Dec. 19, 1939. J. S. JENNINGS, JR 2,183,747

SPARK CONTROL MECHANISM

Original Filed May 6, 1936 2 Sheets-Sheet 1

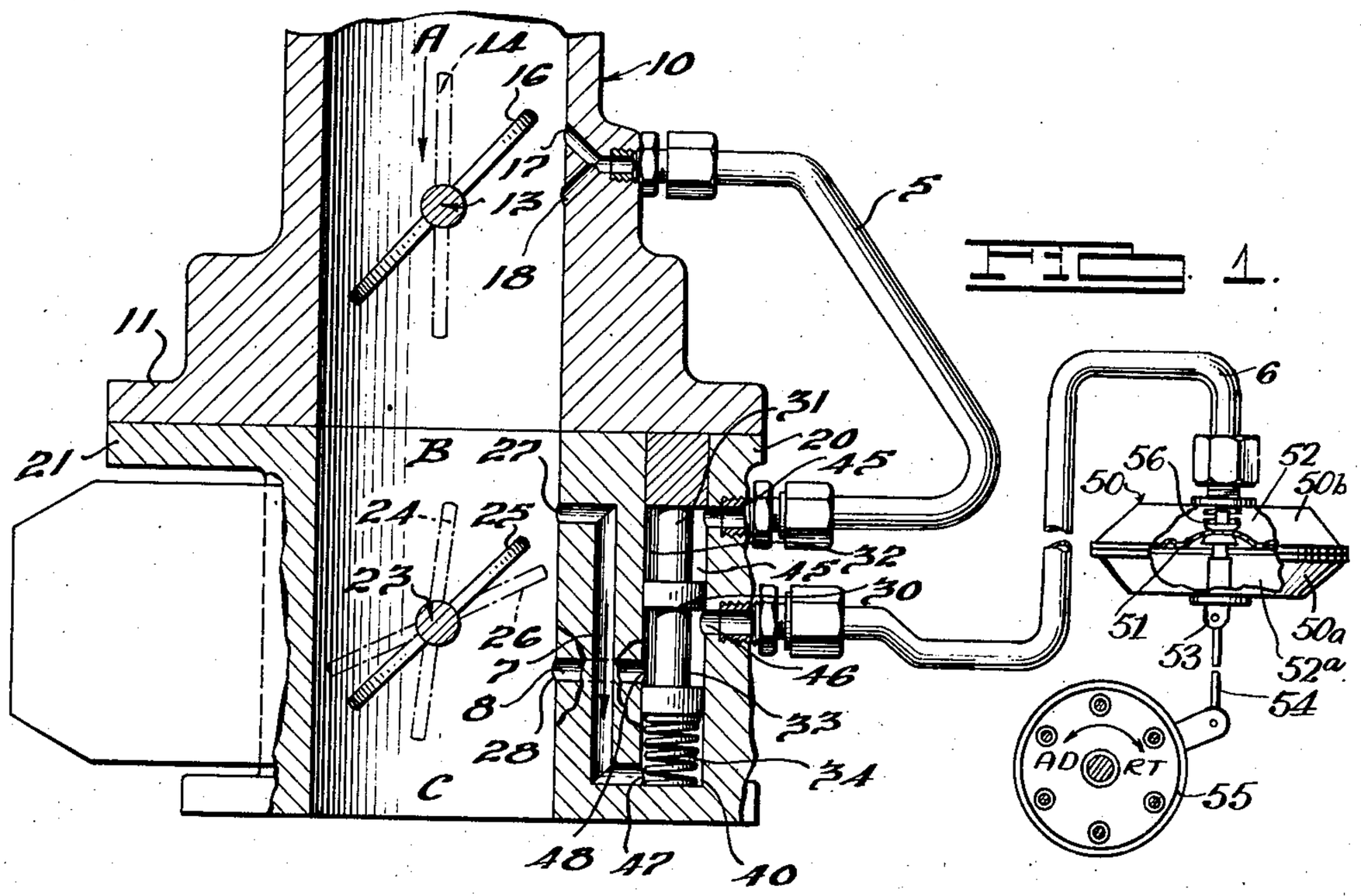

FIG. 1.

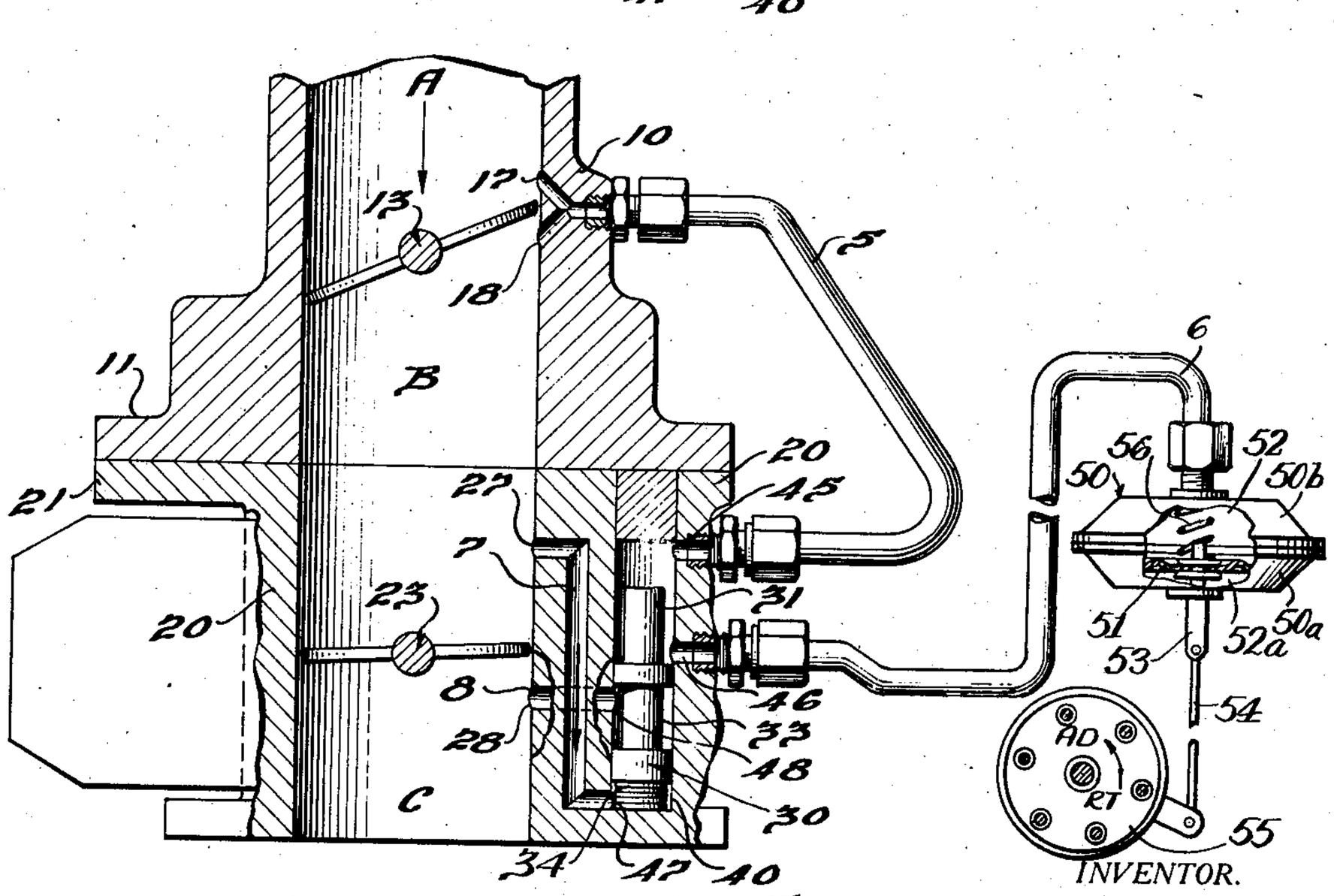

FIG. 2.

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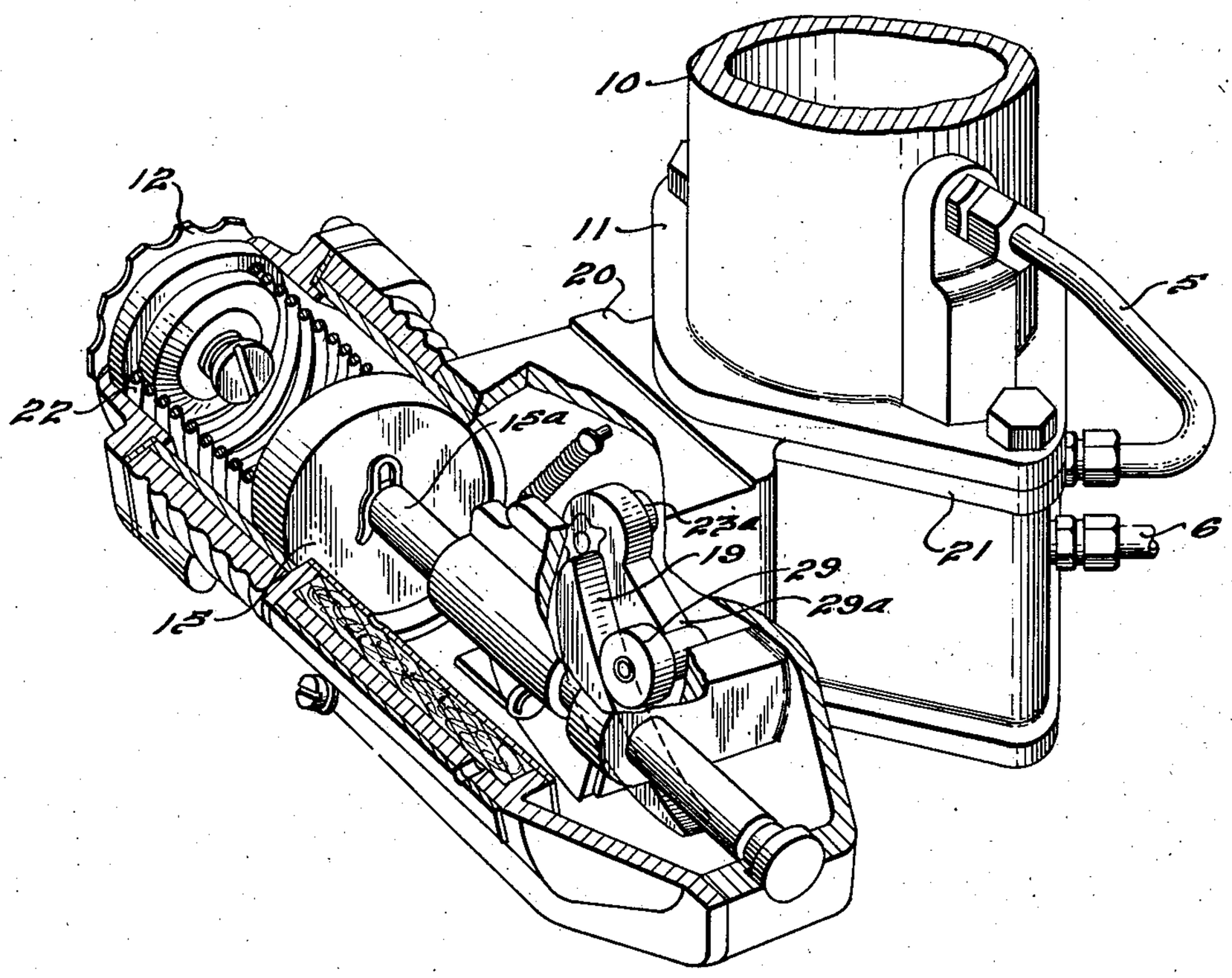
Fig. 3.



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SPARK CONTROL MECHANISM

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Renewed May 19, 1939

11 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 operating 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 device of the above character which is simple in construction and does not require close calibration of its spring or of other means employed.

A still further object of the invention is to provide a novel spark control mechanism 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 of the valve under said conditions and permitting positive holding of the valve in a desired operative position.

Other objects and advantages of the invention will appear more fully hereinafter from a consideration of the following description and appended claims, reference being had to the accompanying drawings wherein like reference characters refer to like parts throughout the several views.

Fig. 1 is a vertical sectional view of a spark control mechanism 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, slow speed); full carburetor throttle with the governor valve partially 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. 2 is a view similar in part to that of Fig. 1, showing the relative positions of parts under idling operation condition of the engine.

Fig. 3 is a perspective view partly broken away showing the carburetor and the governor as the same are operatively connected in the engine intake passage and the governor valve actuating mechanism arranged in the governor casing.

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 the 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 at the moment in said zone.

Referring more particularly to the figures, there is shown a carburetor casing **10** provided with suitable flanges **11** adapted to be secured to flanges **21** of the governor casing **20**. Within the carburetor casing **10** there is operatively arranged in the intake passage therethrough a throttle valve **13** of the butterfly type adapted to be operated in a manner well known in the art. Within the governor casing **20** there is operatively arranged in the intake passage leading to the engine intake manifold a governor valve **23** of the butterfly type adapted to restrict with the aid of a controlling mechanism the passage in accordance with the set requirements of the governor.

In the present embodiment said mechanism comprises (see Fig. 3) a balanced spring **22** adjustable by means of an adjustment disk **12**, which spring bears upon a piston **15** slidably fitted within said casing **20** and provided with a piston rod **15***a* carrying a cam **19** cooperating with a roller **29** carried by a crank arm **29***a* secured to the governor valve shaft **23***a* suitably journalled in the casing and carrying the governor valve **23**. With the increase or decrease of engine speed, the vacuum below the governor valve increase or decreases, and acting on the piston **15** the vacuum causes corresponding movements of said piston **15** against the spring **22**, thus moving the piston rod **15***a* and the cam **19**. The roller **29** following the outline of the cam **19** actuates the arm **29***a* and the governor valve shaft **23***a*, thereby closing or opening the governor valve **23**.

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 throttle **13** and the governor valve **23**; and C indicates the pressure zone in the intake passage below or at the downstream or manifold side of the governor valve **23**.

The spark control mechanism comprises generally a piston valve **30** slidable in a cylinder **40** provided within the governor casing **20**, and a diaphragm mechanism **50** operating the spark advancing means of the character mentioned. Said diaphragm mechanism **50** comprises a casing consisting of two flanged pieces **50***a* and **50***b* between which is held a corrugated diaphragm **51** operatively connected by means of a piece **53** and a rod **54** to the distributor **55** of a conventional design. The space **52** of said casing is hermetically sealed and is connected by means of a diaphragm conduit **6** with a port **46** leading into the cylinder **40**, while the space **52***a* is not sealed and communicates with the atmosphere. If a connection is established between said diaphragm conduit **6** and the pressure zone C, the action of vacuum existing at the time in said zone operates, when transmitted to the space **52**, to move the diaphragm **51** against the resistance of a spring **56** toward the conduit **6**, which movement of the diaphragm is transmitted by the rod **54** to the distributor **55**, 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 **52** decreases, the spring **56** becomes effective to move the diaphragm **51** away from said diaphragm conduit **6**, thereby moving the distributor in a position effecting a correspondingly smaller spark advance. When a connection between the conduit **6** and the pressure zone A is established, the air pressure at both sides of the diaphragm **52** becomes substantially balanced and the spring **56** moves the diaphragm **51** into a position effecting a predetermined degree of spark retard. Connected to the casing **10** is a pipe or conduit **5** which communicates with the intake passage through ports **17** and **18** located, respectively, just above and below the place at which the edge of the throttle **13** is about to engage the casing walls when the engine is set for idling. The opposite end of said conduit **5** communicates with a port **45** leading into the upper end of said cylinder **40**. A spring **34** is provided in the cylinder **40** and, unless compressed by the pressure upon the piston valve **30**, it tends to hold said piston in the extended position shown in Fig. 1, which position is determined by the length of the projecting shank **31** of the piston which serves as a stop for the piston valve **30** in the upward movement thereof. A conduit **7** arranged substantially parallel to the cylinder **40** communicates with the zone B by means of a port **27**, and with the lower end of the cylinder **40** through a port **47**. A conduit **8** connects the pressure zone C with the cylinder **40** through the medium, respectively, of ports **28** and **48**. The length of the cylinder **40** and of the stop projection **31** is such that in any position of the valve **30** the port **48** is included within the

recessed portion 33 of the piston valve 30 and communicates therewith.

In operation, when it is desired to have the spark advanced, the means hereinbefore described cooperate in such a way as to connect the vacuum space 52 with the pressure zone C where the degree of vacuum is the greatest, and the spark is advanced in proportion to the degree of vacuum in said zone. When the engine is operating at 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. 1. Under such operation conditions both the throttle valve and the governor valve are in the positions indicated by the numerals 14 and 24, respectively. The pressure in the zones A, B and C are substantially equal and in magnitude approach atmospheric pressure. This substantially atmospheric pressure is transmitted through the conduit 5 into the cylinder space above the piston valve 30, and through the conduit 7 and port 47 to the space under the piston valve 30. Consequently, as far as fluid pressure is concerned, the piston valve 30 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 will firmly hold the piston valve 30 in its extended position, effecting communication of the vacuum space 52 of the diaphragm casing with the pressure zone C under the governor valve 23, wherein a nearly atmospheric pressure exists at the moment, as explained. Said communication is effected through the port 28, conduit 8, port 48, recessed portion 33 of the valve 30, port 46 and conduit 6. Subjected to nearly atmospheric pressure the diaphragm 51 permits the spring (not shown) to set the spark into a substantially retarded position, as required for proper operation of the engine under such conditions.

With the throttle wide open, should the speed of the engine begin to increase excessively, as may be the case when accelerating in lower gears, or at higher speeds of the vehicle in high gear, the governor valve will partially close as shown, in consequence whereof 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 30, as before, the valve will be still firmly held in its upper position under the full force of the spring 34, while because of the space 52 communicating with the zone C of increasing vacuum, the diaphragm 51 will respond to the vacuum in said zone C and will advance 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 throttle valve 13 is in its partially closed position as at 16, the governor valve will ordinarily assume approximately the position indicated by the numeral 26, which position is substantially the same as that of the throttle 13. 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 16 of the throttle valve that the port 17 is located in the zone B rather than the zone A, and consequently, the piston valve 30 will again be subjected to equal or nearly equal pressures on both of its effective sides. As a consequence the fluid pressure will not effect its operative position and the spring 34 will hold the piston valve in its extended position, causing the conduit 8 to effect communication between the zone C and the space 52 of the diaphragm. This will cause the diaphragm to advance the spark in proportion to the amount of vacuum therein and, consequently, in accordance with the increase of the speed of the engine.

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 pressures 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. 2. It will be appreciated that under idling operation both the throttle 13 and the governor valve 23 are practically closed, and there is a high vacuum created in the pressure zones B and C while approximately atmospheric pressure exists in zone A. As can be noted from an examination of Fig. 2, the throttle 13 is nearly set down upon the walls of the casing 10 with its upper edge located between the ports 17 and 18. Therefore, the port 17 becomes located in the pressure zone A and the port 18 in the pressure zone B. The flow of air from zone A through port 17 reduces the degree of vacuum acting upon the piston valve 30, or in other words, causes a higher pressure to act upon 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 30, compressing the spring 34, and bringing the piston valve into the position shown in Fig. 2. In this position of the piston valve, the space 52 of the diaphragm casing communicates through conduit 6, port 46, upper part of the cylinder 40 and port 45 with conduit 5 wherein the pressure is substantially increased because of the operation of the port 17. In consequence thereof, the diaphragm 51 is moved into a position causing a retarded spark, as is required for a proper operation of the engine under idling conditions. Thus, when the throttle valve 13 is moved from the position of partial opening into the position for engine idling, the piston valve 30 operatively responds thereto and sets the spark in a properly retarded position. It will be understood that with the carburetor valve 13 in the position shown in Fig. 2 the pressure in conduit 5 will approach atmospheric since the effect of port 18 at this time is minimized. In some instances to suit particular engine requirements the passage or port 18 may be dispensed with so that under engine idling conditions substantially atmospheric pressure will exist in conduit 5.

Thus, in one of its broader aspects my invention contemplates providing a novel spark control device wherein the spark controlling diaphragm mechanism is actuated by the fluid pressure existing in the intake passage of the engine with the aid of a pressure responsive valve so arranged that when its response is required it is

actuated by the pressure difference in the zones above and below the carburetor throttle, thus ensuring a more dependable action of the device and a proper operative response of said valve when the engine operation is changed from partial throttle to idling.

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 responsive to the pressure in the intake passage, and a control valve for varying the zone of pressure in said passage to which said means is subjected, said control valve being movable under engine idling conditions in response to pressures at opposite sides of the carburetor valve upstream from the governor valve thereby subjecting said spark control means to a pressure greater than that existing at the engine side of the governor valve.

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 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 when said valves are nearly closed under idling conditions effective to move said control valve into position to subject said spark control means to a pressure greater than the pressure existing at the engine side of the governor valve.

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 and a conduit for normally subjecting the same to the pressure in said passage at the engine side of the governor valve, of means movable in response to pressure differences at opposite sides of the carburetor valve for subjecting said spark control device to a pressure greater than the pressure existing at the engine side of the governor valve when said valves are in engine idling positions.

4. In an internal combustion engine provided with an intake passage having a carburetor valve and a governor valve therein, the combination with a spark control device including a diaphragm, of a piston valve provided with a spring for holding it in a position effective to subject the diaphragm to the pressure at the engine side of the governor valve, said piston valve being movable against the action of said spring when the engine is idling in response to the pressures above and below the carburetor valve thereby causing said diaphragm to be subjected to substantially atmospheric pressure.

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 piston valve in said cylinder, a pair of conduits leading from the pressure zone between the carburetor and governor valves to the cylinder at opposite sides of said piston valve, a vacuum conduit leading from the zone at the engine side of the governor valve to the diaphragm and controlled by said piston valve, and means for subjecting one side of the piston valve to augmented pressure to effect a movement thereof into position to close said vacuum conduit and to open a conduit subjecting said diaphragm to said augmented pressure.

6. In an internal combustion engine provided with an intake passage having a carburetor valve and a governor valve therein, the combination with a spark control device including a diaphragm, of a piston valve provided with a spring for holding it in a position effective to subject the diaphragm to the pressure at the engine side of the governor valve, said piston valve being movable against the action of said spring when the engine is idling in response to the pressures above and below the carburetor valve thereby causing said diaphragm to be subjected to substantially atmospheric pressure through the medium of a conduit communicating with the intake passage at the upstream side of the carburetor valve.

7. 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 piston valve in said cylinder, a pair of conduits leading from the pressure zone between the carburetor and governor valves to the cylinder at opposite sides of said piston valve, a vacuum conduit leading from the zone at the engine side of the governor valve to the diaphragm and controlled by said piston valve, and means for subjecting one side of the piston valve to substantially atmospheric pressure to effect a movement thereof into position to close said vacuum conduit and to open a conduit subjecting said diaphragm to said substantially atmospheric pressure.

8. 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 piston valve 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, and a vacuum conduit connecting said diaphragm with the pressure zone at the engine side of the governor valve, said piston valve being movable when the carburetor valve is substantially closed to connect said diaphragm with said second conduit.

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, a cylinder, a piston valve 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, and a vacuum conduit connecting said diaphragm with the pressure zone at the engine side of the governor valve, said piston valve being movable when the carburetor valve is substantially closed to connect said diaphragm with said second conduit, and spring means for resisting said movement of said piston valve.

10. 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 responsive to the pressure in the intake passage, and a control valve for selecting the pressure zone to which said means are to be subjected under predetermined conditions, said control valve being subjected under all operation conditions of the engine except idling to sub-

stantially equal pressures at both of its effective sides.

11. 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 responsive to the pressure in the intake passage, and a control valve for selecting the pressure zone to which said means are to be subjected under predetermined conditions, said control valve being subjected at its effective sides under all operation conditions of the engine except idling to the pressures existing in the same pressure zone, and in idling conditions being responsive to the pressures existing in the pressure zones just above and below the carburetor throttle.

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