

[54] SPARK TIMING CONTROL

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[58] Field of Search **123/117 A**

References Cited

UNITED STATES PATENTS

2,708,918 5/1955 Caddock 123/117 A

3,252,451 5/1966 Sarto 123/117 A
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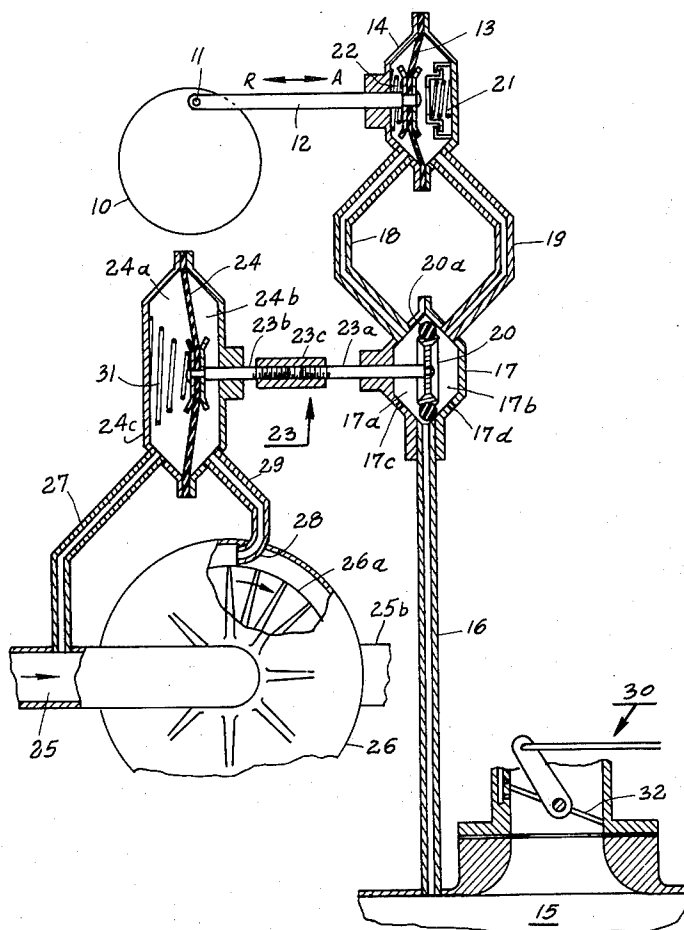
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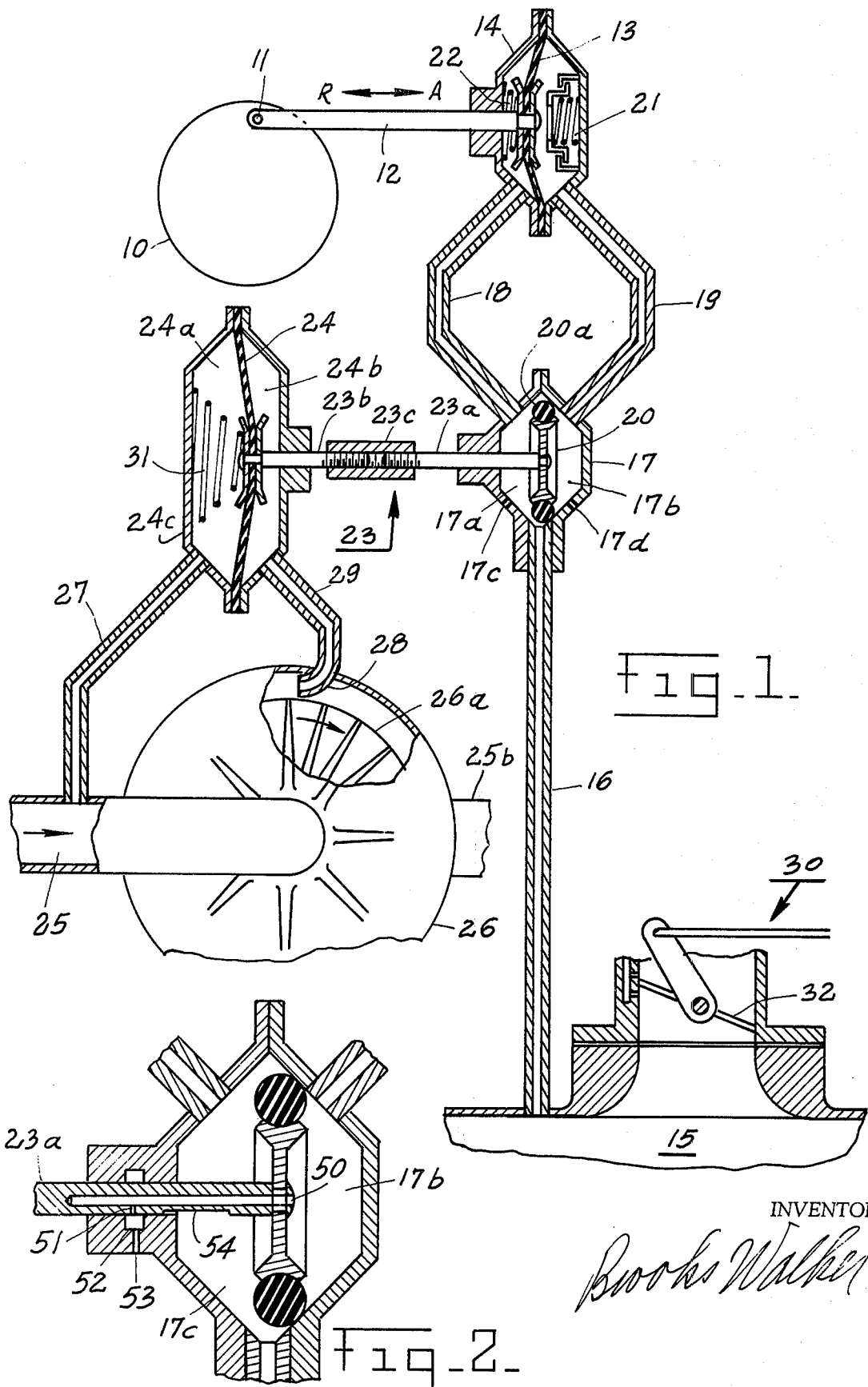
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ABSTRACT

A spark timing control for an internal combustion engine. A suction motor is connected to the timing mechanism to produce spark advance when moved in one direction and spark retard when moved in the opposite direction. The motor comprises a housing having a flexible diaphragm dividing the housing into a pair of chambers and is moved by a speed responsive valve connecting the pressure in the intake manifold to one or the other chambers.

7 Claims, 2 Drawing Figures





SPARK TIMING CONTROL

This application is a continuation of Ser. No. 593,363 filed 11/10/66 and now abandoned.

The invention relates to smog control arrangements in internal combustion engines and more particularly to ignition control devices whereby the emission of noxious by-products of combustion is reduced.

Various arrangements are known whereby the ignition spark, which is basically timed in correlation with the engine speed, and may be subjected to so called governor advances depending upon the various speed ranges, is additionally regulated according to the mode of operation, e.g. idle cruise, acceleration or deceleration, etc. Such arrangements usually comprise sensing elements which are operative to delimit periods of manifold suction operated advance, resp. retard modifications of spark timing. While known arrangements of this type are effective to accomplish various objectives, this invention is believed to offer an improvement or other advantages over known devices.

It is now proposed according to the invention that improved results may be achieved with an arrangement including a speed sensing device and a suction motor which together are operative to achieve, among other objectives, a suction operated advance when the engine decelerates above a given index speed, e.g. around 1000 rpm, and a suction operated retard when the speed lies below this index with a throttle in idle position.

It is accordingly one object of the invention to provide mechanisms whereby manifold suction may be utilized to provide special regulation of the ignition timing in a novel manner for reduced exhaust emissions during certain cycles of operation.

It is another object of the invention to provide a mechanism which will allow a shift from a suction operated ignition advance device to a suction operated ignition retard device, both of which are effected and controlled by engine developed suction, solely for the reason that the engine speed passes through a predetermined engine index speed.

It is a third object of the invention to provide mechanisms whereby aforesaid shift from suction operated advance to a suction operated retard by an engine speed sensing device may be accomplished without undue interference with other functions of the engine.

It is a fourth object of the invention to provide a mechanism of the kind described which will not be adversely affected in a significant degree by changes in barometric pressure of altitude changes. (Cf. here the attached copy of page 6 of the Chrysler Corporation pamphlet entitled "Cleaner Air package," as revised in January 1966).

It is a fifth object of the invention to provide a mechanism which will improve the starting characteristics of internal combustion engines in comparison with the operation of engines having a governor operated spark retard for idling. In applicant's device suction operated spark retard does not occur during the short cranking of a normal start as sufficient suction is not developed until the engine starts, while insuring that such suction operated retard becomes effective as soon as the engine is idling at normal warm operation.

It is another object of the invention to provide a mechanism which will prevent the actuation of the suction operated ignition to be retarded when the engine speed is abnormally low, while the throttle valve is al-

most "wide open," which results in little engine developed suction, as is common in vehicles having straight gear (stick shift) transmission while lugging without the benefit of the slip common in automatic transmissions. The lugging characteristics of an engine having a governor operated retard at idle will be less desirable than lugging with applicant's device.

It is another object of the invention to provide a mechanism which will not produce a suction operated retard while decelerating above a predetermined speed--a condition found in engines depending upon a port below the low edge of the throttle butterfly to control the suction to a suction operated retard mechanism, as shown in FIG. 2 of applicant's U.S. Pat. No. 3,162,184, issued Dec. 22, 1964, and entitled "Spark Timing Control," or to a closed-throttle operated valve between the intake manifold and a suction operated retard device, as shown in FIG. 1 of applicant's cited U.S. Pat. No. 3,162,184.

It is another object of the invention to provide a mechanism whereby a suction operated advance is activated when the engine is decelerating above the predetermined speed--a shortcoming of certain other devices (cf. applicant's cited U.S. Pat. No. 3,162,184, or as shown in Glen's 1962 Auto Repair Manual, page 360, paragraph 4-156-8), per copy attached.

It is another object of the invention to provide mechanisms for the attainment of aforesaid objects which may be utilized in connection with any internal combustion engine having an intake manifold and an ignition timing device and is adaptable to converting engines to reduced exhaust emissions.

It is another object of the invention to provide mechanisms for accomplishing the aforesaid results and whereby engine developed suction is employed solely as the source of motive energy and all discriminating functions are discharged by means independent of engine developed suction.

These and other objects of the invention and its particular advantages will become apparent from the following detailed description of its novel aspects in the context of a preferred embodiment, as illustrated in the drawings, wherein:

FIG. 1 shows a schematic plan view of one form of the invention, partly in section, partly broken away.

FIG. 2 shows a modification of a detail of FIG. 1 in larger scale, also partly in section and partly broken away.

For the sake of simplicity, the drawing has been limited to the bare essentials. Conventional routines, e.g. the joining of materials to form airtight joints or the mounting of mechanical elements, are assumed as known, and therefore neither illustrated nor described.

FIG. 1 shows a conventional distributor breaker plate 10 which is attached by a pin 11 and rod 12 to a diaphragm 13 in a housing 14. Diaphragm 13 is actuated to retard the setting of the breaker plate 10 (thus complementing the setting resulting from other devices, e.g. a governor) by suction derived from an intake manifold 15 either by a circuit including lead 16, left chamber 17a of a switch assembly 17, lead 18, with vent elements including a lead 19, right chamber 17b and vent 17d, or by an analogous circuit including lead 16, right chamber 17b, lead 19, with vent elements including lead 18, left chamber 17a and vent 17c, to advance the breaker plate 10.

It is obvious upon inspection of the drawing that the position of the shift piston 20 determines whether the diaphragm 13 will be in the retard position (as shown) or in the advance position (shift piston 20 moved to the left). It is further quite apparent that essentially the same vacuum supply powers the vacuum advance and the vacuum retard position. Less obvious is the fact that the captive spring 21 and the free spring 22, in combination, center the diaphragm 13 when there is no suction in lead 16 or suction insufficient to cause a deflection in either direction (e.g. when the throttle valve is open or nearly open or when the engine is first cranked for starting). This arrangement is particularly significant in connection with the speedsensitive discrimination discussed below. The apparent short circuit resulting from the provision of a vent in the power circuit (e.g. vent 17c in the illustrated retard circuit) poses no difficulty, as these vents are intended to be much smaller in diameter than the transferring leads (e.g. 16 and 18) so that the loss through a vent does not unduly impair the sufficiency of the suction level.

An alternative embodiment of the venting circuits is shown in FIG. 2 in which the venting is accomplished in the retard operation by means of a hole 5 and a hole 51, both in rod 23a, a groove 52 and a hole 53 in the housing 17. When the shift piston 20 is moved to the left-side position, the hole 51 moves away from the groove 52 and the cut 54 previously out of range on rod 23a enters the groove 52, thus providing the vent.

As further shown in FIG. 1, the shift piston 20, with a securely attached (e.g. bonded) sealing member 20a on its periphery, makes a relatively airtight seal with the cup-shaped walls of the switch assembly housing 17. It is shifted between the right-side extreme (shown) and its corresponding left-side extreme by means of a rod assembly 23 comprising a rod 23a and a rod 23b which are fastened in the shift piston 20, resp. a water diaphragm 24 and connected by means of a connector 23c. On account of the circular form of the shift piston 20, rod 23a may be turned to effect an accurate adjustment of the all-over length of the rod assembly 23.

The water diaphragm 24 is actuated by the differential in pressure between the water moving in an intake lead 25, which fills its left chamber 24a via a duct 27, and the water following the periphery of a rotor 26a of a water pump 26. Its effectiveness derives from the principle of the pitot tube, here shown as the end 28 of a duct 29, whereby the water following the periphery of the rotor 26 is caused to rise into the right chamber 24b of the diaphragm housing 24c. An arrangement of this type is described in full detail in applicant's U.S. Pat. No. 3,204,620 and need not be elaborated upon here.

Since the water pump is operating whenever the engine is running, even though actual circulation may be shut off at times (e.g. by a thermostat) so that there is no output in the output duct 25b, the diaphragm 24 will always be subject to a pressure differential. A spring 31 biases the diaphragm 24 for a right-side position, as shown (which keeps the shift piston 20 in the position in which the retard circuit described above is operative), and it is so calibrated that it will allow a left-side deflection of the diaphragm 24 only when the pressure in the chamber 24b has reached a predetermined level which may correspond to the aforementioned index speed of 1000 rpm. An adjustment to obtain operation within the speed range of 800-1200 rpm will probably be desirable. The left-side deflection of the diaphragm

24 will place the shift piston 20 into its left-side position, and thus activate the advance circuit, with a hysteresis which may be held negligible by proper design of the interior of switch assembly housing 17, and the parts operating within it to reduce the adverse effect of the engine effect on the piston 20 and thus activate the advance circuit. It will be obvious to those skilled in the art that the shift piston 20 could be controlled with the same effect by any other means, e.g. a fly-ball governor, or any means affording a dynamic analog of the engine speed.

The operation of the arrangement according to the invention may be described as follows:

1. During the often recurring short cranking period of a normal start, there will be no suction operated advance or retard; a recognized desideratum.

2. During idling (throttle valve 32 in carburetor 30 closed or barely cracked), assuming a normal idling speed of 500-800 rpm, there will be a suction activated retard; another desideratum.

3. In cruising above 1000 rpm, the shift piston 24 will be a suction operated advance as long as the manifold suction is strong enough to overcome the resistance of the preloaded spring 31; a third desideratum.

4. At full-throttle or "wide-open" operation, the manifold suction will be usually too low to overcome the spring 21 and there will then be no suction operated advance above the predetermined engine speed, and similarly no suction operated retard if the shift piston 20 should happen to be in the retard position (lugging), a fourth desideratum.

5. Upon deceleration above 1000 rpm, with closed throttle there will be a vacuum advance; a fifth desideratum.

6. When the engine speed drops through a predetermined speed the suction operated advance operation will be shifted to a suction operated retard operation because the shift piston 20 shifts to the right-side position. This is a sixth recognized desideratum, resulting in reduced exhaust emissions during closedthrottle decelerations and an improvement over heretofore cited prior art, for the reasons stated.

While the invention has been illustrated and described with reference to a preferred embodiment, it will be obvious to those skilled in the art that it may be adapted to many other embodiments and used, without departing from the inventive concept. The disclosure herein being thus merely illustrative, all applications and uses of the invention are claimed.

I claim:

1. A spark timing control for an internal combustion engine having an intake manifold defining a source of suction comprising a suction operated motor connected to a spark timing mechanism, first conduit means for connecting said motor to the source and to atmosphere for operating the motor to produce an advance of the timing of the spark, second conduit means for connection said motor to the source and to atmosphere for operating the motor to produce a retard of the timing of the spark, and means responsive to a predetermined speed of engine for selectively connecting the source to said first or second conduit means, the motor comprising a movable wall defining an expandable chamber on each side thereof, and said first conduit means is connected to one chamber and the second conduit means is connected to the other chamber, said responsive means including a housing having a pair of

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bleed openings connected to atmosphere and a valve therein shiftably mounted between a pair of positions and said conduit means comprises a conduit connecting said housing to said source and separate conduits connecting the housing to each of said chambers whereby movement of the valve to one position will connect the source of suction to one of said chambers while closing the source of suction to the other chamber and allow said other chamber to bleed to atmosphere.

2. A spark timing control for an internal combustion engine having an intake manifold defining a source of suction comprising a suction operated motor connected to a spark timing mechanism, first conduit means for connecting said motor to the source and to atmosphere for operating the motor to produce an advance of the timing of the spark, second conduit means for connecting said motor to the source and to atmosphere for operating the motor to produce a retard of the timing of the spark, and means responsive to a predetermined speed of engine for selectively connecting the source to said first or second conduit means, the motor comprising a movable wall defining an expansible chamber on each side thereof, and said first conduit means is connected to one chamber and the second conduit means is connected to the other chamber, said responsive means including a housing having a valve therein shiftably mounted between two positions, and said conduit means comprises a conduit connecting said housing to said source and separate conduits connecting the housing to each of said chambers, whereby movement of said valve to one position will connect the source of suction to one of said chambers while closing the source of suction to the other chamber and bleeding said other chamber to atmosphere, the other position will connect the source of vacuum to said other chamber and means bleeding said one chamber.

3. A spark timing control for an internal combustion engine having an intake manifold defining a source of suction and having a throttle valve comprising, a suc-

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tion operated motor connected to a spark timing mechanism, first conduit means for connecting said motor to the source for full manifold suction downstream of the idle position of the throttle valve and to atmosphere for operating the motor by suction to produce an advance of the timing of the spark, second conduit means for connecting said motor to the source for full manifold suction downstream of the idle position of the throttle valve and to atmosphere for operating the motor by suction to produce a retard of the timing of the spark and means responsive to a predetermined speed of engine for connecting the source to said first conduit means for producing an advance of the time of the spark at all positions of the throttle, including closed idle, said responsive means connecting the source to the second conduit means at a lower than said predetermined speed for producing a suction operated retard of the timing of the spark.

4. A device as defined in claim 3 wherein the motor comprises a movable wall defining an expansible chamber on each side thereof, and said first conduit means is connected to one chamber and the second conduit means is connected to the other chamber.

5. A device as defined in claim 3 wherein the responsive means comprises valve means.

6. A device as defined in claim 4 wherein said responsive means includes a housing, a valve therein shiftably mounted between a pair of positions, a valve stem connected to the valve for shifting the valve, and bleed conduit means in said stem for selectively bleeding one of the chambers to atmosphere while the other chamber is connected to the source of vacuum as the valve is shifted to one or the other of said positions.

7. A device as defined in claim 4 wherein said responsive means includes a housing, a valve therein shiftably mounted between a pair of positions, for alternately connecting each of the chambers to the source while bleeding the other to atmosphere.

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