicable the small end silencer 24 constitute the main exhaust device of the engine, traversed by the gases when the motor is working at medium to maximum powers. At this working power, the valve 14 is open. At low and modest working pow-

ers (use of the vehicle in town and built-up areas), the valve 14 is closed as stated, and the exhaust gases are obliged to flow through the supplementary exhaust pipe constituted in the version shown diagrammatically in FIG. 1 by individual small tubes 25 which branch from the individual pipes 9 a short distance from the engine head, by the a small manifold 26 with which the tubes 25 communicate, by a post combustion chamber 27 and a supplementary 28 through which the gases exhaust to atmosphere, the pipe 28 being of modest cross section, but of such a length that the total length of the supplementary pipe is equal to that of the main pipe, and the exit to atmosphere of the gases from the supplementary pipe can take place in the same zone as the exit from the main pipe. Because of their small size it is not difficult (in term of cost, weight and bulk) to insulate the tubes 25 and manifold 26 by surrounding them with a still air chamber in the form of a sheet metal cover. The cover can also comprise the chamber 27 and pipes 9 if required.

If the temperature of the gases in the post-combustion chamber (and consequently also at its exit) is too high and dangerous for the safety of the chamber a temperature sensitive element, indicated diagrammatically with reference numeral 23, directly or indirectly operates a lever 22' controlling a three way cock, shown with reference numeral 22 in one of its possible embodiments, inserted in the tube 21, so as to diminish or annul the vacuum in the cavity 19. The valve 14 in this case opens.

FIG. 2 shows a possible variation of the final section of the two exhaust pipes. In the design shown in FIG. 2, which for the rest is the same as that shown in FIG. 1, the supplementary exhaust pipe does not flow directly to atmosphere in that its terminal portion 30 opens into a pipe 31, which is the terminal portion of the main pipe, downstream of a shut-off valve 32 and upstream of a possible small silencer 33 (corresponding to the valve 14 and silencer 24 respectively of FIG. 1).

FIG. 3 shows a further variation of the device. A membrane 34 (corresponding to the membrane 18 of FIG. 1) operates not only a valve 37 by means of a rod 35 and lever 36 (corresponding respectively to the valve 14, rod 17 and lever 16 of FIG. 1) but also operates by means of a rod 38 and lever 39 a small shut-off valve 40 for the flow of gas through the supplementary pipe. The connection between the two valves is such that when one opens the other closes. The closing of the valve 40 can be made incomplete if during operation at high working power the post-combustion chamber is required to be maintained hot by a certain passage of gas and consequently ready to operate as soon as the engine passes to modest working powers. The shut-off valve in the main exhaust pipe is shown in FIGS. 1, 2 and 3 as a valve of the butterfly type. According to the present invention, the valve being positioned towards the end of the exhaust pipe should be swept by gas which is already fairly cold. However disadvantages could equally arise at the pivots of the valve. High wear or even seizure are favored by the high temperature and presence of exhaust gases (formation of deposits, oxidation, difficulty of lubricating the pivot-bush coupling). In order to avoid this situation, possible variations are provided for the device and are shown in the successive figures.

FIG. 4 shows a main exhaust pipe 41 and supplementary exhaust pipe 41' where they emerge to atmosphere. The possible last silencer in the main pipe is indicated by reference numeral 42. The main pipe comprises an enlargement 43 at its outlet conformed so as to constitute a conical seat for a valve 44 and thus close the pipe when the edges of the valve adhere to the conical seat. The valve 44 is rigid, by way of a rod 45 with a lever 46 pivoted at 47 to a stirrup 48 rigid, by means of a collar 49, with the main pipe 41.

The extremity of a flexible cable 51 is fixed to the extremity of the lever 46. A spring 52 acts against the extremity 50 so as to open the shut-off valve. The other extremity of the spring 52 is based in a stirrup 53 which is also rigid, by means of the collar 49, with the extremity of the main pipe. The extremity of a sheath 54 in which the flexible cable 51 slides is fixed to the stirrup 53. At the other extremity of the cable 51 and sheath 54, there is the control mechanism for opening and closing the shut-off valves. By means of this solution, the pivot 47 and corresponding bush are not exposed to the combined action of temperature and gases and their operation is consequently more regular.

FIG. 5 shows the same variation as FIG. 4, but in the showing relationship of the components when the shut-off valve is open. The sizing of the enlargement 43 and valve 44 must be such as to avoid back pressure being set up at the outlet of the main pipe when the valve is open.

FIG. 6 shows a further variation which is similar to that shown in FIG. 4 with exception that in this case the lever 55 is operated by way of a rod 56 from a membrane 57 on which the vacuum existing in the suction manifold of the motor (not shown in the figure) can act in that the manifold is connected by means of a tube 58 to a cavity 59. The force deriving from the vacuum is opposed by the action of a spring 60. In FIG. 6 the variation is shown in the closed position of the shut-off valve. In FIG. 7 the same variation is shown with the shut-off valve in the open position.

FIG. 8 shows a structural variation of the device, in which a supplementary exhaust pipe 61 branches from a main pipe 62 downstream of the zone of merger of the pipes 9 visible in FIG. 1.

The post-combustion chamber inserted in the pipe 61 is indicated 63 and a first silencer inserted in the pipe 62 with reference numeral 64. Obviously one or more shut-off valves for the exhaust gases may be disposed in the pipes and constructed as shown in the preceding figures.

What we claim is:

1. A device for discharging to the atmosphere the burnt gases of an internal combustion engine of a motor vehicle, comprising a main exhaust pipe having a terminal portion and a supplementary exhaust pipe disposed parallel to the main pipe, means defining a chamber for the further combustion of the unburnt components present in the exhaust gases of the engine, said combustion chamber being positioned in a part of the supplementary exhaust pipe in which the temperature of the exhaust gases is not far lower than the temperature of the exhaust gases issuing from the engine cylinders, a shut-off valve of the main exhaust pipe positioned in the terminal portion of the main exhaust pipe, in said portion the gas temperature being lower than the gas temperature at the outlet of the engine cylinders, said shut-off valve being of the poppet type, the

main exhaust pipe having in said terminal portion an enlargement providing a seat for the poppet valve element, whose opening and closing movements, take place as displacements along the axis of the main exhaust pipe at said terminal portion, and automatic actuating means for said shut-off valve by which said valve is opened at high engine working powers and at high temperatures of the gases in the post-combustion chamber while at low working powers and at reduced gas temperatures in said post-combustion chamber the shut-off valve is closed.

2. The device as claimed in claim 1 in which individual exhaust pipes from individual cylinders of the engine merge together into a single tube and downstream of this merger a branch is disposed permitting the gases to flow into the main pipe or the supplementary pipe.

3. The device as claimed in claim 1, in which in each individual exhaust pipe from an individual cylinder of the engine a branch is disposed permitting the gases to flow into the main pipe or supplementary pipe.

4. The device as claimed in claim 1 in which each of the two said exhaust pipes in parallel has its own individual gas outlet to atmosphere.

5. The device as claimed in claim 1 in which the shut-off valve is operated in relation to the movement of a movable surface, on which the feed pressure of the internal combustion engine acts, a container for the movable surface, the valve being opened by means of said operation at high engine working powers and closed at lower engine working powers.

6. The device as claimed in claim 5 comprising an element sensitive to the temperature of the gases leaving the chamber and a pressure regulation member inserted in a pipe connecting a suction manifold of the engine to the container of said movable surface, said element sensitive to the temperature of the gases acting on said regulation member so that the shut-off valve in the main pipe, even at low working power, is opened when the temperature of the gas leaving the chamber reaches high values.

7. The device as claimed in claim 1 in which the chamber consists of a thermal reactor.

8. The device as claimed in claim 1 in which the chamber consists of a catalytic box.

9. The device as claimed in claim 1 in which at least a first part of the supplementary exhaust pipe, contrary to the main pipe, is made of double wall stainless steel sheet.

10. A device for discharging to the atmosphere the burnt gases of an internal combustion engine of a motor vehicle, comprising a main exhaust pipe having a terminal portion and a supplementary exhaust pipe disposed parallel to the main pipe, a shut-off valve positioned in the terminal portion of the main pipe, means defining a chamber for the further combustion of the unburnt components present in the exhaust gases of the engine, said combustion chamber being positioned in a part of the supplementary exhaust pipe in which the temperature of the exhaust gases is higher than the temperature of the same exhaust gases at the terminal portion of the main pipe and hence higher than the temperature of the gases passing through the shut-off valve, and automatic actuating means for said shut-off valve by which said valve is opened at high engine working powers at high temperatures of the gases in the post-combustion chamber while at low working powers

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and at reduced gas temperatures in said post-combustion chamber the shut-off valve is closed, the main exhaust pipe comprising an enlargement at its outlet to the atmosphere which forms a tight seat for a

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plane valve comprising said shut-off valve whose opening and closing movement is essentially a traverse along the axis of the main pipe at its outlet.
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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3820328 Dated June 28, 1974

Inventor(s) Giampaolo Garcea

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

[30] Foreign Priority Document

Italian No. 30058 A/70 filed September 22, 1970

Signed and sealed this 17th day of September 1974.

(SEAL)
Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents