VACUUM ADVANCE CONTROL SYSTEM

Inventors: Milford M. Scott, Jr., Las Vegas, Nev.; Floyd J. Wheeler, Jr., Marina Del Rey, Calif.

Assignee: STP Corporation, Ft. Lauderdale, Fla.

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Field of Search .................. 123/117 A, 146.5 A

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ABSTRACT

The amount of pollutants expelled from an internal combustion engine is lowered by bleeding a predetermined amount of ambient air into the conduit which connects a conventional vacuum advance control system with the intake manifold. This results in a retardation of the vacuum advance that otherwise would be obtained and provides a considerable reduction in oxides of nitrogen, CO and hydrocarbons. The vacuum advance bleed control comprises a conduit inserted into the vacuum advance line of an internal combustion engine, with a characterized bleed hole in the conduit, and filter medium for preventing dirt from entering the bleed hole. Flanges on the conduit hold the filter in position and an annular recess is provided in the conduit over the bleed hole. An orifice may be provided in the conduit between the bleed hole and the carburetor.

9 Claims, 3 Drawing Figures
VACUUM ADVANCE CONTROL SYSTEM

RELATED APPLICATION

This application is an improvement over the subject matter disclosed and claimed in the copending application of Milford M. Scott, Jr. (Case No. 72,782) filed even date herewith.

BACKGROUND OF THE INVENTION

The invention relates to a vacuum advance control system to lower the amount of pollutants such as NO₂, CO and hydrocarbons expelled from an internal combustion engine.

In an internal combustion engine, it is known to control cylinder spark by a vacuum advance mechanism. For example, when an engine is operating under part throttle, (such as in cruise mode) a partial vacuum is created in the intake manifold. This results in a leaner air-fuel mixture being admitted to the cylinder in comparison to an idling condition, thereby lowering the volumetric efficiency of the engine because of a lower compression of the air-fuel mixture. This leaner air-fuel mixture burns more slowly in the cylinder when ignited. Therefore, to realize full power from the engine, the cylinder spark must be advanced in response to the vacuum created in the inlet manifold.

A typical vacuum advance mechanism used on conventional contact-point distributors contains a spring-loaded, air-tight diaphragm connected by a linkage, or lever to a breaker plate in the distributors. The breaker plate is supported on a suitable bearing so that it can turn with respect to the distributor housing.

The spring loaded side of the diaphragm is connected through a suitable vacuum line or conduit to an opening in the carburetor which, in turn, communicates with the intake manifold. Typically, an engine operating under full vacuum control will have two openings in the carburetor which communicate with the vacuum conduit. One outlet is positioned in the venturi of the carburetor with the other outlet positioned on the atmospheric side of the throttle valve whe the throttle is in an idling position. At this idling position, there is little or no vacuum advance on the distributor since there is little flow of air, etc. through the carburetor venturi.

However, as soon as the throttle is opened, it swings past the opening to the vacuum passage communicating with the vacuum conduit and distributor diaphragm and, simultaneously, air speed through the venturi increases. As a consequence, the intake-manifold vacuum draws air from the vacuum conduit and the air tight chamber in the vacuum advance distributor mechanism, causing the diaphragm to move against the spring. This movement causes the breaker plate to rotate so that the cam, as it rotates, closes and opens the points earlier in the compression stroke of the engine. Consequently, the spark appears earlier in the compression stroke.

While utilizing a vacuum advance control system, either as the sole advance control system or in combination with a centrifugal advance control system, produces improved operating characteristics in an internal combustion engine, it has been discovered that the engine produces excessive amounts of undesirable emissions expelled as exhaust, such as carbon monoxide (CO), hydrocarbons and various nitrogen oxides (NO₂). The present emphasis in solving automotive emission problems is primarily directed at removing the pollutants from the exhaust by the use of special reactors and mufflers. Frequently, expensive catalytic mufflers are proposed to convert the pollutants to inert compounds. In addition, these catalytic mufflers often require that conventional metallic anti-knock agents such as lead alkyls be removed from the fuel to prolong the life of the catalyst. Thus, it is seen that concerted efforts are being taken to clean up undesirable emissions after they are formed.

SUMMARY OF THE INVENTION

It is an object of this invention to develop a system to control the formation of undesirable automotive emissions.

It is another object of this invention to provide an improved vacuum advance control system that results in the formation of lesser amounts of undesirable automotive emissions.

It is a specific object of this invention to provide means for modifying existing vacuum advance control systems to lower the amount of undesirable pollutants in the exhaust of an internal combustion engine.

It has been discovered that in a conventional vacuum advance control system, particularly a full vacuum advance control system, the vacuum created in the intake manifold and the carburetor, advances the cylinder spark too far in the sense that if the advance is retarded a small amount, there is no visible effect on the operation of the engine but there results an appreciable decline in the amounts of noxious emissions such as NO₂, CO and hydrocarbon expelled in the exhaust from the engine. This retardation of the spark advance can be obtained by bleeding in a predetermined amount of ambient air into the vacuum conduit connecting the intake manifold and the vacuum control mechanism in the distributor. This results in a reduction of the vacuum (i.e., a higher absolute pressure) within the conduit and reduces the spark advance that otherwise would be obtained. Preferably, the vacuum in the vacuum conduit is lowered (i.e., absolute pressure raised) about 10 percent to 40 percent. This insures that there is no substantial interference in the operating characteristics of the engine but there is still obtained a substantial reduction (i.e., 5 percent to 20 percent) in the total amount of CO, NO₂ and hydrocarbons expelled in the exhaust.

The vacuum in the vacuum conduit can be lowered by bleeding air through the otherwise air tight diaphragm controlling the advance in the distributor or by bleeding air through a suitable predetermined opening in the conduit per se. Preferably, the vacuum bleed means comprises a second conduit, having at least one predetermined opening therein communicating with the ambient air, positioned in the vacuum conduit connecting the intake manifold through the carburetor to the distributor. The opening is positioned in an annular recess in the conduit. A filter medium is positioned over the opening to prevent dirt particles from obstructing the opening. Flanges retain the filter medium in place over the recess and opening and also prevent the original conduit means from being installed over the bleed orifice itself. When required, an orifice can be provided in the second conduit disposed between the said predetermined opening and the carburetor.
This means allows the conversion of existing vacuum advance control systems.

Other objects, embodiments and a more detailed description of the present invention will become apparent by reference to the following description of the invention.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a perspective view of a bleed orifice to bleed air into the vacuum conduit connecting the carburetor and the distributor;

FIG. 2 is a detailed, enlarged view of the bleed orifice taken along section line 2—2 of FIG. 1; and

FIG. 3 is a detailed, enlarged view of a specific design for the bleed orifice illustrated in FIG. 2.

DETAILED DESCRIPTION OF THE INVENTION

Referring first to FIG. 1, there is illustrated a conventional, multi-cylinder internal combustion engine 1 equipped with a carburetor 2, a distributor 7 and an air cleaner 3 positioned on top of carburetor 2. Engine 1 is equipped with a conventional, full vacuum advance control system comprising a flexible rubber conduit 6 connecting opening 5 in meter block 4 of carburetor 2 with outlet 12 in diaphragm housing 8. Diaphragm housing 8 encloses an air tight diaphragm 11 which is connected to diaphragm lever 9. Advance mechanism 10 is in turn connected to diaphragm 11 through diaphragm lever 9. As indicated, the vacuum advance control system is a conventional system wherein diaphragm 11 moves in response to the vacuum created in the intake manifold of the engine. The movement of diaphragm 11 is transmitted through lever 9 to advance the spark advance mechanism 10 thereby advancing the cylinder spark to an earlier portion of the compression cycle.

Metering orifice means 13 is positioned in vacuum conduit 6 and allows a predetermined amount of ambient air to enter conduit 6 thereby retarding the vacuum advance that would be otherwise obtained at a given engine speed. This, in turn, substantially lowers the amount of pollutants in the engine's exhaust without noticeably interfering with the performance of the engine. Preferably, sufficient ambient air enters orifice means to lower the vacuum (i.e., raise the pressure) about 10 percent to 40 percent.

Metering orifice means 13 is illustrated in greater detail in FIG. 2. In particular, orifice means 13 is a metallic or otherwise rigid conduit 15 positioned in the interior of conduit 6. Suitable ridges (not shown) may be placed on the extreme ends of conduit 15 to help interconnect conduit 15 with vacuum conduit 6. Ambient air enters orifice means 13 through an orifice opening 16 to lower the vacuum in vacuum conduit 6. The amount of air that enters conduit 6 via conduit 15 is a function of the area of the orifice opening or openings 16 in conduit 15. In turn, the total area of the opening 16 is a function of the vacuum advance curve to which the orifice means 13 is applied.

The area of the bleed hole depends on the diaphragm design in the spark advance control mechanism. Some diaphragms are designed to advance the spark to maximum at 18 inches mercury (Hg), whereas other diaphragms are designed to reach maximum advance at only 10 inches mercury (Hg). The bleed hole size depends on the diaphragm design, i.e., the amount of vacuum required to actuate the diaphragm to advance the spark to full advance. When the diaphragm is designed to reach full advance with 10 inches of mercury, the bleed orifice must be larger than the bleed orifice used when the diaphragm is designed to reach full advance at 18 inches mercury.

Following are some examples of this principle, (using a single bleed hole or opening 16), for obtaining about a 10–40 percent reduction in vacuum conduit 6 as a function of distributor vacuum controlled spark advance designs.

<table>
<thead>
<tr>
<th>Inches Mercury Required to Reach Full Spark Advance</th>
<th>Bleed Hole Size (inches diameter)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>0.035</td>
</tr>
<tr>
<td>15</td>
<td>0.042</td>
</tr>
<tr>
<td>20</td>
<td>0.045</td>
</tr>
<tr>
<td>25</td>
<td>0.055</td>
</tr>
<tr>
<td>30</td>
<td>0.065</td>
</tr>
</tbody>
</table>

The number of openings present in conduit 15 can vary with one opening being preferred for ease of manufacture and quality control. Further, conduit 15 could be a porous sintered conduit where the total porous area is sufficient to allow the predetermined amount of air to enter conduit 16.

Ordinarily, the area of opening 16 is relatively small and may be subject to occlusion by dirt and grease particles. Accordingly, filter medium 14 is placed over metallic conduit to prevent dirt etc. from plugging the opening and otherwise interfering with the entry of ambient air to conduit 6. Preferably, filter medium 14 is foam or sponge rubber, although a suitable paper filter can be used.

Tabulated below is an illustrative example of the benefits to be obtained by the placement of an orifice bleed means in the vacuum advance line of a conventional engine. The engine is a 250 CID, 155, HP engine with a single venturi barrel carburetor. The spark advance is under a combined centrifugal and vacuum control. The area of the opening in the orifice means was 0.042 inches and lowered the vacuum in the vacuum conduit as described above. The results obtained, both with and without the orifice bleed means are tabulated in Table II.

<table>
<thead>
<tr>
<th>TABLE II</th>
</tr>
</thead>
<tbody>
<tr>
<td>WITHOUT BLEED</td>
</tr>
<tr>
<td>CO, PPM</td>
</tr>
<tr>
<td>NO₂, PPM</td>
</tr>
<tr>
<td>Hydrocarbons, PPM</td>
</tr>
</tbody>
</table>

A presently preferred orifice means construction is illustrated in FIG. 3. In FIG. 3, conduit 15 is provided with a pair of annular raised ribs or flanges 17 spaced on either side of opening 16. These flanges serve to hold filter 14 in position and prevent the ends of conduit 6 from sliding and covering opening 16, thereby interfering with the operation of orifice means 13. As illustrated in FIG. 3, raised ribs or flanges 17 are provided by a washer or bushing that is concentrically placed on conduit 15 and suitably affixed thereto by friction, welding, or the like. Alternatively, the raised ribs or flanges can be formed or cast or molded integrally with the conduit 15 or by longitudinal compression of conduit 15.

In FIG. 3, opening 16 is positioned in annular recess 18, to provide sufficient free area around opening 16.
so that filter media 14 is not in direct contact with the opening. This is necessary because the opening 16 in conduit 18 is usually so small that the material from which filter 14 is manufactured is often of the same relative size as opening 16. Therefore, when opening 16 is positioned in recess 18, filter medium 14 will not interfere with the passage of air to the opening. Preferably, for ease of construction and enhanced air flow, recess 18 extends around the entire circumference of conduit 15.

Orifice 20 is included in conduit 15 to prevent excessive flow of fresh air into the carburetor/intake manifold by creating a pressure drop to prevent excessive leaning of the air-fuel mixture. The orifice wall 21 must be between opening 16 and the carburetor.

There has been provided by the present invention an improved vacuum advance control that can be used in a vacuum only advance system or a centrifugal/vacuum advance. It is not suited for a centrifugal only system. Significant reductions in the amounts of exhaust emissions have been noted, on the order of 5 to 15 percent for HC, 5 to 10 percent for CO and 10 to 20 percent for NOx.

While we have described and illustrated a preferred embodiment of our invention, it should be understood that our invention is not limited thereto, since it may be otherwise embodied within the scope of the following claims.

What is claimed is:

1. Means for bleeding air into a vacuum advance line of an internal combustion engine including a distributor with a vacuum diaphragm which comprises:
   a. a conduit adapted to be inserted into the vacuum advance line;
   b. an opening in the wall of said conduit to allow ambient air to pass into the interior of the conduit, said opening being of an area related to the design of the vacuum diaphragm;
   c. a filter medium positioned over said opening to prevent dirt particles from obstructing the opening;
   d. said opening in a recess in the wall of said conduit to space the opening apart from the filter medium; and
   e. flange means positioned on said conduit either side of said filter medium for holding the filter in position over the opening and recess, and preventing the ends of the original vacuum advance line from sliding and covering the opening.

2. Bleeding means as in claim 1 wherein said recess extends around the perimeter of the circuit.

3. Bleeding means as in claim 1 wherein said conduit contains more than one opening.

4. Bleeding means in claim 1 wherein said flange means is a raised portion extending peripherally around the circumference of the conduit and formed integrally therewith.

5. Bleeding means as in claim 1 including orifice means in the conduit separate from said opening.

6. Bleeding means as in claim 5 wherein carburetor means is included on the said engine and the orifice means is between said opening and said carburetor means.

7. Bleeding means as in claim 1 wherein the filter medium is a foam material.

8. In an internal combustion engine having a distributor with a vacuum spark advance control system to control the timing of the cylinder spark, said vacuum advance control system including the application of a vacuum from the intake manifold to an advance control in the distributor through a vacuum conduit wherein the intake manifold pressure controls the cylinder spark timing, improved means for reducing the spark advance timing, positioned in communication with said vacuum conduit, said reducing means bleeding a predetermined amount of ambient air into the vacuum conduit thereby reducing the vacuum imposed on the advance control in the distributor to lower the spark advance and reduce the amount of pollutants in the engine exhaust, said reducing means comprising a second conduit having at least one opening in the wall thereof opening to ambient air positioned in the vacuum conduit, said opening being covered by a filter media for preventing dirt particles from entering the opening, said opening being positioned in a recess in the wall of the second conduit to space the opening from the filter media, and flange means positioned on the second conduit for holding the filter media in position over the recess and opening and preventing the ends of the vacuum conduit from sliding and covering the opening.

9. An engine according to claim 8 including an orifice means in said second conduit between said opening and the source of application of the vacuum from the intake manifold.

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