Jan. 27, 1942. A. G. H. VANDERPOEL ET AL 2,270,982

VARIABLE POINT DISTRIBUTOR

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Fig. 1

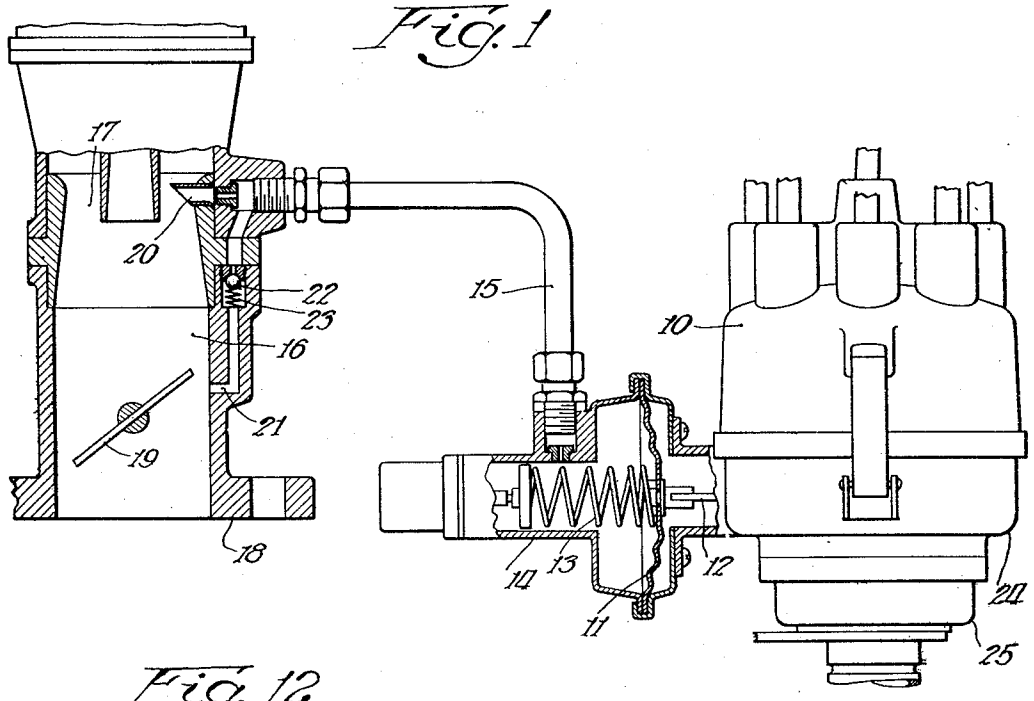
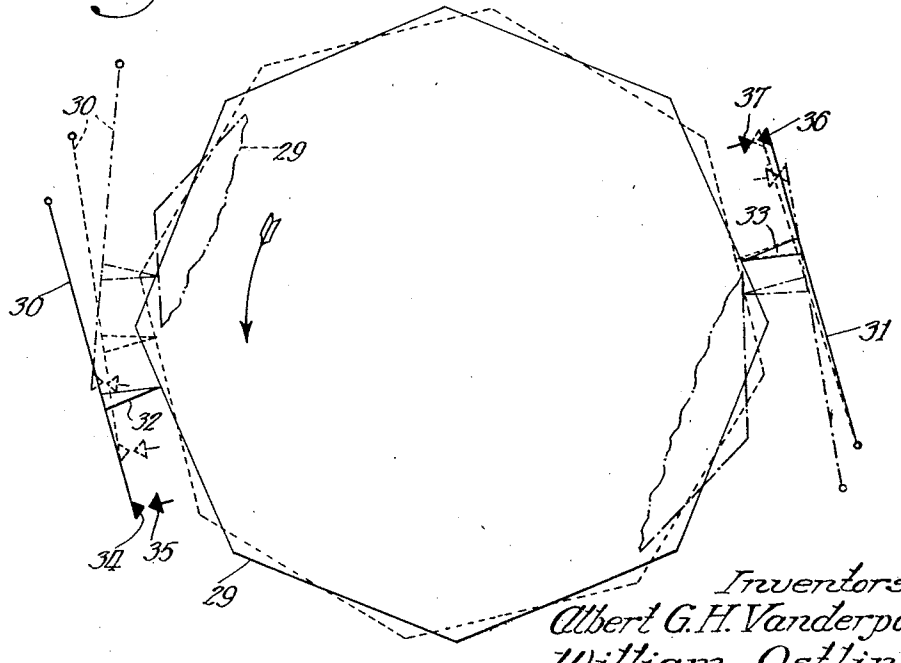


Fig. 12



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Fig. 2

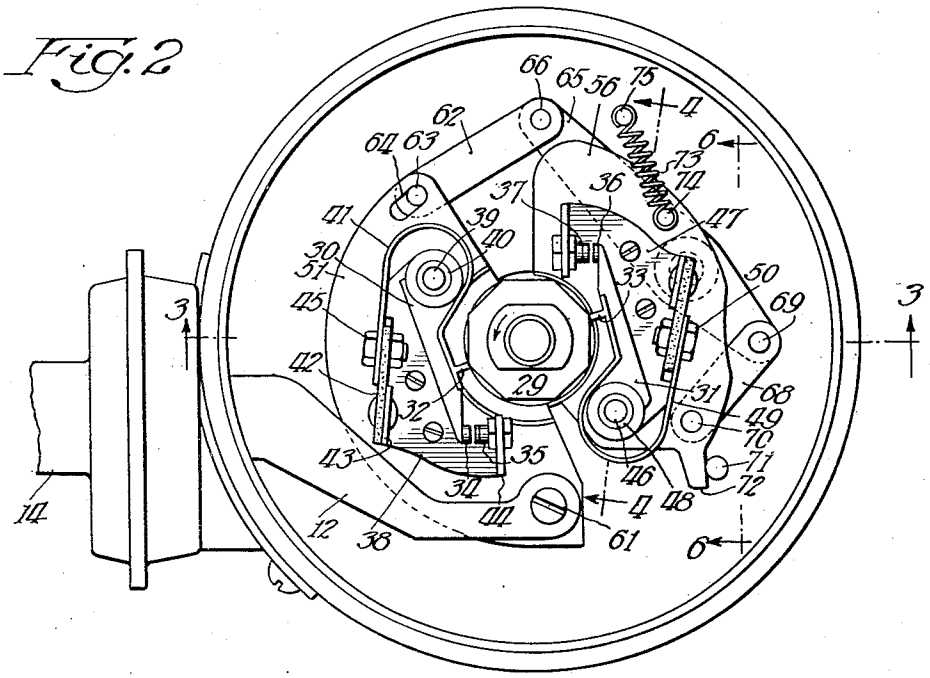


Fig. 3

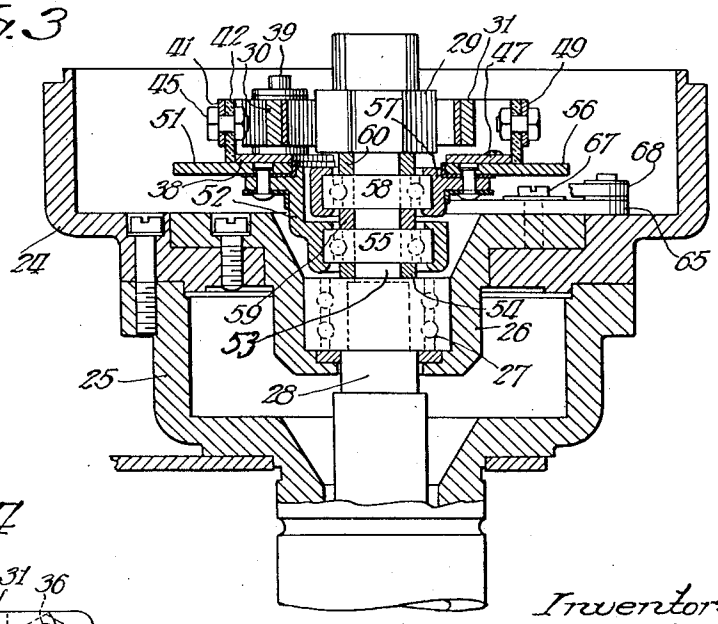
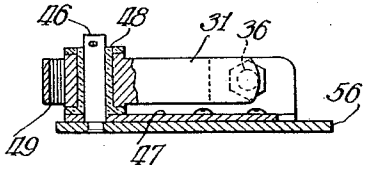


Fig. 4



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Fig. 5

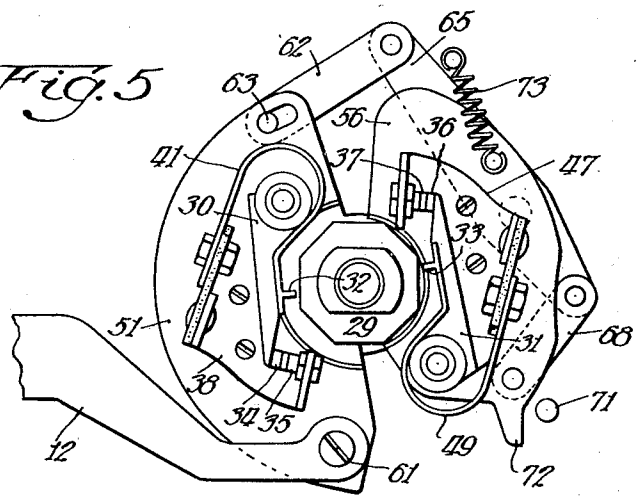


Fig. 6

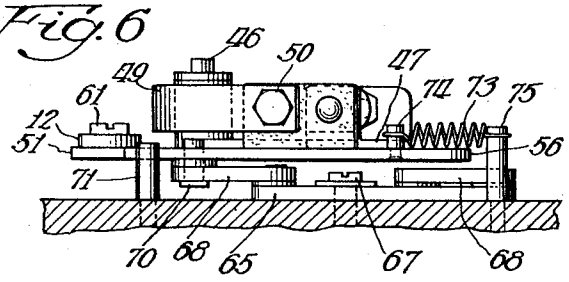


Fig. 7

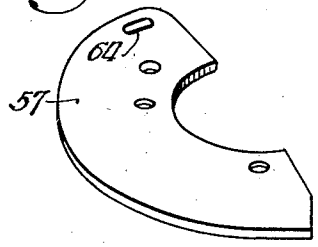


Fig. 8

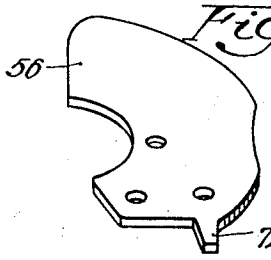


Fig. 11

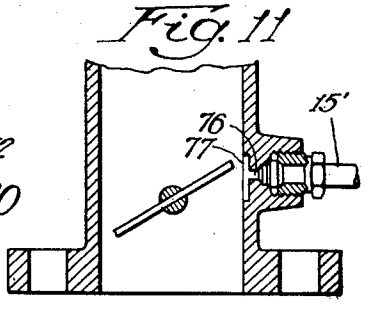


Fig. 9

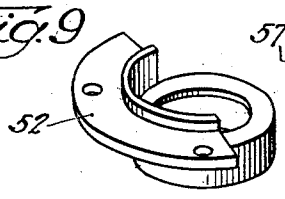
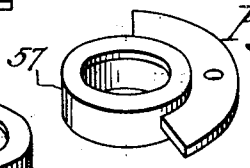


Fig. 10



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2,270,982

UNITED STATES PATENT OFFICE

2,270,982

VARIABLE POINT DISTRIBUTOR

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Application March 5, 1940, Serial No. 322,314

7 Claims. (Cl. 200—31)

The present invention relates to timing devices for internal combustion engines, and particularly to timing devices for controlling the advance of the circuit breaker and varying the periods of closed circuit for the primary coil of ignition circuits for internal combustion engines. The present invention is particularly applicable to engines containing a relatively large number of cylinders, such, for example, as aeroplane and automobile engines having more than eight cylinders.

The present invention utilizes a circuit breaker of the type having two breaker arms cooperating with a single cam. In such a device, a twelve cylinder engine requires a cam, the angle between the points of which is only thirty degrees. It is readily apparent that at high speeds, in order to maintain the primary circuit closed for a sufficient length of time to adequately charge the core of the ignition coil, it is necessary to use a relatively large amount of the thirty degrees for the closed circuit period. Yet at idling speed, it is desirable to utilize only a small amount of the thirty degrees for charging the core and thus avoid over saturation.

In accordance with the present invention, we propose to utilize two breaker arms, the cam engaging heels of which are set to maintain the circuit open for substantially the maximum allowable portion of the time between successive closings when the engine is idle. The breaker arms are controlled by the flow of air and fuel in the intake conduit to increase the closed circuit time and decrease the open circuit time as the velocity of the air and fuel mixture increases. One of these breaker arms is so connected as to respond to increase in the air and fuel velocity in the intake of the engine and thus advance with respect to the cam. The other breaker arm is so connected as to not be responsive to the increase in velocity of the air and fuel mixture until after the first breaker arm has been advanced a predetermined amount. Thereafter, the two breaker arms are both moved for advancing the spark, but one is moved more than the other so as to vary the proportional periods of open and closed circuit while the spark is advanced.

By virtue of advancing one breaker arm independently of the other, we create a varying period of overlap between the action of the cam on the breaker arms so that the breaker contact points, as the engine speeds up, can remain closed for a greater portion of the angle through which the cam travels between successive breaks in the circuit. For example, in a twelve cylinder engine, this action may be continued up to a certain maximum amount of overlap which enables the cam to travel as much as twenty-five degrees with the points closed. Preferably, this condition is reached at full load. Utilizing a suction control similar to that illustrated in our prior application Serial No. 306,606, filed November 29, 1939, we obtain further advance of both breaker arms and thereby obtain substantial advance of the spark for engine operation at high speed. The relative positions of the breaker arms for the further spark advance continues to change as one arm advances faster than the other. Therefore, the periods of open and closed circuit for the primary coil will continue to change. The present invention contemplates also certain improvements in connecting and mounting the breaker arms movably about the cam in order that a more effective control from the velocity of air and fuel in the intake conduit may be accomplished.

Other features and advantages of the present invention will appear more fully as the description proceeds, reference being had to the accompanying drawings, wherein a preferred embodiment of the invention is shown. It is to be understood, however, that the drawings and description are illustrative only, and are not to be taken as limiting the invention except insofar as it is limited by the claims.

In the drawings,

Fig. 1 is an assembly view partly in section showing the connections of the distributor to the air and fuel intake for an internal combustion engine;

Fig. 2 is a plan view of the cam and breaker arm construction of the distributor;

Fig. 3 is a sectional view taken substantially on the line 3—3 of Fig. 2;

Fig. 4 is an enlarged fragmentary detail view taken on the line 4—4 of Fig. 2;

Fig. 5 is a fragmentary plan view similar to Fig. 2 showing the changed position of the parts;

Fig. 6 is a fragmentary sectional view taken on the line 6—6 of Fig. 2;

Fig. 7 is a perspective view of one of the breaker arm carrying plates;

Fig. 8 is a perspective view of the other breaker arm carrying plate;

Fig. 9 is a perspective view of the supporting hub for the plate shown in Fig. 7;

Fig. 10 is a perspective view of the supporting hub for the plate shown in Fig. 8;

Fig. 11 is a fragmentary sectional view illus-

trating a modified form of suction inlet to the air intake conduit of the engine, and

Fig. 12 is a diagrammatic view illustrating the relative angular positions of the breaker arm heels in the two limiting positions of adjustment.

Referring now in detail to the drawings, the present invention is embodied in a circuit breaking mechanism for spark distributors wherein the primary circuit of the distributor is opened and closed by means of a cam cooperating with certain contact carrying breaker arms. The present device comprises a distributor 10, a suction operated diaphragm 11 connected to a spark advancing link 12 and pressed toward the link 12 by a spring 13. The diaphragm 11 and the spring 13 are contained in a suitable housing 14, the interior of which is connected by a conduit 15 to an air and fuel intake conduit 16. The conduit 16 includes a Venturi throat 17 and a portion 18 which connects to the intake manifold of the engine. The usual throttle valve 19 is provided in the conduit 16. The suction conduit 15, as shown in Fig. 1, opens into the Venturi throat 17 at 20 and has an additional check valve controlled opening 21 into the conduit 16 just above the throttle valve 19. The position of the inlet 21 is such that when the valve is slightly open the inlet will be on the lower side of the throttle valve. However, when the valve is closed, it will pass beyond the inlet 21, thus placing the inlet on the upstream side of the valve. A check valve 22 is backed up by a spring 23 so that, except when the suction at the inlet 21 is in excess of the suction at the inlet 20, the inlet 21 is cut off from the conduit 15. In normal full load conditions, with the throttle valve 19 wide open, it will be understood that the greater suction will be applied at the inlet 20, but when the throttle valve is in partially closed position, as, for example, in the position shown in Fig. 1, the velocity of the air past the throttle valve and past the inlet 21 will create more suction in the inlet 21 than at the inlet 20.

Referring now particularly to Figs. 2–10 inclusive, we will describe the mechanism whereby the suction in the air intake conduit 16 is utilized to control the advance of the opening of the primary circuit of the ignition coil with respect to the engine driven cam which actuates the circuit breaker of the spark distributor. As shown best by Figs. 2 and 3, the spark distributor embodies a cup-shaped base 24 which is mounted on a supporting member 25. The base 24 includes an insert 26 in which a bearing 27 is provided for the cam shaft 28. The details of the cam shaft support are of no particular importance to the present invention and will not be described in detail. The cam shaft 28 carries at its upper end the usual cam 29 which is provided with the same number of points as there are cylinders in the engine, that is, for a twelve cylinder engine there would be twelve points, while for a nine cylinder engine there would be nine points. Two circuit breaker arms 30 and 31 are disposed on opposite sides of the cam 29. The breaker arm 30 has a heel 32 riding on the cam 29. The breaker arm 31 has a heel 33 riding on the cam 29.

The breaker arm 30 carries a contact 34 which is adapted to cooperate with a relatively stationary contact 35 to close one point in the primary circuit of the ignition coil. Similarly, the breaker arm 31 carries a contact 36 which cooperates with a relatively stationary contact 37 to close another point in the primary circuit. A mounting plate 38 is provided with a pin 39 upon which the breaker arm 30 is pivotally mounted. An insulating bushing 40 supports the breaker arm on the pin 39 and insulates it from the plate 38 so that electrical connection to the plate 38 from the arm 30 must be through contacts 34 and 35. A spring 41 is fixed to the arm 30 and serves to urge the heel 32 of the arm against the cam 29. The spring 41 is supported from the plate 38 by means of a bar 42 of insulating material which is riveted to an upstanding flange 43 on the plate 38. The stationary contact 35 is adjustably mounted on an upstanding flange 44 of the plate 38. Electrical connection is made to the breaker arm 30 through a terminal 45 on the spring 41.

The breaker arm 31 is supported on a pin 46 mounted on a plate 47 which is similar in all respects to the plate 38. An insulating bushing 48 insulates the arm 31 from the plate 47. The plate 47 supports a spring 49 and the connecting mechanism for the spring 49, as well as the means for supporting the contact 37, are the same on the plate 47 as they are on the plate 38. A terminal 50 is provided on the spring 49 for connection to the ignition coil circuit.

The plate 38 is mounted upon a supporting plate 51 which, in turn, is supported by a hub 52 (see Figs. 3 and 9) that is journalled on a reduced portion 53 of the cam shaft 28. The reduced portion of the cam shaft has a collar 54 on top of the bearing 27. A ball bearing race 55 rests on the collar 54 and supports the hub 52 for rotative movement about the reduced part 53 of the shaft 28. The plate 47 is supported upon a mounting plate 56 (see Figs. 3 and 8) which, in turn, is carried by a hub 57. The hub 57 is rotatably journalled on the reduced portion 53 by a ball bearing race 58. A collar 59 separates the bearings 55 and 58 and another collar 60 separates the bearing 58 with respect to the cam 29.

By means of the construction just described, the two breaker arms 30 and 31 are rotatably journalled on the reduced extension 53 so that they may be turned to advance them with respect to the cam 29 and thus control the advance of the primary circuit breaker for the distributor in accordance with the movements of the diaphragm 11. The arrangement is such that the breaker arm 30 is advanced in response to the initial movement of the link 12 as suction increases in the intake conduit 16 from the condition existing at idling speed of the engine. On the other hand, the breaker arm 31 is not advanced initially, but is only advanced after a predetermined advance of the breaker arm 30.

The link 12 is connected directly to the plate 51 by means of a pivot screw 61. The plate 56 is connected to the plate 51 through a lost motion connection comprising a link 62 connected by a pin 63 and slot 64 to the plate 51. The link 62 connects to a lever 65 by means of a pivot pin 66. The lever 65 (see Fig. 6) is pivoted on the insert 26 by means of a screw 67. A link 68 connects the free end of the lever 65 to the plate 56, pins 69 and 70 providing pivots for this connection.

The plate 56 is normally held in the position shown in Fig. 2 by means of a stop pin 71 mounted in the cup 24 and a projection 72 on the plate 56. A spring 73 under tension between a pin 74 on the plate 56 and a pin 75 on the cup 24 holds the projection 72 against the stop 71. When the plate 51 is moved in a clockwise

direction, it initially does not affect the position of plate 56. However, as soon as the lost motion afforded by the pin and slot connection at 63 and 64 is taken up, the further movement of the plate 51 will also move the plate 56 in a clockwise direction against the tension of the spring 73. During the movement of both plates 51 and 56, there will be a change in the relative positions of the breaker arm heels 32 and 33 due to the fact that the pivot screw 67 is closer to one end of the lever 65. The relation as shown is such that the end of lever 65 to which the link 68 is connected is about one-half as far from the pivot of the lever as the end to which the link 62 is connected. There will also be a change in the angular position of both breaker arms with respect to the cam 29. Since the angular movement of the plates 51 and 56 is in the opposite direction to the direction of rotation of the cam 29, their movement results in an advance of the opening of the primary circuit of the ignition coil. In other words, the spark is advanced while changing the relative periods of open circuit and closed circuit when the two plates 51 and 56 are advanced together.

The modified form of suction inlet to the air and fuel intake illustrated in Fig. 11 utilizes a suction conduit 15', but utilizes only one inlet 76 to the intake conduit. This inlet includes an elongated slot 77 formed in the inner wall of the intake conduit and extending upstream from substantially the closed position of the throttle valve. The purpose of the inlet 76 and the elongated slot 77 is the same as the purpose of the two inlets in the main form of the invention. The elongated slot is a simpler construction, however, and produces a gradual increase in suction in the conduit 15' as the throttle valve is moved toward closed position. Under light load and high speed, this device will give the proper amount of suction to advance the spark in a very simple and effective manner.

Referring now to the preferred form of the invention, and particularly to Figs. 1, 2 and 12, the operation will be briefly described. The lost motion provided at 64 is for certain engines requiring very little flywheel advance. It is desirable to avoid too long a dwell which would keep the primary circuit closed and cause oversaturation of the core of the ignition coil. Therefore, at low speed, the contacts closing the circuit through the primary of the ignition coil should be kept separated through the major part of the cycle of energizing and deenergizing the ignition coil. The breaker arms 30 and 31 are accordingly set so that, when the engine is running at low speed, their normal position is such that the heels of the breaker arms 30 and 31 are engaged by the cam at substantially the same instant, and the contacts 34 and 35 are opened at the same time as the contacts 36 and 37. As the heel 32 of the breaker arm 30 rides over the adjacent cam point, and the contacts 34 and 35 approach each other, the heel 33 on the breaker arm 31 also rides over the adjacent cam point, and the contacts 36 and 37 close when the contacts 34 and 35 come together. The circuit of the primary coil is thus held open during the entire time necessary for the heels 32 and 33 to pass over the corresponding points of the cam until the contacts 34 and 35 and the contacts 36 and 37 come together.

The operation just described enables us to obtain a relatively long period of open circuit for the primary coil when the engine is idling. A correspondingly short period exists for saturating the core of the ignition coil. Over-saturation is thus avoided and the resultant heating and burning of points is eliminated.

As the engine speeds up, the increased velocity of air intake conduit creates a vacuum in the housing 14 so that the diaphragm 11 moves against the spring 13, causing the link 12 to move to the left, as shown in Fig. 2. The link 12 causes the plate 51 to rotate in a clockwise direction. This advances the position of the breaker arm 30 with respect to the cam 29, but at first has no effect upon the position of the breaker arm 31 because of the lost motion at 64.

As a result of advancing the breaker arm 30, its contacts 34 and 35 open before the contacts 36 and 37 open. The circuit of the primary coil is not opened, however, until both sets of contacts open. However, it is again closed as soon as the contacts 34 and 35 close. The net result of the advance of the breaker arm 30 independently of the breaker arm 31 is to reduce the period of open circuit, as measured in degrees of rotation of the cam, causing the period that the breaker arm 30 holds its contacts open to overlap less with the period that the breaker arm 31 holds its contacts open.

The proportion of each cycle during which the primary circuit of the ignition coil is held open is, therefore, greatest at idling speed and is reduced as the breaker arm 30 is advanced. The proportion of closed circuit of the primary coil is increased and the proportion of open circuit thereof is decreased as the breaker arm 30 is advanced as far as it can without also advancing the breaker arm 31. This lost motion at 64 is necessary with certain engines to obtain full coil saturation as the speed is increased.

The advance of the spark plug will begin as soon as the breaker arm 30 has advanced far enough to also cause the breaker arm 31 to advance. The advance is increased by the higher suction obtained in the conduit 15 and the housing 14 when the throttle valve 19 is partly closed, as shown in Fig. 1. The further advance continues to effect a change in the proportion of times of open and closed circuit for the primary coil because the two breaker arms 30 and 31, although advanced together, are advanced different amounts. That is, the arm 30 is advanced further because of the greater length of lever arm 65 connected to it.

The two sets of contacts 34—35 and 36—37 control parallel points in the primary circuit of the ignition coil, as will be readily understood. The cycle of operation of the ignition controlling device is as follows: Assuming that the engine is idling, the breaker arms 30 and 31 are in the full line position shown in Fig. 12. Both contact pairs will therefore open during the same travel of the cam 29. The opening of the throttle and the speeding up of the engine will first advance the arm 30. As the arm 30 advances independently of the arm 31, there will be a shortening of the angular travel of the cam during which both contact pairs are open. The shortening will continue until the limit of movement of the arm 30 allowed by the slot 64 is reached. The dotted line showing of the arm 30 in Fig. 12 represents this position. This limit of movement may be made more or less in any particular device by changing the length of the slot 64 in the plate 51.

When the suction in the conduit 15 is further increased, the two breaker arms 30 and 31 are

both advanced together, but the arm 30 is advanced further than the arm 31. Thus the spark is advanced and there is a further gradual increase in the proportionate time in the cycle during which the primary coil circuit is closed.

From the foregoing description it is believed that the nature of the present invention will be readily apparent to those skilled in this art. Having thus described our invention, what we claim as new and desire to secure by Letters Patent is:

1. A timing apparatus for internal combustion engines having means for adjusting the timing apparatus for differential operation as the movement of the air and fuel mixture through the air intake varies, the combination of a cam, two breaker arms movably mounted adjacent to said cam so as to be operable thereby, separate supporting members for said breaker arms respectively adapted to have rotary movement about the cam independently of each other, contact members adjacent to said cam, other contact members mounted on said breaker arms respectively so as to be movable into and out of engagement with said first-named contact members for producing sparks in timed relation as said breaker arms are actuated by said cam, actuating means for giving one of said breaker arms a movement about said cam so as to vary the effect of the cam thereon, and lost motion connections between said actuating means and the other breaker arm for giving said other breaker arm a delayed movement in the same direction about said cam.

2. A timing apparatus for internal combustion engines having means for adjusting the timing apparatus for differential operation as the movement of the air and fuel mixture through the air intake varies, the combination of a cam, two breaker arms movably mounted adjacent to said cam so as to be operable thereby, separate supporting members for said breaker arms respectively adapted to have rotary movement about the cam independently of each other, contact members adjacent to said cam, other contact members mounted on said breaker arms respectively so as to be movable into and out of engagement with said first-named contact members for producing sparks in timed relation as said breaker arms are actuated by said cam, actuating means for giving one of said breaker arms a movement about said cam so as to vary the effect of the cam thereon, yielding means normally holding said other breaker arm yieldingly against movement in the same direction about said cam, and lost motion connections between said actuating means and said other breaker arm adapted to give said other breaker arm a delayed movement against the action of said yielding means after said one breaker arm has passed through the initial portion of its adjustment movement.

3. A timing apparatus for internal combustion engines having means for adjusting the timing apparatus for differential operation as the movement of the air and fuel mixture through the air intake varies, the combination of a cam, two breaker arms movably mounted adjacent to said cam so as to be operable thereby, separate supporting members for said breaker arms respectively adapted to have rotary movement about the cam independently of each other, contact members adjacent to said cam, other contact members mounted on said breaker arms respectively so as to be movable into and out of engagement with said first-named contact members for producing sparks in timed relation as said breaker arms are actuated by said cam, actuating means for giving the supporting member for one of said breaker arms a movement about said cam so as to vary the effect of the cam on said breaker arm, and lost motion connections between said supporting members for giving the supporting member for the other one of said breaker arms a delayed movement in the same direction about said cam.

4. A timing apparatus for internal combustion engines having means for adjusting the timing apparatus for differential operation as the movement of the air and fuel mixture through the air intake varies, the combination of a cam, two breaker arms movably mounted adjacent to said cam so as to be operable thereby, separate supporting members for said breaker arms respectively adapted to have rotary movement about the cam independently of each other, contact members adjacent to said cam, other contact members mounted on said breaker arms respectively so as to be movable into and out of engagement with said first-named contact members for producing sparks in timed relation as said breaker arms are actuated by said cam, and actuating means operatively connected with said breaker arms adapted by an operative movement to give one of said breaker arms a movement about said cam at one rate and to give other of said breaker arms a movement about the cam at a slower rate.

5. A timing apparatus for internal combustion engines having means for adjusting the timing apparatus for differential operation as the movement of the air and fuel mixture through the air intake varies, the combination of two sets of cooperating contacts adapted when connected in parallel with each other in a circuit to break the circuit for producing a spark only when both sets of contacts are open simultaneously, and means acting on both sets of contacts adapted in one adjustment to hold both sets open for the same time and adjustable so as to change the time of opening one set in comparison with the time of opening the other set whereby the period during which the circuit is broken may be controlled.

6. A timing apparatus for internal combustion engines having means for adjusting the timing apparatus for differential operation as the movement of the air and fuel mixture through the air intake varies, the combination of two sets of cooperating contacts adapted when connected in parallel with each other in a circuit to break the circuit for producing a spark only when both sets of contacts are open simultaneously, means acting on both sets of contacts adapted normally to open and close both sets substantially simultaneously and adjustable for changing the time of action on said two sets of contacts, and actuating means adapted by the initial portion of a stroke in one direction to adjust said contact opening means for advancing the action on one set of contacts while leaving the action on the other set of contacts unchanged so as to cut down the period during which the circuit is broken and adapted by a later portion of said stroke to adjust said contact opening means for advancing still further the action on said one set of contacts and for advancing to a smaller extent the action on said other set of contacts.

7. A timing apparatus for internal combustion engines having means for adjusting the timing

apparatus for differential operation as the movement of the air and fuel mixture through the air intake varies, the combination of a cam, two breaker arms movably mounted adjacent to said cam so as to be operable thereby, separate supporting members for said breaker arms respectively adapted to have rotary movement about the cam independently of each other, contact members adjacent to said cam, other contact members mounted on said breaker arms respectively so as to be movable into and out of engagement with said first-named contact members for producing sparks in timed relation as said breaker arms are actuated by said cam, a link pivotally connected with one of said supporting members for giving it a movement about said cam so as to vary the effect of the cam on the breaker arm carried by said supporting member, and connections between said two supporting members comprising a lever pivotally mounted on a vertical axis adjacent to said supporting members, a link providing a lost motion connection between said lever and said one supporting member, and a second link connecting the other of said supporting members with said lever at a point substantially closer to the pivotal axis of the lever than that at which the other link is connected to said lever.

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