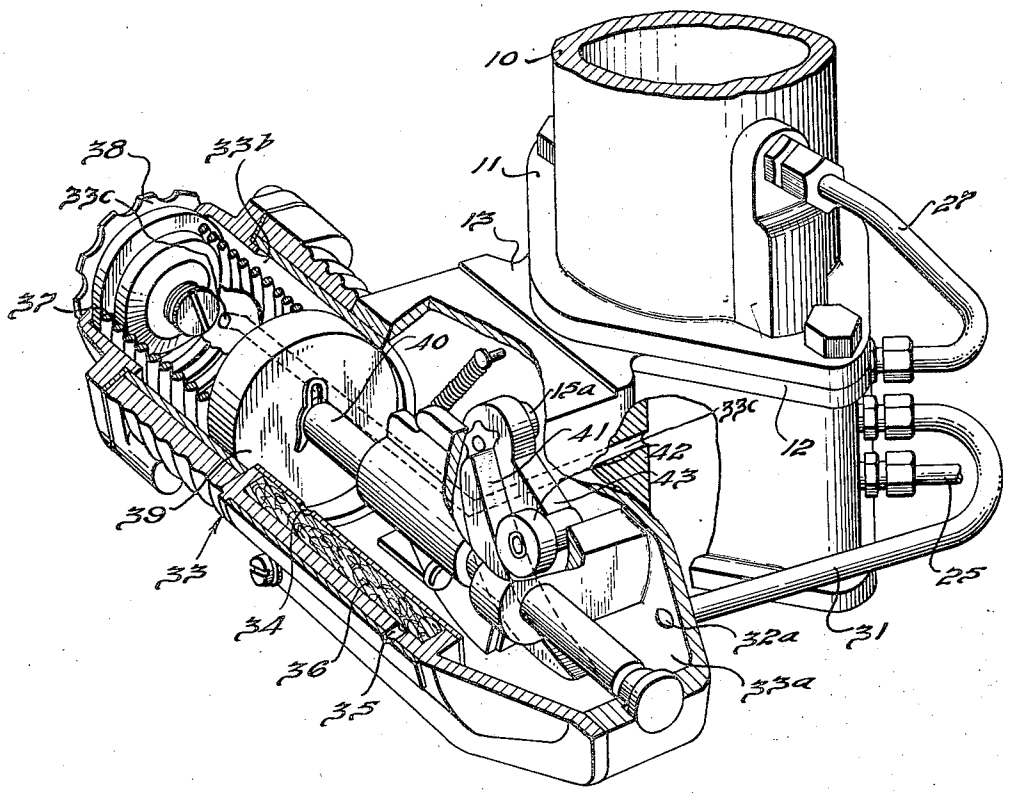
Aug. 30, 1938. J. S. JENNINGS, JR 2,128,363

SPARK CONTROL MECHANISM

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Fig. 1.



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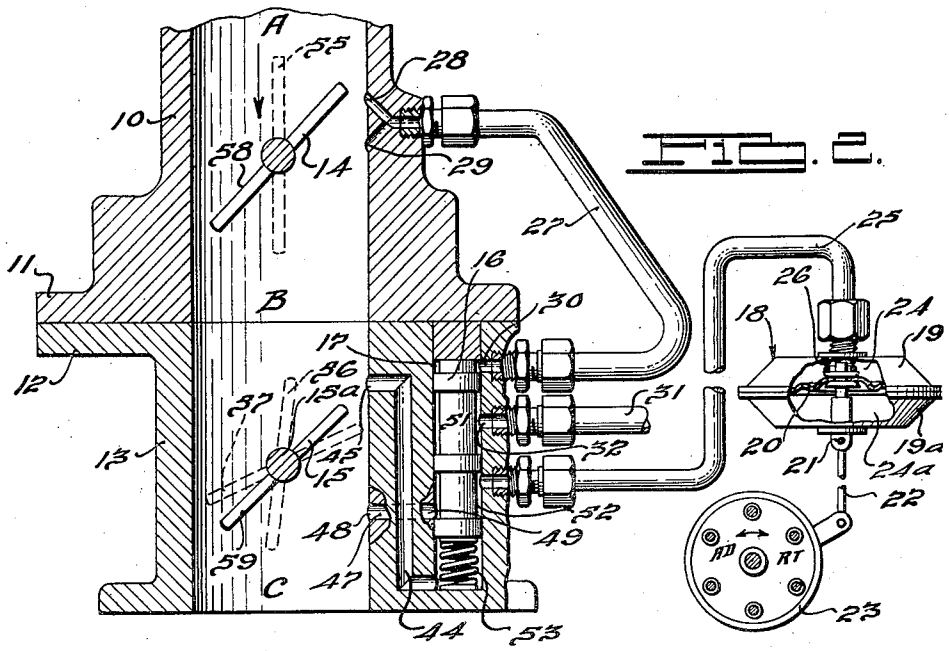


FIG. 2.

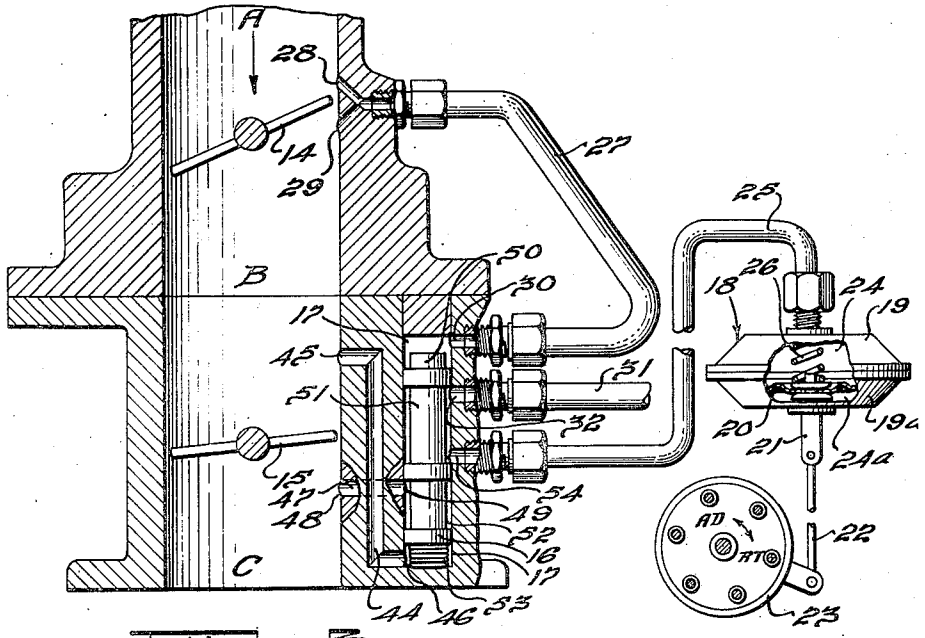


FIG. 3.

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SPARK CONTROL MECHANISM

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9 Claims. (Cl. 123—117)

This invention relates to internal combustion engines and more particularly to vacuum controlled spark advance devices used with such engines.

In the operation of an internal combustion engine having a vacuum or suction type governor installed in the intake passage between the carburetor throttle valve and the intake manifold there are found to exist between the atmospheric end and the engine end of the intake passage three pressure zones, pressures in each of said zones varying in accordance with changes in operation conditions of the engine. There is a pressure zone, substantially atmospheric, at the upstream side of the carburetor valve; a pressure zone between the carburetor and governor valves; and a pressure zone downstream of the governing valve, i. e., at the manifold or engine side of the intake passage. Pressures in these three zones, and particularly in the last two zones, differ in accordance with the conditions of engine operation, and particularly with the speed and the torque developed.

The change of respective pressures in said zones has been utilized in many structures in order to effect the desired spark control. However, difficulties have been encountered in providing a dependable and a quickly responsive spark control means, which difficulties are due chiefly to the fact that the pressure difference between the two particular zones which are usually chosen to actuate said means does not vary or behave in a desired way or does not reach a sufficient value. I have found that a dependable and quickly responsive spark control of an engine cannot be adequately obtained by means of a mechanism operated by a piston valve responsive merely to the pressures above and below the governor valve, inasmuch as in many instances the conditions of engine operation change so as to require corresponding change in spark occurrence, whereas such changes are not always accompanied by any material change in the difference of respective pressures at opposite sides of the governor valve. Moreover, in many instances requiring response of the piston valve, said pressure difference is very slight and a very close calibration of the spring or other means employed must be depended upon to assure sufficient response of the piston valve under such conditions. Consequently, such devices have the disadvantages either of requiring close calibrations and adjustments or of not always responding to changes in engine operation conditions. Hence, they accomplish at best only a partial spark control.

Accordingly it is one of the objects of the present invention to provide a novel spark control device which effects a proper spark occurrence for all conditions of engine operation and responds to the changes in both the speed and the torque developed.

Another object of the invention is to provide a novel spark control device having a movable pressure responsive valve controlling the passages communicating with a diaphragm casing in which is housed a diaphragm responding to the changes in engine operating conditions irrespective of whether such changes produce any material difference between the pressures above and below the governor valve.

A still further object of the invention is to provide a novel spark control device having a piston valve which, when the engine is idling, will be brought into position to permit retardation of the spark, said valve being controlled at this time by atmospheric or near atmospheric pressure in the zone upstream from the carburetor valve.

A further object of the invention is to provide a novel spark control device having a piston valve which responds to predetermined pressure changes in the intake passage when the carburetor throttle is moved from a partially closed position into idling position, thereby effecting a particularly large spark retard for a very slow engine operation or when the engine is idling for a long period of time.

A still further object of the invention is to provide a novel spark control device in which the pressure responsive valve is adapted to be subjected at both of its effective sides under all engine operation conditions, except idling, to the pressure existing in the same pressure zone, thereby preventing hesitation or hunting of the valve under said conditions and permitting firm holding of the valve in a desired operative position.

A still further object of the invention is to provide a device of the above character which is simple in construction and does not require close calibration of its springs or of other means employed.

Other objects of this invention will appear in the following description and appended claims, reference being had to the accompanying drawings forming a part of this specification wherein like reference characters designate corresponding parts in the several views.

In said drawings:

Fig. 1 is a perspective view partly broken away

showing the carburetor and the governor as the same are operatively connected in the engine intake passage.

Fig. 2 is a vertical sectional view of a spark control device embodying my invention, showing the relative positions of parts for the following operation conditions: full carburetor throttle with a full governor valve opening (high torque, low speed); full carburetor throttle with the governor valve partly closed (governing condition at increasing speed); both the throttle and the governor valve partially closed. For each of said conditions the positions of both the throttle and the governor valve are indicated by similar types of lines.

Fig. 3 is a view similar in part to that of Fig. 2, showing the relative positions of parts under idling operation condition of the engine.

Before explaining in detail the present invention it is to be understood that the invention is not limited in its application to the details of construction and arrangement of parts illustrated in the accompanying drawings, since the invention is capable of other embodiments and of being practiced or carried out in various ways. Also it is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation, and it is not intended to limit the invention claimed herein beyond the requirements of the prior art.

In the drawings there is illustrated a part of the intake passage of an internal combustion engine, namely, the portion thereof including the carburetor and the governor valves, as well as the portions immediately adjacent thereto, showing my novel spark control device in operative arrangement with respect to said passage. There is also shown the casing of a diaphragm adapted to change the position of an engine distributor, or other spark current controlling means. In the present embodiment, shown by way of example, the diaphragm is so arranged that when subjected to atmospheric pressure it holds the spark retarded. On the other hand, when it is subjected to the action of the vacuum developed in a given zone in the engine intake passage, said diaphragm operates against the action of a special spring to advance the spark in accordance with the degree of vacuum existing in said zone at the moment.

Referring more particularly to the figures, there is shown a carburetor casing 10 provided with suitable flanges 11 adapted to be secured to flanges 12 of the governor body 13. Within the carburetor casing 10 there is operatively arranged in the intake passage therethrough a throttle valve 14 of the butterfly type adapted to be operated in a manner well known in the art. Within the governor body or casing 13 there is operatively arranged in the intake passage leading to the engine intake manifold a governor valve 15 of the butterfly type adapted to restrict the passage in accordance with the set requirements of the governor. The reference letter A indicates the pressure zone in the intake passage above or at the upstream side of the carburetor throttle; B indicates the pressure zone between the carburetor valve 14 and the governor valve 15; and C indicates the pressure zone in the intake passage below or at the downstream or manifold side of the governor valve 15.

The spark control device comprises generally a piston valve 16 slidable in a cylinder 17 provided within the governor casing 13, and a diaphragm mechanism 18 operating in the spark controlling means.

The diaphragm mechanism 18 comprises a casing consisting of two flanged pieces 19 and 19a between which is held a thin corrugated diaphragm 20 operatively connected by means of a piece 21 and a rod 22 to the distributor 23 of a conventional design. The space 24 of said casing is hermetically sealed and is connected by means of a diaphragm conduit 25 with the cylinder 17, while the space 24a is not sealed and communicates with the atmosphere. If a connection is established between said diaphragm conduit 25 and the pressure zone C, the action of vacuum transmitted to the space 24 operates to move said diaphragm against the resistance of the spring 26 toward the conduit 25, which movement of the diaphragm is transmitted by the rod 22 to the distributor 23 thereby moving the same into a position effecting an advance of the spark in proportion to the degree of vacuum acting upon said diaphragm. As the degree of the vacuum in the space 24 decreases, the spring 26 becomes effective to move the diaphragm away from said diaphragm conduit 25, thereby moving the distributor in a position effecting a correspondingly smaller spark advance. When a connection between the conduit 25 and the atmosphere is effected, the air pressure at both sides of the diaphragm 20 becomes balanced, and the spring 26 moves the diaphragm 20 into a position effecting a particularly large spark retard.

Connected to the casing 10 is a pipe or a conduit 27 which communicates with the intake passage through ports 28 and 29 located, respectively, just above and below the place at which the edge of the carburetor valve 14 is about to engage the walls of the casing 10 when the engine is set for idling. The opposite end of said conduit 27 communicates with a port 30 leading into the upper end of said cylinder 17. Atmospheric conduit 31 connects the cylinder 17 with the atmosphere. In the present embodiment its inner end 32 communicates with the cylinder 17 and the outer terminal 32a thereof is connected to the atmospheric space 33a of the governor casing which space is provided with atmospheric outlets 34 and 35 between which there is interposed suitable packing 36, protecting the interior of said casing from dust and dirt and preventing them from getting into the cylinder 17 through said conduit 31.

The governor casing 33 which is offset to one side of the body 13 houses the mechanism controlling the governor valve 15. Said mechanism consists of a balanced spring 37 adjustable by means of an adjustment disk 38, which spring bears upon the piston 39 slidably fitted within said casing and provided with a piston rod 40 carrying a cam 41 cooperating with a roller 42 carried by the crank arm 43 secured to the governor valve shaft 15a suitably journalled in the governor body 13 to which shaft the governor valve is fastened. Space 33b communicates with the intake passage of the engine below the governor by means of a passage 33c leading from said space to the portion 13, as is clearly indicated in Fig. 1. The space 33a is provided with atmospheric outlets, as mentioned. With the increase or decrease of engine speed, the vacuum below the governor valve increases or decreases, causing corresponding movements of the piston 39 against said spring 37, thus moving the piston rod 40 and the cam 41. The roller 42 following the outline of the cam actuates the arm 43 and the governor

valve shaft 15a, thereby closing or opening the governor valve 15.

A conduit 44 arranged substantially parallel to the cylinder 17 provides through the medium of ports 45 and 46 a communication between the zone B and the lower end of the cylinder 17, while the conduit 47 connects the middle portion of the cylinder 17 with the zone C through the medium of ports 48 and 49 respectively.

In the present embodiment of the invention the piston valve is in the form of an elongated cylindrical piece slidably fitted within the cylinder 17, and provided with an extension 50 and annular recesses 51 and 52. A spring 53 is provided in the cylinder 17 under the piston valve 16 and, unless compressed by the pressure upon the piston valve 16, said spring holds the piston valve in the extended position shown in Fig. 2, which position is determined by the length of the extension 50 which serves as a stop of the piston valve 16 in the upward movement thereof. The length of the cylinder and of the valve 16, as well as the respective location of ports in said cylinder and recesses in said valve, is such that the end 32 of the atmospheric conduit 31 is always included within the recess 51 of the piston valve 16, while the port 49 of the conduit 47 is always included within the recess 52, conduits 44 and 27 communicating with cylinder 17 above and below the piston at all times. Port 54 of the diaphragm conduit 25 is included, depending upon the position of the piston valve 16, either in the recess 51 or the recess 52. When said port 54 is included in the recess 52 (see Fig. 2) the atmospheric conduit 31 has no communication with the diaphragm conduit 25, said diaphragm conduit being connected by means of the recess 52 and conduit 47 with the zone C. On the other hand, when the port 54 is included in the recess 51 (see Fig. 3), communication between zone C and the diaphragm conduit 25 is interrupted, and communication between said diaphragm conduit and the atmospheric conduit is established through the medium of recess 51.

When the engine operation conditions are such that spark advance is desired, the means hereinbefore described cooperate to connect the diaphragm vacuum space 24 with the pressure zone C where the degree of vacuum is the greatest, and the spark is advanced because of the movement of the diaphragm 20 in proportion to the degree of vacuum in said zone C. When the engine is operating at the wide open throttle and maximum torque, which may be a condition arising from acceleration or hill climbing or the like, the engine should operate with a substantially retarded spark. Operation of the present spark control device effecting the proper spark occurrence for such operation conditions is illustrated in Fig. 2. Under such operation conditions both the carburetor throttle valve and the governor valve are in the positions indicated by the numerals 55 and 56, respectively. The pressures in the zones A, B and C are under such conditions nearly equal and in magnitude approach atmospheric pressure. The substantially atmospheric pressure is transmitted through the conduit 27 into the cylinder space above the piston valve 16, and through the conduit 44 into the space under the piston valve 16. Consequently, as far as fluid pressure is concerned, the piston valve 16 is in a substantially balanced condition, which is to say that there is no resultant force tending to move said piston valve. Therefore, the spring 34 can firmly hold the piston valve 16 in its extended position, thereby effecting communication of the vacuum space 24 of the diaphragm casing with the pressure zone C wherein a nearly atmospheric pressure exists at the moment, as explained. Said communication is effected through the port 48, conduit 47, port 49, recess 52, port 54 and conduit 25. Subjected to a nearly atmospheric pressure, the diaphragm 20 aided by the spring 26 moves down and pushing on the rod 22 sets the distributor 23 into a position effecting a substantially retarded spark, which is required for the proper operation of the engine under such conditions.

With the carburetor throttle wide open as described, should the torque required begin to decrease, the engine speed will increase proportionally and may become objectionably high. Such conditions may arise during acceleration in lower gears or in speeding in high gear. Under such conditions the governor valve moves toward the position shown at 57 keeping the speed of the engine at the predetermined maximum. As a result of such position of the governor valve 15, a substantially atmospheric pressure will continue to exist in both the zone A and the zone B, while a certain degree of vacuum is created in the zone C. Atmospheric pressure acting above and below the piston valve 16, as before, the valve will be still firmly held in its extended position under the full force of the spring 53, while because of the space 24 communicating with the zone C of increased vacuum, the diaphragm 20 responds to the vacuum in said zone C and advances the spark in proportion to the degree of vacuum created in said zone, that is to say in proportion to the closing of the governor valve and, consequently, in proportion to the increasing speed of the engine.

When the carburetor throttle valve 14 is in its partially closed position as at 58, the governor valve will ordinarily assume approximately the position indicated by the numeral 59, which position is substantially the same as that of the carburetor throttle valve 14. Under these conditions there will be atmospheric pressure in the zone A and a partial vacuum in the zones B and C. It will be noticed from an examination of the position 58 of the carburetor throttle valve that the port 28 of the conduit 27 is located in the zone B rather than in the zone A, and consequently, the piston valve 16 will again be subjected to the equal or nearly equal pressures on both of its effective sides. As a consequence the fluid pressure does not effect the operative position of the piston valve 16, and the spring 53 holds the piston valve in its extended position, causing the diaphragm conduit 25 to maintain communication between the zone C and the space 24 of the diaphragm casing. This causes the diaphragm 20 to advance the spark in proportion to the degree of vacuum existing in the zone C and, consequently, in proportion to the increase or decrease of the engine speed.

An important advantage of the present spark control device consists in that feature thereof that causes it to respond operatively to an adjustment of the carburetor throttle from partially opened position into the practically closed position for idling. It will be appreciated that under such conditions there will be practically no change in the difference of pressures in the zones B and C and, consequently, if the piston valve is responsive only to the difference of pres-

sures in the zones just above and below the governor valve, as heretofore it will not respond operatively when the engine is set for idling.

The operation of the spark control device when the engine is set for idling is illustrated in Fig. 3. It will be appreciated that under idling operation both the throttle 14 and the governor valve 15 are practically closed, and there is a high vacuum created in the pressure zones B and C. As can be noted from an examination of Fig. 3, the carburetor throttle valve 14 is nearly set down upon the walls of the casing 10 with its upper edge located between ports 28 and 29. Therefore, the port 28 becomes located in the pressure zone A and the port 29 in the pressure zone B. The flow of air from the zone A through port 28 reduces the degree of vacuum acting upon the piston valve 16, or in other words, causes a higher pressure to act upon the top of said piston valve. At the same time the increased vacuum in the pressure zone B is caused to act upon the lower side of the piston valve 16. As a result, the spring 53 is compressed, and the piston valve 16 is brought into the position shown in Fig. 3. In this position of the piston valve the vacuum space 24 of the diaphragm casing communicates with the atmosphere through the conduit 25, port 54, recess 51, port 32, atmospheric conduit 31, port 32*a*, atmospheric side 33*a* of the governor casing and openings 34 and 35. In consequence thereof, the diaphragm 20 is moved into the position shown in Fig. 3, causing a retarded spark, which is required for a proper operation of the engine under idling conditions. Thus, when the throttle valve 14 is moved from a position of partial opening into the position for engine idling, the piston valve 16 operatively responds thereto and sets the spark in a properly retarded position. It will be understood that with the carburetor valve 14 set in the position shown in Fig. 3, the pressure in the conduit 27 will approach atmospheric, since the effect of port 29 at this time is minimized. In some instances to suit particular engine requirements the passage or port 29 may be dispensed with so that under engine idling conditions substantially atmospheric pressure will exist in the conduit 27.

I claim:

1. In a spark control device for an engine provided with an intake passage having a carburetor throttle valve and a governor valve therein, spark control means normally responsive to the pressure in the intake passage at the engine side of said governor valve, and a control valve responsive entirely to pressures existing at the upstream side of said governor valve, said control valve being effective at a predetermined time to subject said spark control means entirely to the action of the atmospheric pressure.

2. In a spark control device for an engine provided with an intake passage having a carburetor throttle valve and a governor valve therein, spark control means normally responsive to the difference of pressures in the atmosphere and in the intake passage at the engine side of said governor valve, and a control valve responsive entirely to pressures existing at the upstream side of said governor valve, said control valve being effective in engine operation conditions requiring particularly large spark retard to subject said spark control means entirely to the action of the atmospheric pressure.

3. In an internal combustion engine provided with an intake passage having a carburetor throttle valve and a governor valve therein, the combination with a spark control device having a diaphragm normally responsive to the pressure in the intake passage at the engine side of said governor valve, of a control valve responsive entirely to pressures existing at the upstream side of said governor valve and effective at a predetermined time to cut off responsiveness of said diaphragm to pressure in the intake passage and cause atmospheric pressure to act on said diaphragm.

4. In a spark control device for an engine provided with an intake passage having a carburetor valve and a governor valve therein, a spark controlling diaphragm, a cylinder, a recessed piston slidably fitted in said cylinder, a conduit connecting said cylinder at one side of the piston valve to the pressure zone between the carburetor and governor valves, a second conduit connecting said cylinder at the opposite side of the piston valve to the pressure zone upstream from the carburetor valve when the latter is substantially closed, a diaphragm vacuum conduit connecting said diaphragm with said cylinder, a vacuum conduit connecting said cylinder with the pressure zone at the engine side of the governor valve, and an atmospheric conduit connecting said cylinder with the atmosphere, said piston valve being movable when the carburetor valve is substantially closed to connect said diaphragm vacuum conduit with said atmospheric conduit.

5. In a spark control device for an engine provided with an intake passage having a carburetor valve and a governor valve therein, a spark controlling diaphragm, a cylinder, a two-recess piston slidably fitted within said cylinder and responsive entirely to pressures existing at the upstream side of said governor valve, an atmospheric conduit connecting said cylinder with the atmosphere through a path omitting said intake passage, a diaphragm conduit connecting said cylinder with the diaphragm, and a vacuum conduit connecting said cylinder with the intake passage at the engine side of the governor valve, said piston normally closing the atmospheric conduit and connecting said diaphragm conduit and said vacuum conduit, and effective in idling condition of the engine to close said vacuum conduit and to connect said atmospheric conduit and said diaphragm conduit.

6. In a spark control device for an engine provided with an intake passage having a carburetor valve and a governor provided with a governor valve in said passage and a casing offset therefrom and having a space subject to atmospheric pressure, a spark controlling diaphragm, a cylinder, a two-recess piston slidably fitted within said cylinder and responsive entirely to pressures existing at the upstream side of said governor valve, an atmospheric conduit connecting said cylinder with the atmosphere, a diaphragm conduit connecting said cylinder with the diaphragm, and a vacuum conduit connecting said cylinder with the intake passage at the engine side of the governor valve, said piston normally closing the atmospheric conduit and connecting said diaphragm conduit and said vacuum conduit, and effective in idling condition of the engine to close said vacuum conduit and to connect said atmospheric conduit and said diaphragm conduit, said atmospheric conduit being connected to said space within the governor casing.

7. In an internal combustion engine provided with an intake passage having a carburetor throttle valve and a governor valve therein, the com-

bination with a spark control device having a diaphragm open at one side at all times to atmosphere, of a control valve responsive entirely to pressures existing at the upstream side of said governor valve, said control valve being effective at a predetermined time to subject the other side of said diaphragm to the action of the atmospheric pressure.

8. In an internal combustion engine provided with an intake passage having a carburetor throttle valve and a governor valve therein, the combination with a spark control device having a diaphragm normally having atmospheric pressure acting on one of its sides and the pressure existing in said passage at the engine side of the governor valve acting on its other side, of a piston valve effective in idling operation conditions of the engine to subject the side of said diaphragm normally acted upon by the pressure in the engine passage below the governor valve to the action of substantially atmospheric pressure.

9. In a spark control device for an engine provided with an intake passage having a carburetor valve and a governor valve therein, a spark controlling diaphragm normally operatively connected and responsive to pressure in the intake passage at the engine side of the governor valve, the other side of said diaphragm being open to atmosphere at all times, a recessed piston effective in engine operation conditions requiring a particularly large spark retard to interrupt the communication between the intake passage of the engine and said diaphragm and to establish a communication between said diaphragm and the atmosphere through a path omitting said intake passage, whereby said diaphragm becomes subjected at both of its sides to the action of atmospheric pressure.

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