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(54) **REDUCING EMISSIONS FROM AN INTERNAL COMBUSTION ENGINE**

ABGASREINIGUNGSVORRICHTUNG FÜR EINE BRENNKRAFTMASCHINE

REDUCTION DES EMISSIONS D'UN MOTEUR A COMBUSTION INTERNE

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Description

Field of the invention

The present invention relates to an exhaust port of an internal combustion engine, designed with a view to improving post flame oxidation, to allow further opportunity for unburnt hydrocarbons and carbon monoxide to be oxidised by unreacted oxygen before the exhaust gases are discharged to atmosphere or supplied as so-called feed gas to a catalytic converter.

Background of the invention

The charge supplied to the combustion chamber of an engine is not fully burnt during the combustion cycle and it is known that the exhaust gases contain carbon monoxide and unburnt hydrocarbons that continue to be oxidised in the exhaust port in the vicinity of the hot exhaust valve. A probe measuring local concentrations of hydrocarbons will show a marked reduction as the gases are discharged past the exhaust valve. However, this post-flame reaction is quenched by the cold surfaces of the exhaust port and manifold and in a conventional engine is restricted to the vicinity of the exhaust valve.

There have previously been made some proposals to promote such post-flame oxidation in the exhaust port. One such proposal (see for example US-A-4 346 555) was to place an insulating liner in the exhaust port to reduce cooling of the gases and allow a longer time for the oxidation reaction to occur. Another proposal (see for example US-A-4 574 588) was to increase the exhaust gas temperature by engine management techniques, such as delaying the spark and injection timing or altering the exhaust valve timing. In a still further proposal for use during cold operation, air has been injected into each exhaust port as close as possible to the exhaust valve.

Summary of the invention

According to the present invention, there is provided an internal combustion engine in which a bluff body is supported within each exhaust port to lie in the path of the exhaust gases, which bluff body is thermally isolated from the exhaust port and is shaped to promote mixing of the gases in the exhaust port, characterised in that the bluff body serves to split the gas flow into two or more streams that follow paths of different lengths before being recombined, the difference in length between the paths resulting in mixing between gases emitted during different phases of the exhaust stroke, such that hydrocarbon rich gases emitted towards the beginning and end of the exhaust stroke are mixed with oxygen rich gases emitted towards the middle of the exhaust stroke.

The flow of exhaust gases in the exhaust ports of an internal combustion engine is not homogeneous. In-

stead, it is made up of pockets rich unburnt hydrocarbons and other pockets still containing excess air. These pockets are separated both across the cross section and along the length of the exhaust port. In conventional engines, a small degree of mixing between these pockets does occur and if this happens close enough to the exhaust valve, where the temperature is still sufficiently high, some degree of post flame oxidation can take place which helps to reduce the amount of unburnt hydrocarbons and carbon monoxide in the exhaust gases before they reach the catalytic converter.

The present invention seeks to promote the post flame reaction by improving the homogeneity of the exhaust gases, while at the same time ensuring that the gases remain at a temperature high enough to permit oxidation to take place.

Because the bluff body in the present invention is in poor thermal contact with the cooled walls of the exhaust port and exhaust manifold, it rapidly reaches the temperature of the exhaust gases leaving the combustion chamber.

Preferably, the bluff body is supported in the centre of the exhaust port, the exhaust gases passing around all sides of the body. The body may either be supported by thin radial fins or by a hollow stem mounted downstream from the exhaust manifold. The thin section of the supports serves to isolate the bluff body thermally from the exhaust port and therefore maintains the bluff body at a high temperature.

The pockets of oxygen rich gases and those with a high hydrocarbon and carbon monoxide content tend to be spaced from one another in time, that is to say along the length of the exhaust port. This is because the oxygen rich and fuel rich exhaust gas pockets are discharged at different crank angles and are emitted time sequentially from the exhaust port. Merely stirring the gases in one transverse plane in the exhaust port is not therefore sufficient to achieve good mixing and it is important to shape the bluff body to define gas flow paths having different travel times, either by having different axial velocities or by the flow path being extended so that part of the flow at any instant may be delayed to mix with the flow arriving at a later instant from the combustion chamber.

To this end, it is convenient to shape the bluff body as an Archimedes screw contained within a sleeve of smaller outer diameter than the exhaust port. The gas flow adhering to the screw will in this case follow a longer flow path than the gases passing around the body. At the interface between the two flow paths, that is behind the rim of the screw, the turbulence will cause extensive mixing between the two gas flows. Furthermore, the gases following the longer flow path will have been heated by the screw to permit a post flame reaction to take place even at a distance from the exhaust valve.

In a further embodiment of the invention, the bluff body may be hollow with the exhaust gases being diverted to flow through it and around it, the path through

the body being folded back on itself or convoluted so as to be sufficiently longer than the path around the body to permit mixing of gas pockets emitted at different times from the engine cylinder.

Initially, the bluff body must of course be heated by the exhaust gases, as is the case for a catalytic converter. However, once a post flame-reaction has commenced it will heat the bluff body and this will maintain the desired high temperature in the exhaust port.

Brief description of the drawing

The invention will now be described further, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a section through an exhaust port of an engine constructed in accordance with a first embodiment of the invention, and

Figures 2 and 3 and 4 are sections similar to that of Figure 1, showing alternative embodiments of the invention.

Detailed description of the preferred embodiments

Figure 1 shows an exhaust port 12 and a schematically represented exhaust valve 10 in its closed position. A bluff body 20 is centred in the exhaust port 12 by means of thin radial spider legs 30a, 30b that do not allow significant heat flow from the bluff body 20 to the exhaust port wall.

The body 20 in the case of Figure 1 is formed as an Archimedes screw 22 supported on a stem 32 that is mounted further downstream in the exhaust manifold. The Archimedes screw 22 is contained within a sleeve of smaller diameter than the inner diameter of the exhaust port.

The stem 32 should preferably also offer high resistance to heat flow. This may be achieved by appropriate selection of the material of the stem 32 and by minimising the heat flow cross section, for example by making the stem hollow. The heat loss through the stem is in any event kept low by its length and it is desirable to make it as long as possible.

The bluff body 20 is required to reach a high temperature and to promote mixing of the gases. To assist it in reaching and maintaining a high temperature it is desirable for the bluff body to have a low thermal capacity and to be well isolated thermally from the exhaust port. It is advantageous for the body to be made of a metal so that heat can be distributed over its length and the heat may be stored throughout its body. It is alternatively possible however for the bluff body to be formed of a ceramic material.

The shape of the bluff body illustrated in Figure 1 achieves improved mixing both across and along the exhaust port 12. The gases that enter the bluff body at its

intake end 24 and leave through its discharge end 26 follow a helical path around the screw 22 and take longer to cover this path than the gases that pass between the bluff body 20 and the inner wall of the exhaust port, while remaining in good thermal contact with the bluff body. This promotes mixing between gases emitted at different times from the combustion chamber and ensures a sufficiently high temperature in the exhaust gases to achieve a post flame reaction. This reaction is itself exothermic and further assists in heating the bluff body 20.

The embodiments of Figures 2 and 3 also rely on splitting off and delaying part of the flow while avoiding turbulence. The travel time difference between the two flows is sufficient to cause the small pockets of high hydrocarbon concentration that leave the combustion chamber immediately after the exhaust valve opens (caused by leakage of the valves and crevices near the valve seat) and immediately before it closes (caused by crevices around the piston crown) to mix with oxygen rich gases emitted from the centre of the combustion chamber. This delay is introduced in Figures 2 and 3 by making the gases flowing through the interior of the bluff body follow a folded over or convoluted path that is longer than the path followed by the gases flowing around the bluff body.

In Figure 2, the bluff body 120 has an opening 124 at its end facing the exhaust valve 10. This opening 124 directs part of the exhaust gases to flow up a duct 122 and then to flow in the reverse direction through the annular space between the duct 122 and the interior surface of the bluff body 120, before exiting at apertures 126 and mixing with the gases flowing around the bluff body 120. The shape and position of the aperture 124 create a positive pressure in the bluff body while the apertures 126 can be designed to generate a negative pressure so that a pressure difference is created by the gas flow to cause part of the gases to follow the longer path through the bluff body. Deflectors may be provided to cause the gases to follow a helical path within the bluff body and thereby increase the delay time of the diverted gases.

Figure 3 achieves a similar result to the embodiment of Figure 2 while using a simpler design of hollow bluff body 130. In this case, the bluff body 130 is not internally partitioned and only has intake and discharge scoops 134 and 136 strategically positioned on its outer surface to create a positive pressure near its end remote from the exhaust valve 10 and a negative pressure near its end close to the exhaust valve, thereby causing the recirculating flow represented by the arrows in the drawing.

The bluff bodies in Figures 2 and 3 should be supported in a similar manner to the body of Figure 1 to avoid heat losses from the bodies and ensure that they reach and remain at the same temperature as the exhaust gases in order to promote the desired post flame reaction.

Claims

1. An internal combustion engine in which a bluff body (22,120,130) is supported within each exhaust port (12) to lie in the path of the exhaust gases, which bluff body is thermally isolated from the exhaust port (12) and is shaped to promote mixing of the gases in the exhaust port, characterised in that the bluff body (22,120,130) serves to split the gas flow into two or more streams that follow paths of different lengths before being recombined, the difference in length between the paths resulting in mixing between gases emitted during different phases of the exhaust stroke, such that hydrocarbon rich gases emitted towards the beginning and end of the exhaust stroke are mixed with oxygen rich gases emitted towards the middle of the exhaust stroke. 5
2. An internal combustion engine as claimed in claim 1, wherein the bluff body (22,120,130) is supported in the centre of the exhaust port (12), the exhaust gases passing around all sides of the body. 10
3. An internal combustion engine as claimed in claim 2, wherein the body is centred in the exhaust port by thin radial spider legs (30a,30b). 15
4. An internal combustion engine as claimed in any preceding claim, wherein the bluff body is supported by means of a stem (32) mounted further downstream from the exhaust port (12) in the exhaust manifold. 20
5. An internal combustion engine as claimed in any preceding claim, wherein the bluff body includes an Archimedes screw contained with a sleeve smaller outer diameter than the exhaust port. 25
6. An internal combustion engine as claimed in any one of claims 1 to 4, wherein the bluff body is formed as a hollow body through which some of the exhaust gases are diverted. 30
7. An internal combustion engine as claimed in claim 6, wherein the bluff body has intake (134) and discharge (136) scoops, the intake scoops (134) being positioned further away from the exhaust valve than the discharge scoops (136) so as to cause partial recirculation of the exhaust gases through the interior of the bluff body. 35
8. A internal combustion engine as claimed in claim 6, wherein the bluff body has an intake aperture (124) facing the exhaust valve and is internally partitioned by a duct such that the gases diverted to flow through the interior of the bluff body follow a convoluted path, defined by the duct and the annular space between the outer surface of the duct and the 40

inner surface of the bluff body, before being discharged to mix with the gases flowing around the bluff body.

Patentansprüche

1. Ein Verbrennungsmotor, in dem ein stumpfer Körper (22, 120, 130) in jedem Auspuffkanal (12) gehalten wird, um im Strömungspfad der Abgase zu liegen, wobei dieser stumpfe Körper thermisch von dem Auspuffkanal (12) isoliert ist und durch dessen Form das Vermischen der Gase in dem Auspuffkanal gefördert wird, dadurch gekennzeichnet, daß der stumpfe Körper (22, 120, 130) dazu dient, den Gasstrom in zwei oder mehr Ströme aufzuteilen, die Wege unterschiedlicher Länge zurücklegen, bevor sie wieder zusammengeführt werden, wobei die unterschiedliche Länge der Wege zur Vermischung von Gasen führt, die zu unterschiedlichen Phasen des Auspuffhubs ausgestoßen wurden, so daß kohlenwasserstoffreiche Gase, die gegen Anfang und Ende des Auspuffhubs ausgestoßen werden, mit sauerstoffreichen Gasen vermischt werden, die in der Mitte des Auspuffhubs ausgestoßen werden. 45
2. Ein Verbrennungsmotor nach Anspruch 1, in dem der stumpfe Körper (22, 120, 130) in der Mitte des Auspuffkanals (12) gehalten wird, so daß die Abgase den stumpfen Körper an allen Seiten umströmen. 50
3. Ein Verbrennungsmotor nach Anspruch 2, in dem der Körper in dem Auspuffkanal durch dünne, radiale Spinnenbeine (30a, 30b) zentriert wird. 55
4. Ein Verbrennungsmotor nach irgendeinem der vorhergehenden Ansprüche, in dem der stumpfe Körper mittels eines Schafts (32) gehalten wird, der weiter hinter dem Auspuffkanal (12) in dem Auspuffkrümmer angebracht ist.
5. Ein Verbrennungsmotor nach irgendeinem der vorhergehenden Ansprüche, in dem der stumpfe Körper eine archimedische Schraube in einer Hülse mit geringerem äußeren Durchmesser als der Auspuffkanal einschließt.
6. Ein Verbrennungsmotor nach irgendeinem der Ansprüche 1 bis 4, in dem der stumpfe Körper als hohler Körper gebaut wird, durch den ein Teil der Abgase geleitet wird.
7. Ein Verbrennungsmotor nach Anspruch 6, in dem der stumpfe Körper Einlaßschaufeln (134) und Auslaßschaufeln (136) aufweist, wobei die Einlaßschaufeln (134) weiter von dem Auslaßventil entfernt sind als die Auslaßschaufeln (136), so daß

die Abgase teilweise durch das Innere des stumpfen Körpers zurückgeleitet werden.

8. Ein Verbrennungsmotor nach Anspruch 6, in dem der stumpfe Körper eine dem Auslaßventil zugewandte Einlaßöffnung (124) aufweist und im Inneren durch eine Rohrleitung unterteilt wird, so daß die in das Innere des stumpfen Körpers abgeleiteten Gase, bevor sie entladen werden, entlang einem gewundenen Weg strömen, der durch die Rohrleitung und den ringförmigen Raum zwischen der äußeren Oberfläche der Rohrleitung und der inneren Oberfläche des stumpfen Körpers abgegrenzt wird, um sich dann mit den Gasen zu vermischen, die um den stumpfen Körper strömen.

Revendications

1. Moteur à combustion interne dans lequel un corps camus (22, 120, 130) est monté à l'intérieur de chaque orifice d'échappement (12) de façon à se trouver sur le trajet des gaz d'échappement, lequel corps camus est isolé thermiquement de l'orifice d'échappement (12) et présente une forme qui favorise le mélange des gaz dans l'orifice d'échappement, caractérisé en ce que le corps camus (22, 120, 130) sert à diviser le courant de gaz en deux ou plusieurs flux qui suivent des trajets de longueurs différentes avant de se recombiner, la différence de longueur entre les trajets résultant en un mélange entre des gaz émis pendant des phases différentes de la course d'échappement, de sorte que les gaz riches en hydrocarbures émis vers le début et la fin de la course d'échappement sont mélangés avec les gaz riches en oxygène émis vers le milieu de la course d'échappement.
2. Moteur à combustion interne selon la revendication 1, dans lequel le corps camus (22, 120, 130) est monté dans le centre de l'orifice d'échappement (12), les gaz d'échappement passant autour de tous les côtés du corps.
3. Moteur à combustion interne selon la revendication 2, dans lequel le corps est centré dans l'orifice d'échappement par de fines pattes d'araignée radiales (30a, 30b).
4. Moteur à combustion interne selon l'une quelconque des revendications précédentes, dans lequel le corps camus est supporté au moyen d'une tige (32) montée plus loin en aval de l'orifice d'échappement (12) dans le collecteur d'échappement.
5. Moteur à combustion interne selon l'une quelconque des revendications précédentes, dans lequel le corps camus comprend une vis d'Archimède conte-

nue à l'intérieur d'un manchon de plus petit diamètre extérieur que l'orifice d'échappement.

6. Moteur à combustion interne selon l'une quelconque des revendications 1 à 4, dans lequel le corps camus prend la forme d'un corps creux à travers lequel une partie des gaz d'échappement est déviée.
7. Moteur à combustion interne selon la revendication 6, dans lequel le corps camus comporte des cuillers d'admission (134) et d'évacuation (136), les cuillers d'admission (134) étant positionnées plus loin de la soupape d'échappement que les cuillers d'évacuation (136) de manière à provoquer une recirculation partielle des gaz d'échappement à travers l'intérieur du corps camus.
8. Moteur à combustion interne selon la revendication 6, dans lequel le corps camus comporte une ouverture d'admission (124) faisant face à la soupape d'échappement, et est cloisonné intérieurement par un conduit de sorte que les gaz déviés de façon à s'écouler à travers l'intérieur du corps camus suivent un trajet convoluté, défini par le conduit et l'espace annulaire défini entre la surface externe du conduit et la surface interne du corps camus, avant d'être évacués afin de se mélanger avec les gaz s'écoulant autour du corps camus.

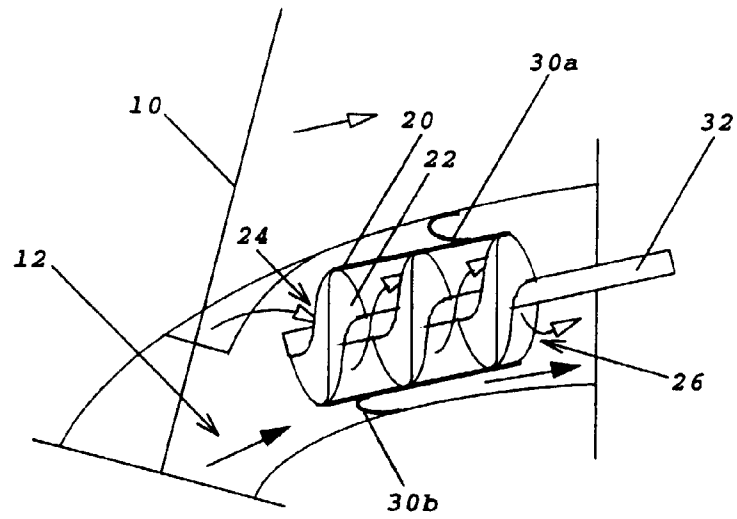


Fig. 1

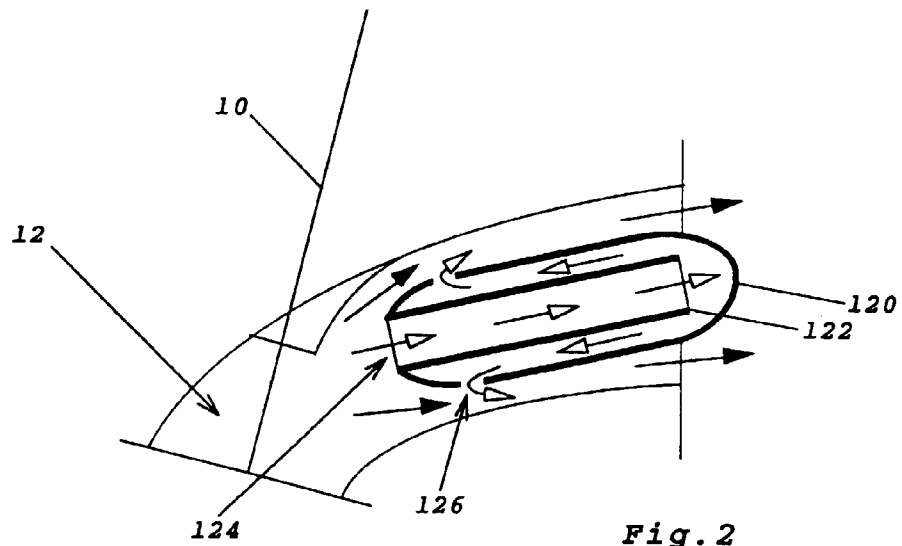


Fig. 2

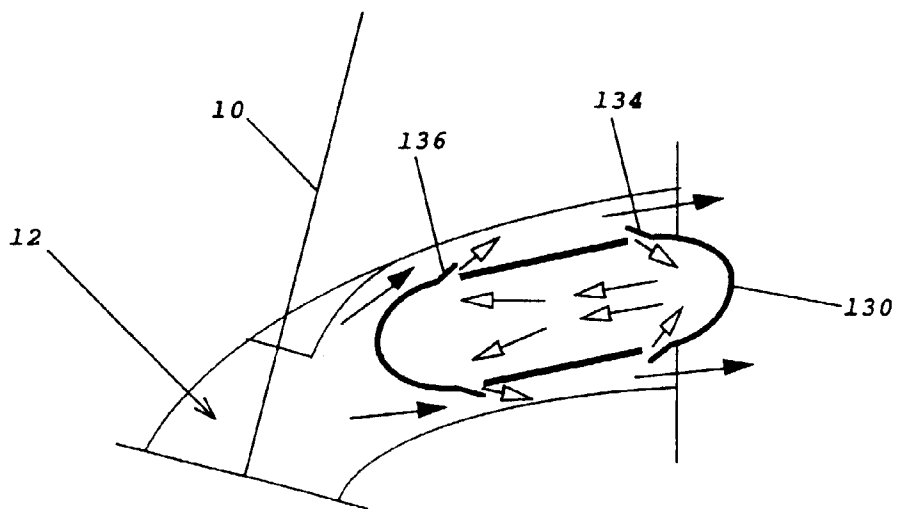


Fig. 3