Dec. 29, 1942. T. G. LOUIS 2,306,549

AUTOMATICALLY ADJUSTABLE CAM-OPERATED IGNITION CIRCUIT BREAKER

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Fig. 1.

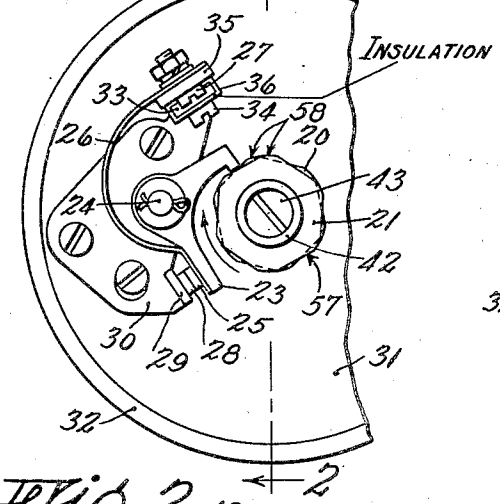


Fig. 3.

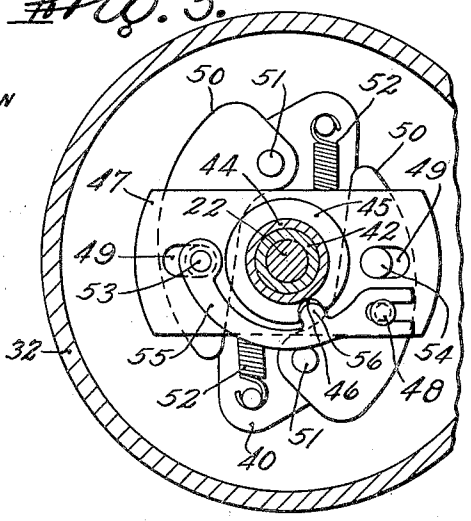


Fig. 2.

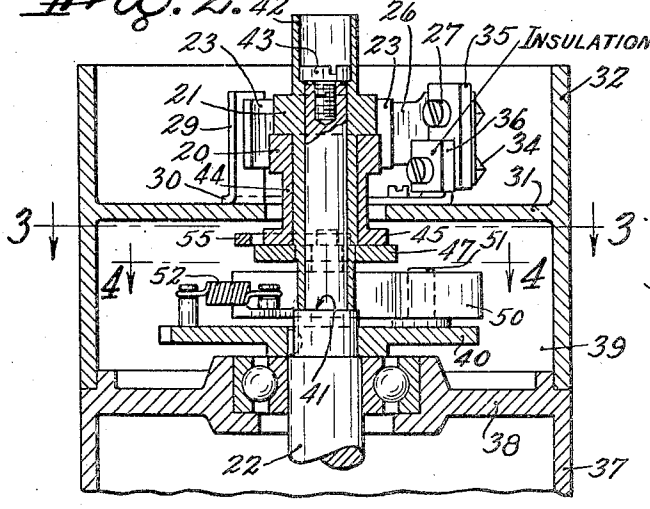


Fig. 4.

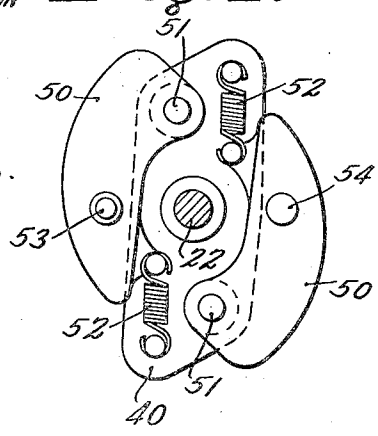
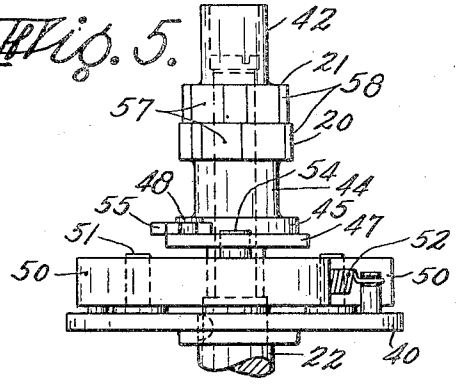


Fig. 5.



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Fig. 6.

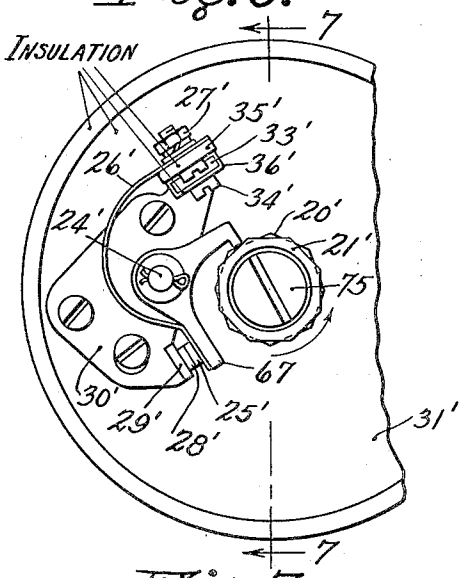


Fig. 8.

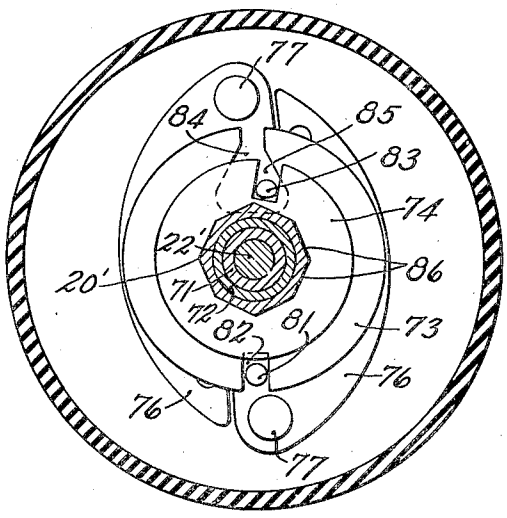


Fig. 7.

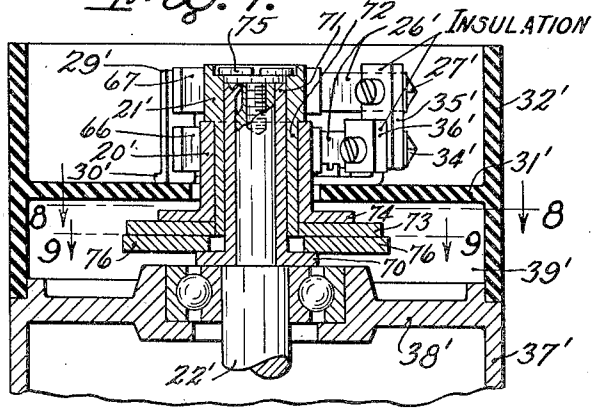


Fig. 9.

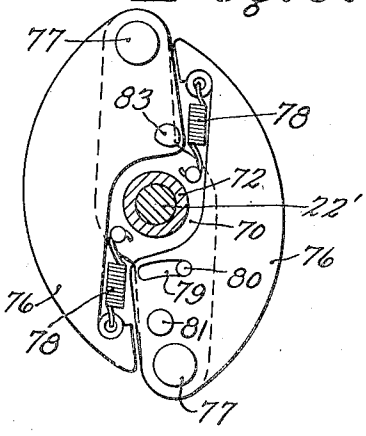
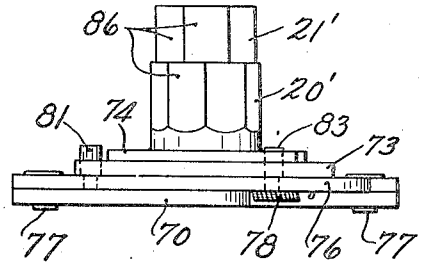


Fig. 10.



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Fig. 11.

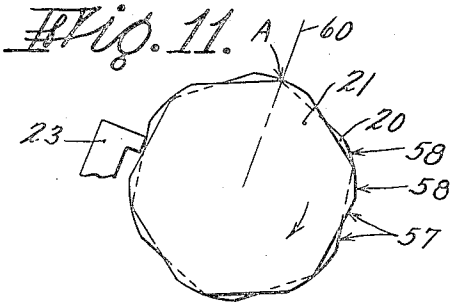


Fig. 13.

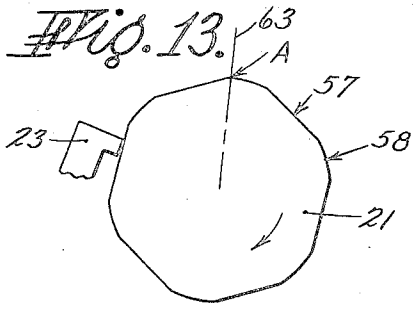


Fig. 12.

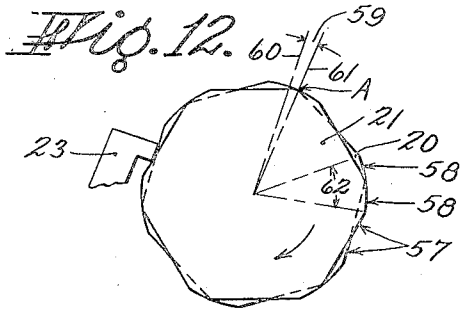


Fig. 14.

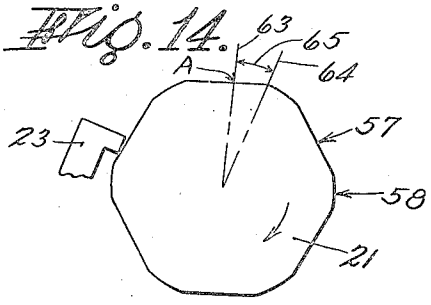


Fig. 15.

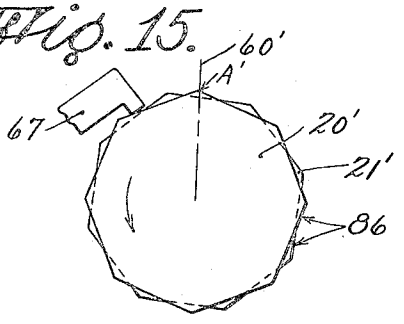


Fig. 17.

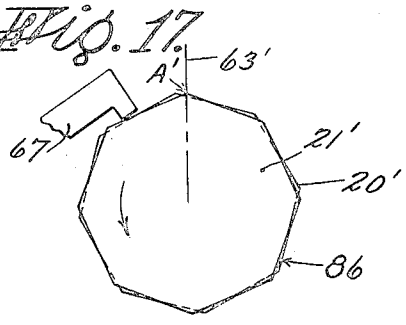


Fig. 16.

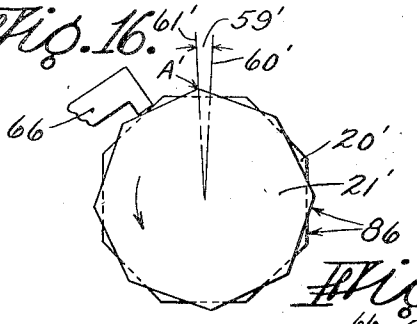


Fig. 18.

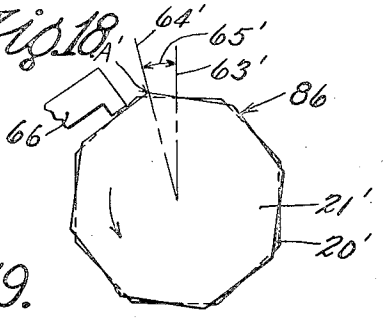
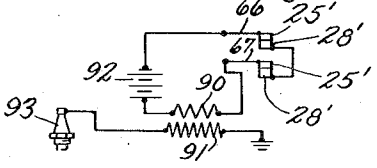


Fig. 19.



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AUTOMATICALLY ADJUSTABLE CAM-OPERATED IGNITION CIRCUIT BREAKER

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Fig. 20.

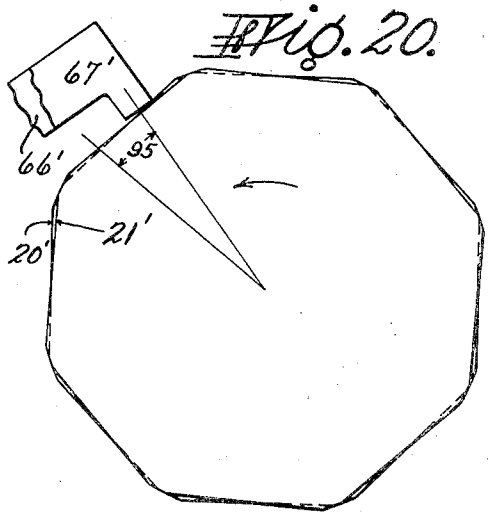


Fig. 21.

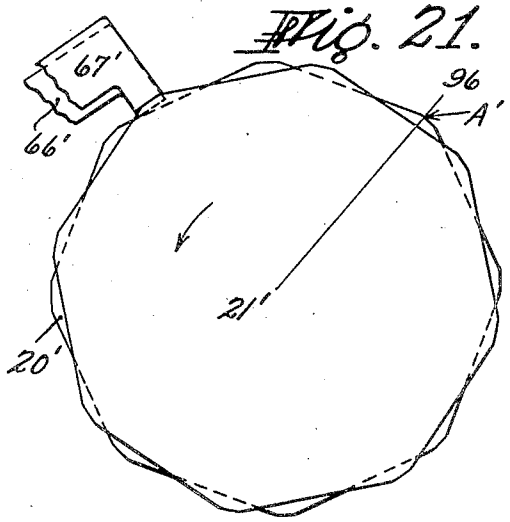


Fig. 22.

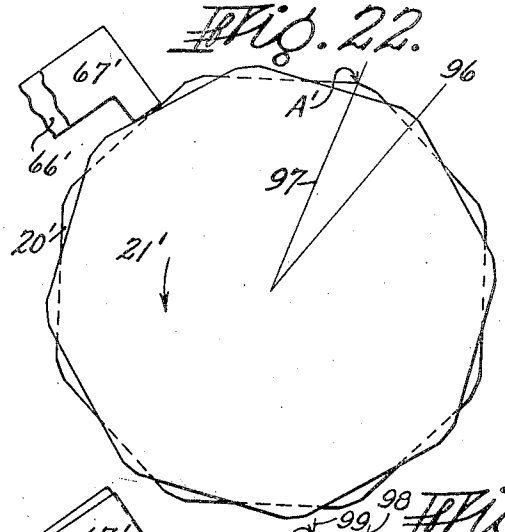


Fig. 23.

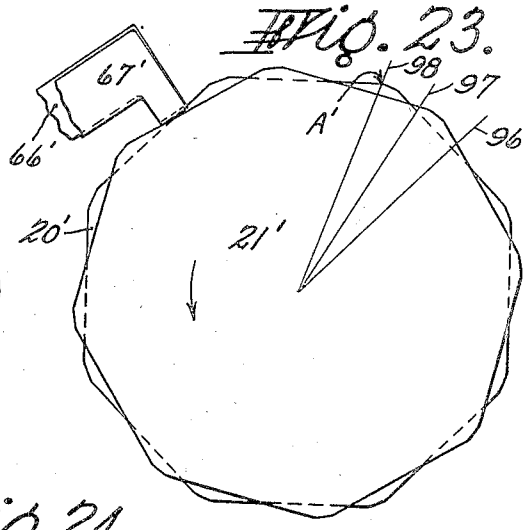


Fig. 24.

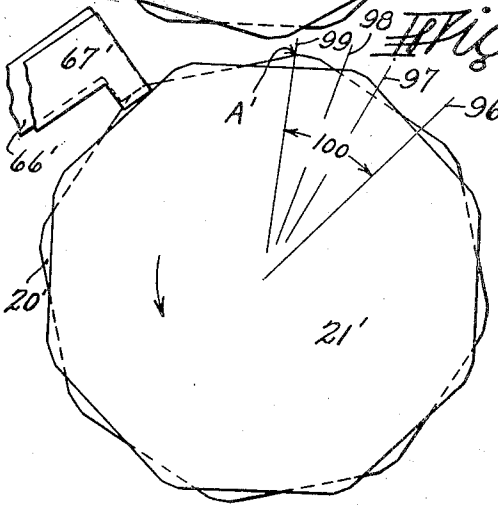
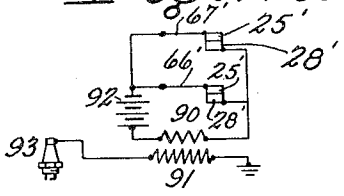


Fig. 25.



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Patented Dec. 29, 1942

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UNITED STATES PATENT OFFICE

2,306,549

AUTOMATICALLY ADJUSTABLE CAM-OPERATED IGNITION CIRCUIT BREAKER

Terrence G. Louis, West Springfield, Mass., assignor to Wico Electric Company, West Springfield, Mass., a corporation of Massachusetts

Application October 31, 1941, Serial No. 417,246

10 Claims. (Cl. 200—31)

This invention relates generally to improved mechanism for controlling the closing and opening of an ignition circuit of an internal combustion engine and for automatically regulating the ignition voltage to compensate for variations in engine speed.

More particularly, the invention relates to an improved cam-operated circuit breaker, adjustable automatically in response to variations in engine speeds to vary the angular extent of the dwell interval of the cam means, increasing and decreasing the dwell accordingly as the engine speed increases and decreases, respectively, with the object in view of maintaining substantially constant the time intervals during which the ignition circuit is closed irrespective of variations in engine speed.

The invention has for an object to provide a pair of cams, mounted side by side on a driving shaft and relatively shiftable in response to variations in speed of said shaft, together with circuit making means controlled by one cam and circuit breaking means controlled by the other cam, whereby on relative rotation of said cams the time intervals during which the ignition circuit remains closed may be varied.

The invention has for another object to provide in mechanism of the character described, a compact arrangement of the cams and their speed-responsive shifting means and one which is susceptible to quantity production manufacture at low unit cost.

The invention also provides for automatic spark advance as is usually desired and the same speed-responsive mechanism usually used to shift one cam ahead on its drive shaft for this purpose may also be employed to impart a different degree of shifting of the other cam to create a relative movement between the cams for varying the closed intervals of the ignition circuit.

These and other objects will best be understood as the detailed description proceeds and they will be particularly pointed out in the appended claims.

The invention will be disclosed with reference to the accompanying drawings, in which:

Fig. 1 is a fragmentary top plan view of one form of breaker-point mechanism embodying the invention;

Fig. 2 is a sectional elevational view taken on the line 2—2 of Fig. 1;

Figs. 3 and 4 are sectional plan views taken on the lines 3—3 and 4—4, respectively, of Fig. 2;

Fig. 5 is an exterior elevational view of the unit, comprising the cams and the speed-responsive means for shifting them;

Fig. 6 is a fragmentary top plan view of another form of breaker point mechanism, embodying the invention;

Fig. 7 is a sectional elevational view taken on the line 7—7 of Fig. 6;

Figs. 8 and 9 are sectional plan views taken on the lines 8—8 and 9—9, respectively, of Fig. 7;

Fig. 10 is an exterior elevational view of the unit, comprising the cams and the speed-responsive means for shifting them;

Figs. 11, 12, 13 and 14 are diagrammatical views illustrative of the operation of the mechanism shown in Figs. 1 to 5 inclusive;

Figs. 15, 16, 17 and 18 are diagrammatical views illustrative of the operation of the double breaker mechanism shown in Figs. 6 to 10 inclusive when the breakers are connected in series;

Fig. 19 is a wiring diagram showing the series connection of the breakers in an ignition system;

Figs. 20 to 24 inclusive are diagrammatical views illustrative of the operation of the double breaker mechanism shown in Figs. 6 to 10, inclusive, when the breakers are connected in parallel; and

Fig. 25 is a wiring diagram showing the parallel connection of the breakers in an ignition system.

Referring first to that form of the invention which is shown in Figs. 1 to 5 inclusive, the mechanism includes two cams 20 and 21. These cams are mounted side by side on a drive shaft 22 and arranged to actuate a single breaker arm 23 of any suitable kind. As shown, the breaker arm is made of insulating material; is pivotally mounted on a stud 24 and carries a breaker point 25, which is electrically connected by a spring 26 to a terminal bolt 27. A cooperating breaker point 28 is fixed to an upstanding part 29 of a plate 30 which is suitably fixed, in a manner to enable adjustment toward and away from the cams, to the bottom wall 31 of the breaker box 32. The spring 26 tends to hold one end of the breaker arm against the cams 20 and 21. The arm is wide enough to engage both cams as shown in Fig. 2. The plate 29 has an upstanding lug 33 to which is secured by the bolt 34 a metallic member 35. Member 35 is suitably insulated from lug 33, as indicated in part by the insulation 36. The spring 26 is secured to member 35 by the bolts 28 and 34.

As shown herein, the breaker box is mounted

on a casing 37 having an end wall 38 in which is provided a suitable bearing, such for example as the ball bearing shown, for one end of drive shaft 22. Between the walls 31 and 38 is a compartment 39 in which the speed-responsive, cam-shifting mechanism may be located.

The invention is more particularly concerned with the shiftable cams and any suitable speed-responsive mechanism for shifting them. The other structure, thus far described, may be varied as desired.

The speed-responsive mechanism includes a plate 40 fixed centrally between its ends to the drive shaft 22. This shaft extends beyond plate 40 and is turned down to form a portion of reduced diameter and a shoulder 41. Rotatably mounted upon such portion is a sleeve 42, one end of which seats against the shoulder 41. In the other end of sleeve 42 is a counterbore to receive the head of a screw 43 which is threaded into the outer end of the drive shaft, whereby the sleeve 42 is held against any substantial axial displacement on the shaft but is free to rotate thereon. The cam 21 is formed on this sleeve. The cam 20 is an integral part of a second sleeve 44 which is rotatably mounted on the first sleeve 42 and which terminates with a flange 45 having a notch 46 in its periphery. The sleeve 42 has fixed thereto a flange 47 which lies adjacent the flange 45 and is provided with a pin 48 and two diametrically opposed slots 49. The cams are located in the breaker box but the flanges 45 and 47 are located on the opposite side of wall 31 in the compartment 39.

The speed responsive mechanism, in the particular form herein shown, comprises two weights 50 which are pivoted to plate 40, one near each end thereof, on studs 51. Each weight is provided with a spring 52 which connects it to plate 40 and tends to hold the weight in the inner and retracted position illustrated. One weight is provided with a stud 53 and the other with a pin 54. The stud 53 passes through one of the slots 49 in flange 47 and the pin 54 passes through the other of the slots 49. As the weights move outwardly under the influence of centrifugal force, the stud and pin each engage a side wall of a slot 49 and turn flange 47 in a clockwise direction, thereby turning cam 21 ahead on shaft 22 in the direction of revolution thereof. The stud 53 pivotally receives one end of a link 55. The other end of this link is forked to straddle the pin 48 which serves to guide the link in a straight line path relatively to flange 47. This link has a projection 56 which is engaged in recess 46 of flange 45, whereby the movement of one of the weights 50 turns flange 45 in a clockwise direction, thereby turning cam 20 ahead on shaft 22 in the direction of revolution thereof. The movement imparted to cam 20 for any given movement of weight 50 is greater than that imparted to cam 21.

The cams 20 and 21 are identical in shape. Each has a plurality (six in this particular case) of flat surfaces 57 (Figs. 1 and 5) interconnected by curved surfaces 58 which are coaxial with the drive shaft 22. On starting, the two cams are angularly displaced one from the other as shown in Figs. 11 and 12. Since the one breaker arm 23 rides on both cams, there will be a very small angular interval between the closing and the opening of the breaker points 25 and 28, for example, the angle 59 shown in Fig. 12. The parts are shown in Fig. 11 in the position they assume when the breaker points close and in Fig. 12 in the positions they assume when the breaker points start to open. The point A in Fig. 11 moves from the radial line 60 to the radial line 61 (Fig. 12) in travelling clockwise from the closing to the opening position of the breaker points. The angle between lines 60 and 61, designated 59, represents the angular interval during which the breaker points are closed and thus during which flux can build up in the ignition coil. This interval is relatively small. The dwell of the breaker points in open position is relatively large and is represented by the angle 62. The breaker arm then rides on a curved surface which is coaxial with the drive shaft and made up of two curves 58 (one on each cam) and positioned end to end. As the shaft 22 speeds up the weights 46 swing outwardly under the influence of centrifugal force and the outer cam 21 is swung ahead in the direction of rotation (shown by the arrow) to give the necessary spark advance and the inner cam 20 is swung ahead in the same direction to a greater angular extent to increase the angular dwell interval during which the breaker points are closed. As the speed increases, the aforesaid dwell angle increases to compensate with the object of maintaining the actual time, during which the breaker points remain closed, approximately constant. At full speed, the two cams move into positions where their surfaces 57 and 58 substantially coincide as shown in Figs. 13 and 14. Fig. 13 shows the cams positioned to cause closing of the breaker points and Fig. 14 shows the cams positioned to cause opening of the breaker points. The point A moves from the radial line 63 to the radial line 64 in travelling from the Fig. 13 to the Fig. 14 position and it will be seen that the angle between these lines 63 and 64, denoted 65, is substantially larger than the angle 59.

Another form of the invention is shown in Figs. 6 to 10 inclusive. As before, inner and outer cams 20' and 21' are mounted for rotation relatively to a drive shaft 22' and these cams are located in a breaker box 32'. In this case, however, two breaker arms 66 and 67 are employed—one arm 66 rides on cam 20' and the other arm 67 rides on cam 21'. Both breaker arms are mounted on a stud 24' and each carries a breaker point 25'. The stud 24' and fixed breaker point 28' are mounted on a metal plate 30' secured as before to the bottom wall 31' of the breaker box which is of insulating material. A spring 26' is employed for each breaker arm as before and both springs are mechanically connected as before to terminal plate 35', which in this case is of insulating material.

The speed-responsive mechanism for shifting the cams 20' and 21' is, as before, located in a compartment 39' formed in a casing 37' between walls 31' and 38'. This mechanism is of specifically different form although it functions in a manner similar to that already described. The mechanism includes a plate 70. Suitably fixed to this plate at a point intermediate its ends is a sleeve 71. Upon this sleeve is rotatably mounted the outer cam 21' and an integral tubular extension 72 of such cam. A flange 73 is fixed to the extension 72 and axially spaced from cam 21'. Upon the tubular extension 72, the inner cam 20' is rotatably mounted. Cam 20' has at one end a flange 74 which abuts flange 73. The other end of cam 20' abuts the inner end of cam 21'. The cam 20' is placed on extension 72 and thereafter the flange 73 is suitably fixed in position on such extension. The

cams are located in the breaker box 32' while the flanges 73 and 74 are located in the compartment 39'. The sleeve 71 is keyed to shaft 22' as shown in Fig. 7. The plate 70 rests against a shoulder on shaft 22' and is held thereagainst by a stud 75 threaded into one end of the shaft. This stud also serves to limit the outward movement of cam 21' and its tubular extension 72 on shaft 22'.

The speed-responsive mechanism, in the form herein shown, comprises a pair of weights 76 which are pivoted one to each end of plate 70 on studs 77. The weights lie between plate 70 and the adjacent face of flange 73. A spring 78 interconnects each weight to plate 70 and tends to hold it in the illustrated and innermost position. A slot 79, provided in one of the weights, is curved concentrically with its pivot and receives a pin 80, fixed to plate 70. This pin and slot connection limits the inward and outward swinging movement of this weight and with it the movement of cam 21', as will appear.

These weights are arranged to move the cams 20' and 21' on shaft 22' and relatively to one another. This may be done in any suitable way. As shown, one weight has fixed thereto at a point relatively close to its pivot stud 77, a pin 81 which engages in a recess 82 in the flange 73, whereby to rotate cam 21' when this weight moves. The other weight has a pin 83 which passes through a large clearance opening 84 in flange 73 and enters a recess 85 in flange 74, whereby to rotate cam 20' when this weight moves. The pin 83 riding in opening 84 limits the movement of this weight and with it the movement of cam 20'.

The cams 20' and 21' are identical in shape. Each has a plurality (eight in this particular case) of flat surfaces 86 intersecting in nearly sharp edges and arranged in octagonal form. On starting, the two cams are angularly displaced as shown in Figs. 15 and 16. When the weights move outwardly under the influence of centrifugal force, the cams are shifted in the direction of rotation (counterclockwise as illustrated) and to extents increasing as the speed increases until the two cams come into registration or nearly so, as shown in Figs. 17 and 18. As above described, the outer cam 20' moves to a less degree than the inner cam 21', the former serving to advance the spark and the latter to increase the dwell as the speed increases. Figs. 15 and 17 show the outer breaker arm 67 positioned to cause closing of the breaker points while Figs. 16 and 18 show the inner breaker arm 66 positioned to cause opening of the breaker points. The two breakers are connected in series in any suitable ignition circuit, for example as shown in Fig. 19. In this figure, 90 and 91 represent the primary and secondary of an ignition coil; 92 represents a battery or other suitable source of electromotive force; and 93 a spark plug. The two breakers control the circuit in which the primary coil 90 and battery 92 are included. This circuit will be closed only when both breaker arms 66 and 67 move into position to engage their breaker points 25' and 28'. The circuit will be opened, however, whenever either of the breaker arms moves outwardly into position to disengage its breaker points. Each breaker arm moves to closed and subsequently to open position during each 45 degree movement of its actuating cam. Only the closing movement of one breaker arm and only the opening movement of the other breaker arms is effective insofar as exercising any control of the ignition circuit is concerned. For example, as shown in Fig. 15, the breaker arm 67 has moved to engage its breaker points. The other breaker arm 66, which lies immediately in back of arm 67, has just previously moved into closed position. The second arm (67) to move into closed position is the one which causes the closing of the ignition circuit. The first arm (66) when moved into closed position was not effective to close the ignition circuit because the breakers are wired in series in the ignition circuit as shown in Fig. 19. Now, when the cams have moved through the angle 59' into the positions shown in Fig. 16, the breaker arm 66 has been moved to disengage its breaker points while the other set of breaker points controlled by arm 67 will still be closed. The arm 66, being the first to move into breaker point opening position, controls the opening of the ignition circuit. The subsequent disengagement of the other set of breaker points by the outward movement of arm 67 will be ineffective. Thus, as in the first form of the invention, one cam controls the closing and the other cam controls the opening of the ignition circuit.

The two breakers may be also connected in parallel as indicated diagrammatically in Fig. 25. The operation of the invention will then be as illustrated in Figs. 20 to 24 inclusive. Fig. 20 shows the low speed positions of the cams 20' and 21'. They are nearly in coincidence and the two breaker arms 66' and 67' move almost simultaneously. The dwell interval, during which the ignition circuit is closed is illustrated by the angle 95. Now, as the engine speeds up, the cams are relatively shifted in the direction of rotation, say for example into the relative positions shown in Figs. 21 to 24 inclusive. In Fig. 21 the cam 20' has just allowed the breaker arm 66' to move to breaker point closing position and this will cause closing of the ignition circuit. In Fig. 22, the point A' has moved from its former position, marked by the radial line 96, to the position marked by the radial line 97, in which position the other breaker 67' will allow the other set of breaker points to close. This closing of the second set of breaker points will have no effect on the ignition circuit since the circuit is already closed. Then, when the point A moves to the position marked by the radial line 98 in Fig. 23, the breaker arm 66' will have moved to open position but this will not cause opening of the ignition circuit since the other set of breaker points are still closed. Finally, the point A moves into the position marked by the line 99 in Fig. 24 and in this position the cam 21' will have moved the breaker arm 67' into position to open its breaker points thereby opening the ignition circuit. The angle 100 between the radial lines 96 and 99 represents the angular interval during which the ignition circuit is closed and it is much greater than the dwell angle 95 at low speed as shown in Fig. 20. As before, one cam controls the closing and the other cam controls the opening of the ignition circuit.

The invention provides a compact arrangement of two relatively shiftable cams and a speed responsive mechanism for actuating them. The cams are of usual contour, such as has been proved by long experience to be practical and workable in a commercially satisfactory manner. They may be readily manufactured in quantities at low unit cost. The speed responsive mechanism need be no different from that which is usually employed anyway in order to secure automatic spark advance. The cams and the breaker

mechanism readily fit within a breaker box of standard form and size and the speed-responsive mechanism, having weights which move in a single plane at right angles to the axis of the drive shaft, takes up little room and may be housed in the small compartment **39** beneath the breaker box.

What I claim is:

1. In combination, circuit making and breaking means, a driving shaft, two cams mounted side by side on said shaft and driven thereby, one cam intermittently actuating said means into circuit making position, the other cam intermittently actuating said means into circuit breaking position, said cams being relatively rotatable to vary the angular interval between said making and breaking positions, and means responsive to the speed of said shaft for relatively rotating said cams.

2. In combination, circuit making and breaking means, a driving shaft, two cams mounted side by side on said shaft and rotatable relatively thereto and to each other, one cam intermittently actuating said means to circuit making position and the other cam intermittently actuating said means into circuit breaking position, and driving connections between said shaft and cams including means responsive to the speed of said shaft for shifting both cams on said shaft but to different degrees, whereby the cams may be relatively shifted to vary the interval between said making and breaking positions.

3. In combination, circuit making and breaking means, a driving shaft, two cams mounted side by side on said shaft and rotatable relatively thereto and to each other, one cam intermittently actuating said means to circuit making position and the other cam intermittently actuating said means into circuit breaking position, and driving connections between said shaft and cams including means responsive to the speed of said shaft for shifting one of said cams on said shaft to advance or retard one of said positions and for shifting the other cam to vary the interval between successive making and breaking positions.

4. In combination, a casing having a breaker box and a compartment adjacent thereto and separated therefrom by a partition, a driving shaft extending from said compartment through said partition into said box, circuit making and breaking means mounted in said box, cams in said box for actuating said means, one for controlling the making and the other for controlling the breaking, a sleeve on one cam rotatably mounted on said shaft, a second sleeve on the other cam rotatably mounted on the first sleeve, both sleeves extending through said partition into said compartment, flanges one on each sleeve and located in said compartment, a governor mounted on and driven by said shaft and located in said compartment, and connections between said governor and flanges for angularly moving said cams in response to speed variations of said shaft but to different degrees.

5. In combination, a casing having a breaker box and a compartment adjacent thereto and separated therefrom by a partition, a driving shaft extending from said compartment through said partition into said box, circuit making and breaking means mounted in said box, cams in said box for actuating said means, one for controlling the making and the other for controlling the breaking, a sleeve on one cam rotatably mounted on said shaft, a second sleeve on the other cam rotatably mounted on the first sleeve, both sleeves extending through said partition into said compartment, flanges one on each sleeve and located in said compartment, speed-responsive means driven by said shaft and located in said compartment, and connections between the last-named means and said flanges, whereby both cams may be moved angularly ahead in the direction of rotation of said shaft as the speed thereof increases but to different degrees for respectively varying the timing of said means and the angular interval between the making and breaking of said means.

6. In combination, a casing having a breaker box and a compartment adjacent thereto and separated therefrom by a partition, a driving shaft extending from said compartment through said partition into said box, circuit making and breaking means mounted in said box, cams in said box for actuating said means, one for controlling the making and the other for controlling the breaking, a sleeve on one cam rotatably mounted on said shaft, a second sleeve on the other cam rotatably mounted on the first sleeve, both sleeves extending through said partition into said compartment, flanges one on each sleeve and located in said compartment, a face plate fixed to said shaft and located in said compartment, plate-like weights pivotally connected to said face plate and movable outwardly and inwardly in a plane at right angles to said shaft as the speed of said shaft increases and decreases, and driving connections between said weights and flanges for turning the flanges and the cams connected thereto relatively to said shaft and relatively to each other.

7. In combination, a driving shaft, two substantially identical multi-lobed cams mounted side by side on said shaft and relatively rotatable, speed-responsive means driven by said shaft for angularly shifting one cam relatively to the other from a low speed position wherein corresponding lobes of the two cams are angularly spaced to a high speed position wherein corresponding lobes of the two cams substantially coincide, and circuit making and breaking means having a single breaker arm riding on both cams and actuated by the lobes of one cam to circuit making position and by the lobes of the other cam to circuit breaking position, the relative shifting of said cams varying the angular interval between said positions increasing it as the speed of said shaft increases and vice versa.

8. In combination, a driving shaft, two substantially identical multi-lobed cams mounted side by side on said shaft and relatively rotatable, speed-responsive means driven by said shaft for angularly shifting one cam relatively to the other from a position wherein corresponding lobes of the two cams are angularly spaced to a position wherein corresponding lobes of the two cams substantially coincide, and circuit making and breaking means comprising a pair of arms one for each cam and actuated successively thereby, one such arm operable to effect the circuit making and the other to effect the circuit breaking, the shifting of said cams varying the angular interval between such making and breaking, increasing it as the speed of said shaft increases and vice versa.

9. In combination, a driving shaft, two substantially identical multi-lobed cams mounted side by side on said shaft and relatively rotatable, speed-responsive means driven by said shaft for angularly shifting one cam relatively to the other from a position wherein corresponding lobes of the two cams are angularly spaced to a position

wherein corresponding lobes of the two cams substantially coincide, and circuit making and breaking means comprising a pair of arms one for each cam and actuated successively thereby, each arm carrying a breaker point, stationary breaker points cooperating one with each of the first-named breaker points, said cooperating pairs of breaker points being electrically connected in series whereby the second pair to close and the first pair to open respectively control the circuit making and breaking, the shifting of said cams varying the angular interval between such making and breaking, increasing it as the speed of said shaft increases and vice versa.

10. In combination, a driving shaft, two substantially identical multi-lobed cams mounted side by side on said shaft and relatively rotatable, speed-responsive means driven by said shaft for angularly shifting one cam relatively to the other from a position wherein corresponding lobes of the two cams are angularly spaced to a position wherein corresponding lobes of the two cams substantially coincide, and circuit making and breaking means comprising a pair of arms one for each cam and actuated successively thereby, each arm carrying a breaker point, stationary breaker points cooperating one with each of the first-named breaker points, said cooperating pairs of breaker points being electrically connected in parallel, whereby the first to close and the second to open respectively control the circuit making and breaking, the shifting of said cams varying the angular interval between such making and breaking, increasing it as the speed of said shaft increases and vice versa.

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