May 7, 1940. L. F. SARNES 2,200,043

SPARK CONTROL DEVICE

Filed Dec. 17, 1937 2 Sheets-Sheet 1

Fig. 1.

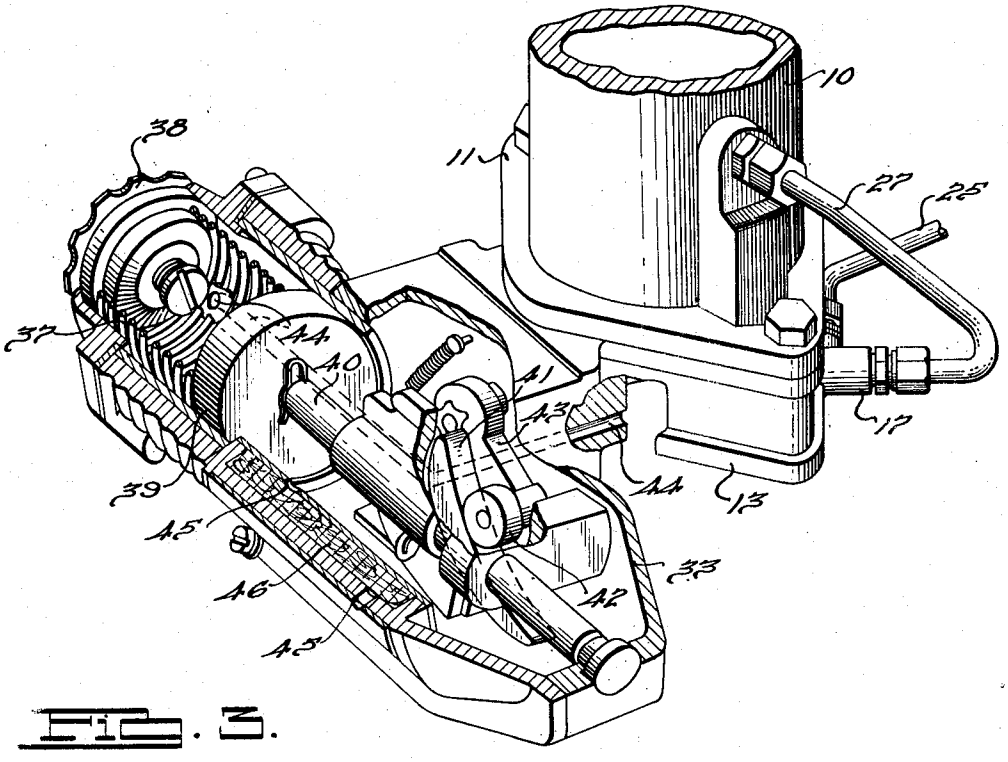
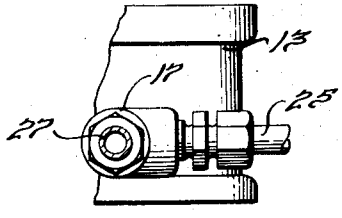


Fig. 3.



INVENTOR

BY Lowell F. Sarnes.

Dike, Calver & Gray

ATTORNEYS.

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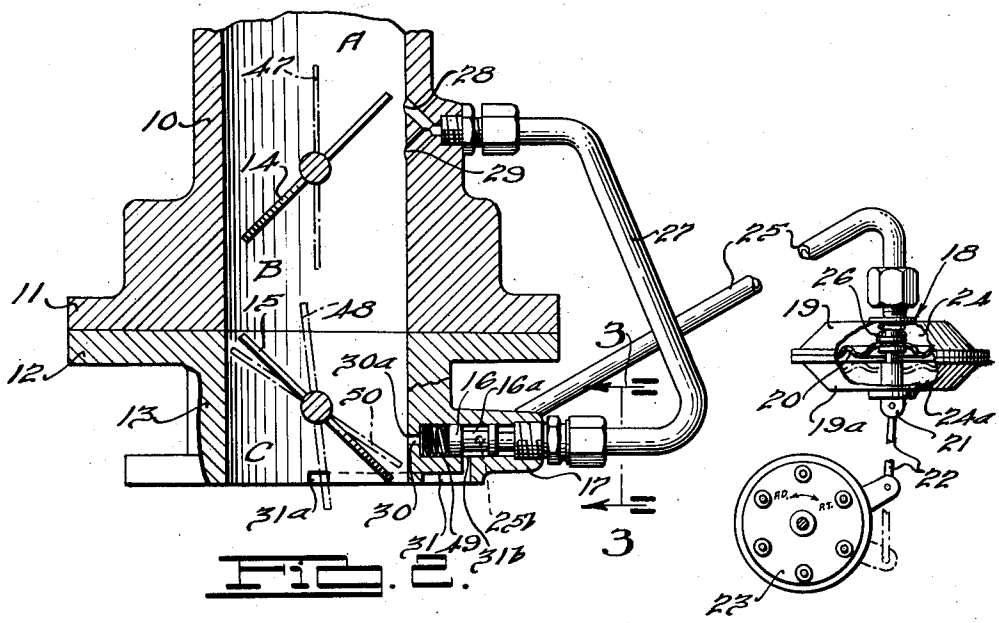


FIG. 2.

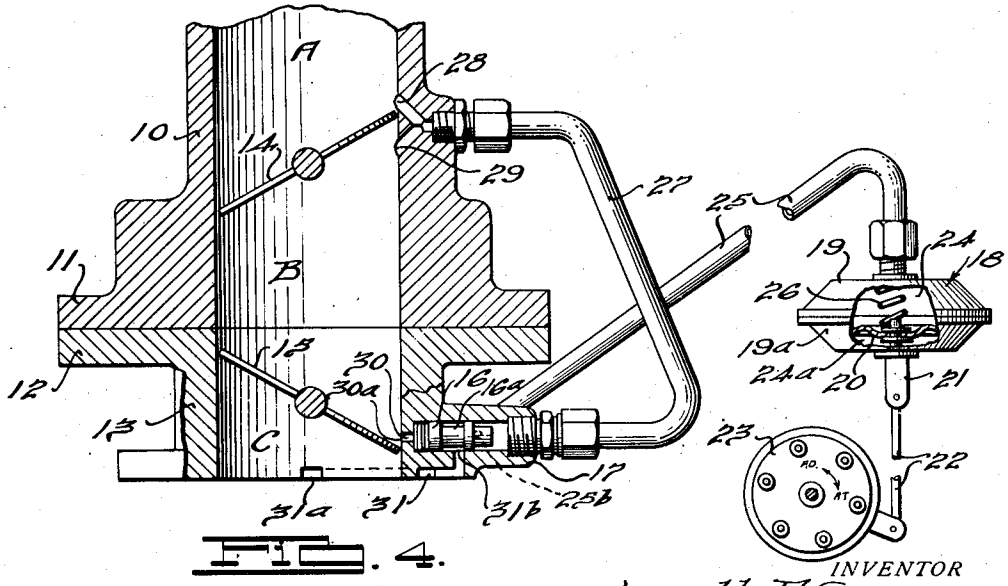


FIG. 4.

INVENTOR
Lowell F. Sarnes.

BY
Dike, Calver & Gray
ATTORNEYS.

Patented May 7, 1940 2,200,043

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2,200,043

SPARK CONTROL DEVICE

Lowell F. Sarnes, Detroit, Mich., assignor to Monarch Governor Company, Detroit, Mich., a corporation of Michigan

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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.

The requirements for spark occurrence for proper engine operation vary in a particular engine in accordance with both the speed at which the engine is operating and the pressure within a cylinder thereof at the end of the compression stroke of the piston. Consequently, the requirements for spark occurrence under some particular condition of engine operation are a combination of the above two factors. 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 intake manifold there are found to be three pressure zones in the intake passage, the pressure in each zone varying under varying operation conditions. There is a pressure zone, substantially atmospheric, at the upstream side of the carburetor valve; a pressure zone between the carburetor and governor valves, in which zone the pressure widely varies; and a pressure zone downstream of the governing valve, i. e., at the manifold side thereof. Pressures in these three zones differ in accordance with the conditions of engine operation and particularly with the speed and torque developed.

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 pressure differential at opposite sides of the governor valve. Moreover, in many instances requiring response of the piston valve, the pressure difference in the pressure zones just above and below the governor valve is very slight and a very close calibration of the spring or other means employed must be depended upon to assure response of the piston valve under such conditions. Consequently, such devices have the disadvantage either of requiring close calibrations and adjustments, or of not always responding to changes in 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 change 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 an element 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.

Another object of the invention is to provide a novel spark control mechanism 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 conditions in the zone upstream from the carburetor valve.

A further object of the invention is to provide a novel spark control mechanism 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 spark control device of the foregoing character, in which long narrow passages such as made by drilling operations are entirely eliminated, the passages being so arranged that they can be formed in the process of casting the governor body.

A still further object of the invention is to provide a spark control device of such a construction that practically all machining operations in manufacturing the main body thereof can be made in one setting.

A still further object of the invention is to provide a spark control device which is very compact and takes a minimum length of the engine intake passage, and which may therefore be inserted into a minimum available space.

A still further object of the invention is to provide a spark control device in which the control piston and the spring may be easily removed for inspection or cleaning without the necessity of withdrawing permanently set plugs and the like.

Other objects and advantages of this invention will appear in the following description and ap-

pended 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.

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 section of a spark control device embodying my invention, showing the relative positions of the parts thereof 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); and for the condition where both the throttle and the governor valve are partially closed. For each of the above specified conditions the positions of both the throttle and the governing valve are indicated by similar types of lines.

Fig. 3 is a view taken on the far end of the controlling cylinder from the line 3—3 of Fig. 2 and in the direction of the arrows.

Fig. 4 is a view similar in part to that of Fig. 2 showing the relative positions of the operative parts of the device under the 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 the 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 the flanges **12** of a 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 intake passage leading to the engine intake manifold through the governor body or casing **13** there is operatively arranged 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 control cylinder **17** provided within the governor casing **13** and extending transversely thereof, and a diaphragm mechanism **18** operating the spark advance and retarding 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 control cylinder **17**, while the space **24a** is not sealed and it communicates with the atmosphere. If a communication is established between said diaphragm conduit and the pressure zone C, the action of the 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 setting the same to effect an advance of the spark in proportion to the degree of vacuum acting upon said diaphragm. As the degree of vacuum in the space **24** decreases, the spring **26** becomes effective to move the diaphragm **20** away from the diaphragm conduit **25**, thereby setting the distributor to effect an increasingly 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**, preferably by means of a threaded connection, 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** is connected by means of a similar threaded connection to the far end of the control cylinder **17**. At the near end of the control cylinder **17**, that is to say, at the end thereof closest to the intake passage, there is provided a hole **30** whereby a constant communication between the pressure zone B and the near end of the control cylinder **17** is effected. The hole **30** is preferably made concentric with the bore of the cylinder **17** in order to enable drilling it in one setting of the governor body **13**, and even with a single tool, if desired. It should be noted that the port **30a** through which the conduit formed by said hole opens into the passage remains in the pressure zone B irrespective of the position of the governor valve **15**. A passage **31** opening into the main intake passage through a port **31a** and into the control cylinder **17** through a port **31b** is provided for the purpose of establishing a constant communication between the pressure zone C and the space **16a** formed by the recessed piston valve **16**. The diaphragm conduit **25** opens into the control cylinder **17** through a port **25b** located in the mid-

dle portion of the control cylinder closer to the far end thereof.

It should be noted that location of the port 31*b* is such that it remains within the recess space 16*a* in both the fully extended and the fully retracted positions of the control valve 16, while the location of the port 25*b* is such that it opens into the recess space 16*a* in the fully extended position of the control valve 16 but remains outside thereof in the fully retracted position of the piston valve, see Figs. 2 and 4.

It should also be noted that the passage 31 is brought a distance around the main intake passage, and that the port 31*a* remains in the pressure zone C in all positions of the governor valve 15. An important advantage of the present invention results from the fact that the passage 31 is so arranged that it may be easily formed in the process of casting of the governor body 13, whereby drilling of long holes as well as the necessity of plugging the ends thereof to provide passages with turns as is the case with previous structures, is entirely eliminated. By virtue of such a construction the cost of drilling operations as well as the cost of drills and loss of time resulting from frequent breakage of drills in drilling long passages in the comparatively soft metal with the aid of rather thin drills is eliminated.

The governor casing 33 which is offset to one side of the body 13 houses a suitable mechanism controlling the governor valve 15. Said mechanism may take different forms and in the present instance, for the purposes of illustration only, is shown as comprising a balanced spring 37 adjustable by means of an adjustment disk 38, which spring bears upon a 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 crankarm 43 secured to the governor valve 15*a* suitably journalled in the governor body 13 to which shaft the governor valve is fastened. The space 33*b* communicates with the intake passage of the engine below the governor valve by means of a conduit or passage 44 leading from said space to the bottom of the body portion 13. The space 33*a* is provided with atmospheric outlets 45 protected by a dust filter 46. 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 15*a*, thereby closing or opening the governor valve 15.

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 decrease 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 a 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 47 and 48 respectively. The pressures in the zones A, B and C are under such conditions nearly equal and in magnitude they approach the atmospheric pressure. The substantially atmospheric pressure is transmitted through the conduit 27 into the far end of the control cylinder 17. Since a substantially equal pressure will be transmitted into the near end of the control cylinder through the hole 30, the spring 49 will keep the piston valve 16 in its fully extended position. In this position of the piston valve a communication between the pressure zone C and the vacuum space 24 will be effected. But since the pressure in the zone C is substantially atmospheric, the pressures on both sides of the diaphragm 20 are balanced and the spring 26 will move the diaphragm down into the position indicated in Fig. 2 by the dotted lines, setting the distributor for particularly large spark retard, see dotted position of the distributor in Fig. 2.

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 gears. Under such conditions the governor valve moves toward the position shown at 50 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. Therefore, substantially equal pressures will act on both ends of the piston valve 16 enabling the spring to keep the valve in its fully extended position. Since a communication is established between the pressure zone C and the vacuum space 24 of the diaphragm mechanism 18, the diaphragm 20 will move up into the position indicated in Fig. 2 in full lines setting the distributor for a large spark advance. Proportional in its decrease to the degree of vacuum created in the zone C, 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 13 is in its partially closed position indicated in Fig. 2 in full lines, the governor valve 15 will ordinarily assume approximately the position shown in full lines in Fig. 2, which position is substantially the same as that of the carburetor throttle valve 14. Under these conditions atmospheric pressure will exist in the pressure zone A, while a partial vacuum is created in the pressure zones B and C. It will be noticed from an examination of the position 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 therefore the piston valve 16 will again be subjected to the equal or nearly equal pressures at both of its effective ends. As a consequence, the fluid pressure acting thereon is balanced enabling the spring 49 to hold the piston valve 16 firmly 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 the feature thereof that

causes it to respond operatively to an adjustment of the carburetor throttle from a partially open 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 pressures in the zones immediately above and below the governor valve, as heretofore, it will not respond operatively when the engine is set for idling.

The operation of my improved spark control device when the engine is set for idling is illustrated in Fig. 4. It will be appreciated that under idling operation both the throttle valve 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 being located between the 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 the port 28 reduces the degree of vacuum acting upon the piston valve 16 and causes a higher pressure to act upon the top of said piston valve. At the same time, the increased vacuum in pressure zone B is caused to act upon the near end of the piston valve 16. As a result, the spring 49 is compressed and the piston valve 16 is brought into the position shown in Fig. 4. In this position of the piston valve the vacum space 24 of the diaphragm casing communicates with the atmosphere through the conduit 25, port 25b, conduit 27 and the port 28. In consequence thereof, the diaphragm 20 is moved into the position shown in Fig. 4, causing a retarded spark, just as 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. 4 the pressure in the conduit 27 will approach atmospheric pressure, since the effect of the 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 a substantially atmospheric pressure will exist in the conduit 27.

I claim:

1. In an internal combustion engine provided with an intake passage having a carburetor valve and a governor valve therein, a control cylinder extending transversely of said passage, a recessed piston slidable in said cylinder, a conduit connecting the near end of said cylinder with said intake passage immediately adjacent said governor valve at its upstream side, a conduit connecting an intermediate portion of said cylinder with said intake passage immediately adjacent said governor valve at its downstream side and opening into the control cylinder with a port confined within the piston recess at all operation positions of said piston, a conduit connecting the far end of said cylinder with said engine passage, said last named conduit opening into said passage through a port which under all operation conditions except idling remains below said carburetor valve, a vacuum responsive diaphragm mechanism connected with said control cylinder by means of a conduit opening into said cylinder with a port adapted to be included in the recess of said piston for connecting the intake passage at the downstream side of the governor valve with said mechanism, and a distributor device operated by said diaphragm mechanism and adapted to advance the ignition spark when such connection is established.

2. In an internal combustion engine provided with an intake passage having a carburetor valve therein, a governor device adapted to be interposed into said passage downstream of said carburetor valve, said device including a body having a passage therein registering with the engine intake passage and forming a part thereof, a governor valve operatively mounted in said passage, a control cylinder formed in said body and extending transversely thereof, a recessed piston slidable within said cylinder, a conduit connecting the near end of said cylinder with said intake passage immediately adjacent said governor valve at the upstream side thereof, a conduit connecting an intermediate portion of said cylinder with said intake passage immediately adjacent said governor valve at the downstream side thereof, a vacuum responsive diaphragm mechanism connected with said control cylinder by means of a conduit opening into said cylinder with a port adapted to be included in the recess of said piston for connecting the intake passage at the downstream side of the governor valve with said mechanism, and a distributor device operated by said diaphragm mechanism and adapted to advance the ignition spark when such connection is established.

3. In an internal combustion engine provided with an intake passage having a carburetor valve therein, a governor device adapted to be interposed into said passage downstream of said carburetor valve, said device including a body having a passage therein registering with the engine intake passage and forming a part thereof, a governor valve operatively mounted in said passage, a control cylinder formed in said body and extending transversely thereof, a recessed piston slidable in the cylinder, said cylinder being connected with the pressure zone of said passage immediately adjacent the upstream side of the governor valve with the aid of a hole provided in the near end of the cylinder concentrically of its bore, with the pressure zone of the intake passage immediately adjacent the downstream side of the governing valve by means of a passage in said body leading from an intermediate portion of the control cylinder to the engine passage, a vacuum responsive diaphragm mechanism connected with said control cylinder by means of a conduit opening into said cylinder with a port adapted to be included in the recess of said piston for connecting the intake passage at the downstream side of the governor valve with said mechanism, and a distributor device operated by said diaphragm mechanism and adapted to advance the ignition spark when such connection is established.

4. In an internal combustion engine provided with an intake passage having a carburetor valve therein, a governor device adapted to be interposed into said passage downstream of said carburetor valve, said device including a cast body having a passage therein registering with the engine intake passage and forming a part thereof, a governor valve operatively mounted in said passage, a control cylinder formed in said body and extending transversely thereof, a recessed piston slidable in the control cylinder, said cylinder

being connected with the pressure zone of said passage immediately above the governor valve with the aid of a hole provided in the near end of the cylinder concentrically of its bore, with the pressure zone of the intake passage immediately below the governing valve by means of a passage in said body leading from the middle portion of the control cylinder to the engine passage, said cylinder adapted to be bored and said hole drilled in one setting of the body, said passage adapted to be formed in the process of casting of the body, a vacuum responsive diaphragm mechanism connected with said control cylinder by means of a conduit opening into said cylinder with a port adapted to be included in the recess of said piston for connecting the intake passage at the downstream side of the governor valve with said mechanism, and a distributor device operated by said diaphragm mechanism and adapted to advance the ignition spark when such connection is established.

5. In an internal combustion engine provided with an intake passage having a carburetor valve therein, a governor device adapted to be interposed into said passage downstream of said carburetor valve, said device including a body having a passage therein registering with the engine intake passage and forming a part thereof, a governor valve operatively mounted in said passage, a control cylinder formed in said body and extending transversely thereof, a recessed piston slidable in the control cylinder, said cylinder being connected with the pressure zone of said passage immediately above the governor valve with the aid of a hole provided in the near end of the cylinder concentrically of its bore, with the pressure zone of the intake passage immediately below the governing valve by means of a passage in said body leading from the middle portion of the control cylinder to the engine passage, with the pressure zone immediately above said carburetor valve by means of a conduit leading from the far end of said cylinder to said zone, a vacuum responsive diaphragm mechanism connected with said control cylinder by means of a conduit opening into said cylinder with a port adapted to be included in the recess of said piston for connecting the intake passage at the downstream side of the governor valve with said mechanism, and a distributor device operated by said diaphragm mechanism and adapted to advance the ignition spark when such connection is established.

6. In an internal combustion engine provided with an intake passage having a carburetor valve therein, a governor device adapted to be interposed into said passage downstream of said carburetor valve, said device including a cast body having a passage therein registering with the engine intake passage and forming a part thereof, a governor valve operatively mounted in said passage, a control cylinder formed in said body and extending transversely thereof, a recessed piston valve slidable in the control cylinder, said cylinder being connected with the pressure zone of said passage immediately above the governor valve with the aid of a hole provided in the near end of the cylinder concentrically of its bore, with the pressure zone of the intake passage immediately below the governing valve by means of a passage in said body leading from the middle portion of the control cylinder to the engine passage, with the pressure zone immediately above said carburetor valve by means of a conduit leading from the far end of said cylinder to said zone, said cylinder adapted to be bored and said hole drilled in one setting of the body, said passage being adapted to be formed in the process of casting of the body, a vacuum responsive diaphragm mechanism connected with said control cylinder by means of a conduit opening into said cylinder with a port adapted to be included in the recess of said piston for connecting the intake passage at the downstream side of the governor valve with said mechanism, and a distributor device operated by said diaphragm mechanism and adapted to advance the ignition spark when such connection is established.

7. In an internal combustion engine provided with an intake passage having a carburetor valve therein, a governor device adapted to be interposed into said passage downstream of said carburetor valve, said device including a body having a passage therein registering with the engine intake passage and forming a part thereof, a governor valve operatively mounted in said passage, a control cylinder formed in said body and extending transversely thereof, a control valve slidable in said cylinder, said control valve adapted to respond entirely to pressures existing in said passage upstream of said governor valve, a vacuum responsive diaphragm mechanism connected with said control cylinder, said connection being controlled by said valve, and a distributor device operated by said diaphragm mechanism and adapted to advance the ignition spark when such connection is established.

8. In an internal combustion engine provided with an intake passage having a carburetor valve therein, a governor device adapted to be interposed into said passage downstream of said carburetor valve, said device including a body having a passage therein registering with the engine intake passage and forming a part thereof, a governor valve operatively mounted in said passage, a control cylinder in said body and extending transversely thereof, a recessed piston valve slidable in said control cylinder, said valve being adapted to be subjected at its near end to the action of pressure existing in the engine passage immediately adjacent the upstream side of the governor valve, a vacuum responsive diaphragm mechanism connected with said control cylinder, said connection being controlled by said valve, and a distributor device operated by said diaphragm mechanism and adapted to advance the ignition spark when such connection is established.

9. In an internal combustion engine provided with an intake passage having a carburetor valve and a governor valve therein, a control cylinder extending transversely of said passage, a piston valve slidable in the control cylinder, a conduit connecting the end of said cylinder closest to said passage with the portion of said passage which lies immediately adjacent said governor valve at the upstream side thereof, a separate conduit connecting independently of said first conduit an intermediate portion of said cylinder with the portion of said passage which lies immediately adjacent said governor valve at the downstream side thereof, a vacuum responsive diaphragm mechanism connected with said control cylinder, said connection being controlled by said valve, and a distributor device operated by said diaphragm mechanism and adapted to advance the ignition spark when such connection is established.

LOWELL F. SARNES.