United States Patent [19]

Henderson

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[54] **TIMING MECHANISM FOR BREAKERLESS IGNITION SYSTEMS**

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[73] Assignee: **Colt Industries Operating Corp.,** New York, N.Y.

[22] Filed: **Aug. 20, 1973**

[21] Appl. No.: **389,680**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 242,324, April 10, 1972, abandoned.

[52] **U.S. Cl.** ..... **123/117 R;** 123/148 E

[51] **Int. Cl.** **F02p 5/02**

[58] **Field of Search** ..... 123/148, 149, 146.5 A, 123/149 C, 149 D, 117 R

[56] **References Cited**

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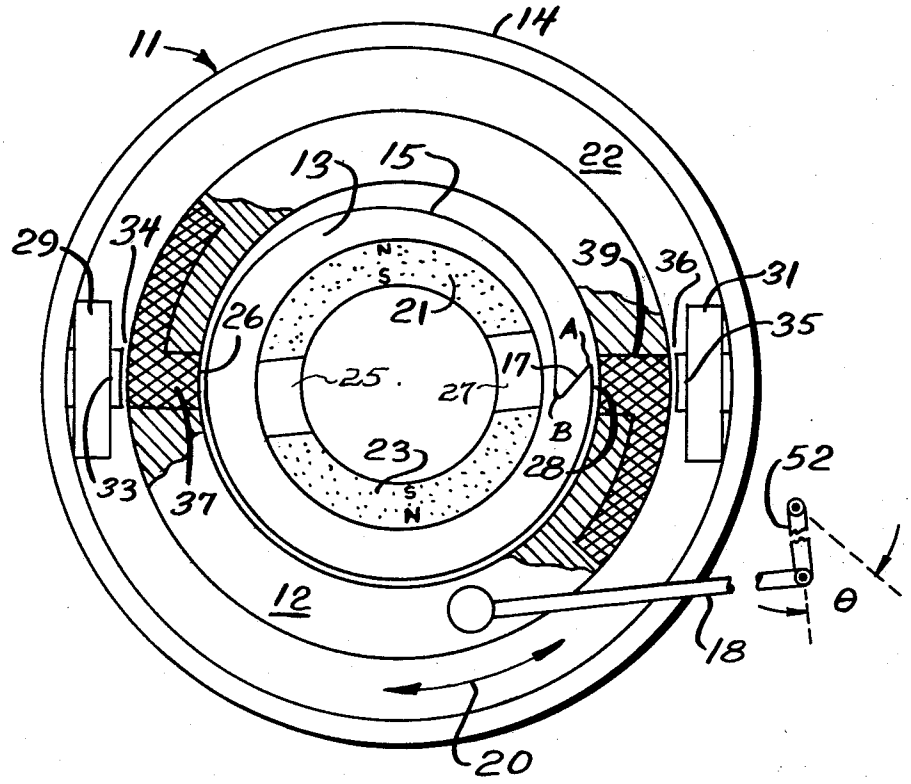
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Primary Examiner—Manuel A. Antonakas
Assistant Examiner—James David Liles
Attorney, Agent, or Firm—Leo J. Aubel

[57] **ABSTRACT**

In an ignition system for use with spark ignited engines, a timing mechanism for manually advancing or retarding the firing point of the cylinders in the engine.

6 Claims, 17 Drawing Figures



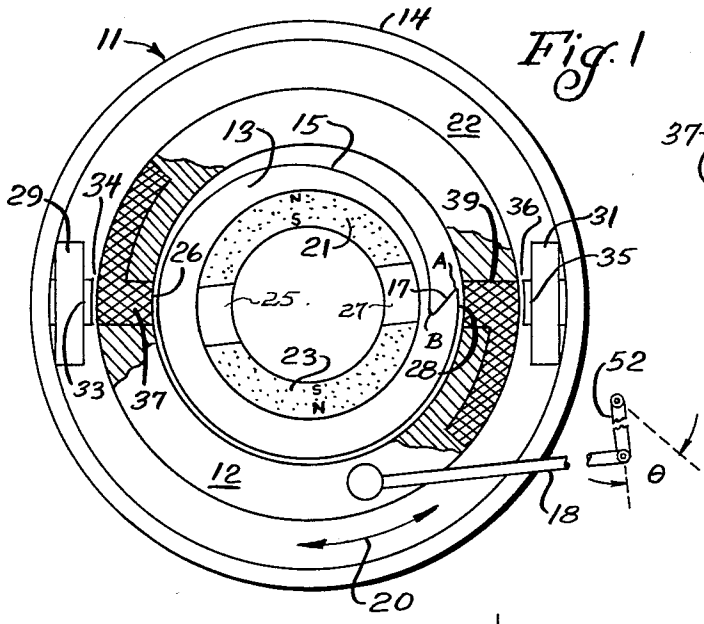


Fig. 1

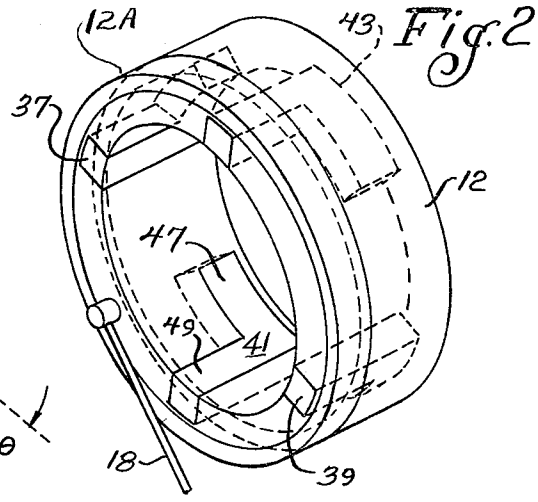


Fig. 2

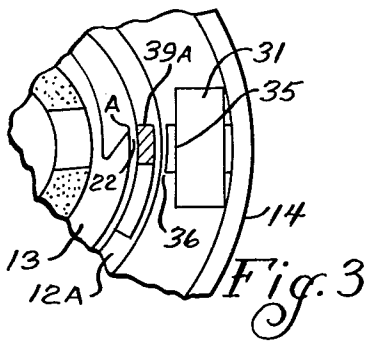


Fig. 3

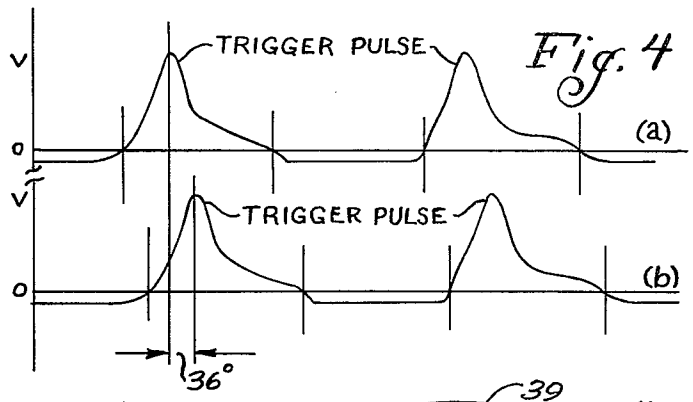


Fig. 4

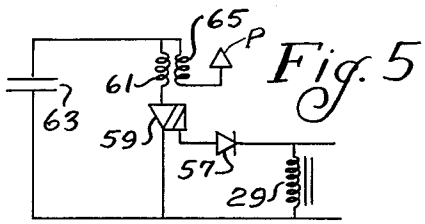


Fig. 5

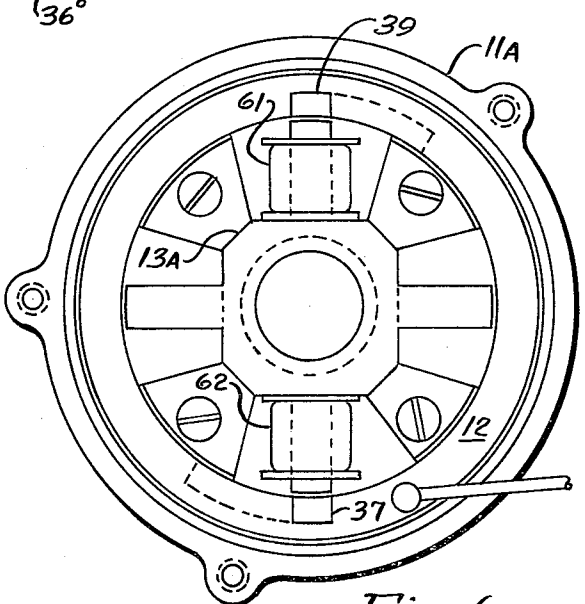
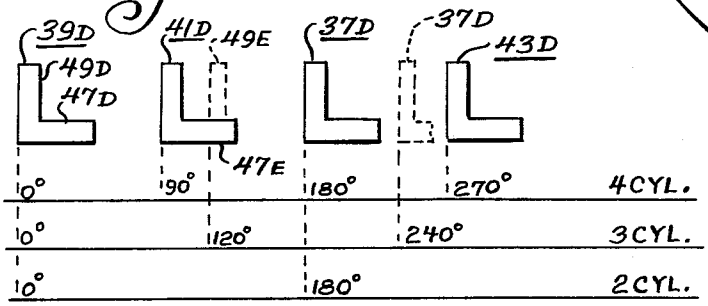


Fig. 6

Fig. 14



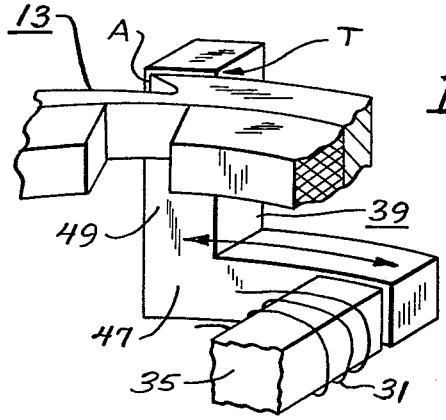


Fig. 7

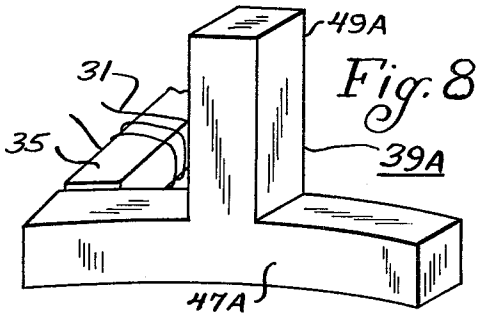
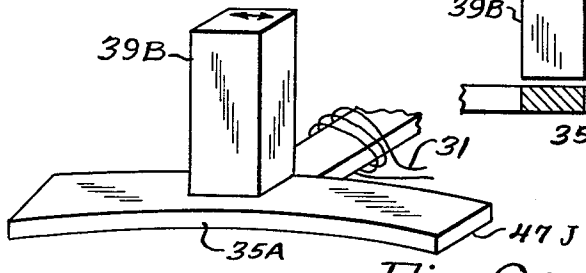


Fig. 8



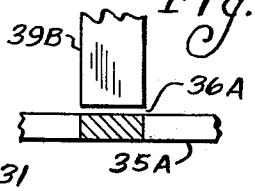


Fig. 9B

Fig. 9A

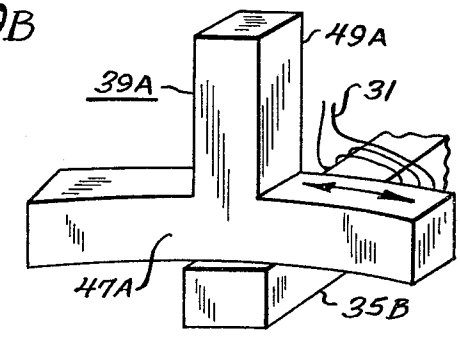


Fig. 9C

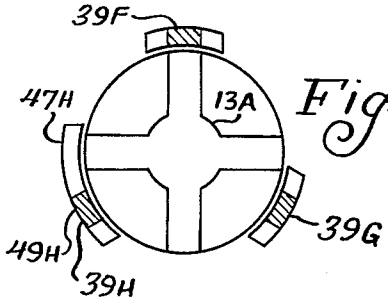


Fig. 10A

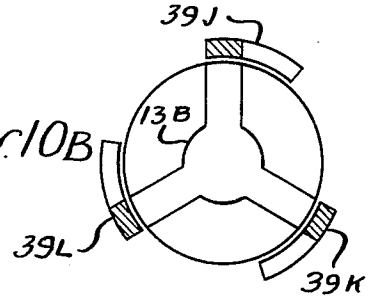


Fig. 10B

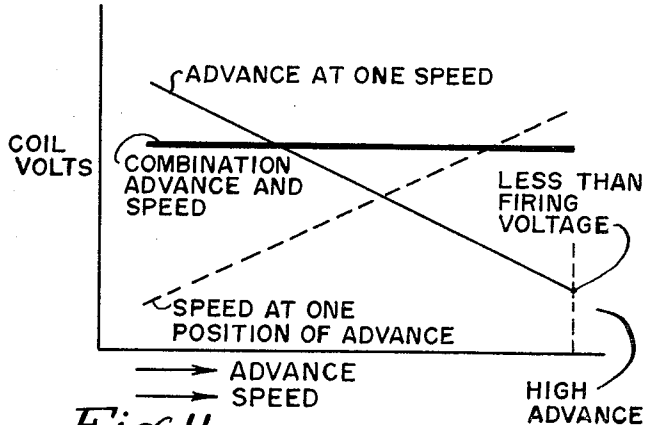


Fig. 11

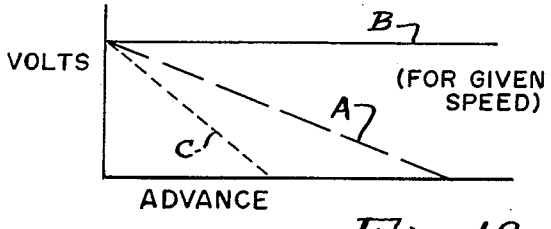


Fig. 13

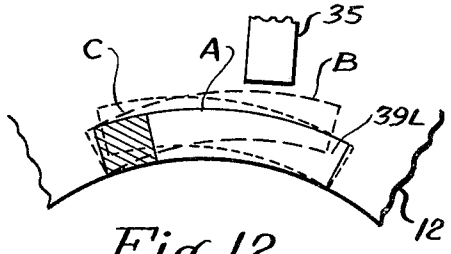


Fig. 12

TIMING MECHANISM FOR BREAKERLESS IGNITION SYSTEMS

CROSS-REFERENCE TO RELATED APPLICATION

This application is a continuation-in-part of application Ser. No. 242,324, filed Apr. 10, 1972 now abandoned.

BACKGROUND OF THE INVENTION

The invention relates to ignition systems for spark ignited engines and is directed particularly to an advance or retard mechanism. Hereinafter, the term "timing mechanism" will also be used to refer to the advance and retard operations and to the associated mechanism respectively.

Various breakerless ignition systems have been disclosed in the prior art wherein mechanical breakers are replaced by solid state electronic switches controlled by a trigger signal, which are generally more reliable than the mechanical systems and are less subject to mechanical wear and deterioration.

Various prior art advance mechanisms generally rotate the spark initiation means relative to the piston and crank shaft position when changing the advance characteristics of the associated engine and wires connecting the rotating trigger mechanism to the stationary portions of the engine are thus continuously flexed. Thus, it is desirable to prevent movement or flexing of the wires to prevent eventual damage and breakage.

The present invention is directed to a breakerless ignition system including a simplified and manually adjustable ring mechanism which possesses the feature of maintaining an essentially constant or controlled air gap between each pole piece mounted in the timing ring and the associated triggering coil core, and can provide the feature of lowering the triggering coils output voltage when the timing ring is moved by the throttle to a high speed operating condition. In addition, the timing ring mechanism of the invention eliminates flexing of the associated wires.

The foregoing and other features, objects and advantages of the invention will be apparent from the following more particular description of preferred embodiments of the invention, as illustrated in the accompanying drawings, wherein:

DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a plan view of a rotor assembly including an advance mechanism in accordance with the invention;

FIG. 2 is an isometric view of one embodiment of a timing ring in accordance with the invention;

FIG. 3 is a plan view of a portion of a rotor assembly utilizing the timing ring of FIG. 2.

FIG. 4 shows curves useful in explaining the operation of the inventive assembly;

FIG. 5 shows a schematic diagram of an electronic circuit suitable for electrical connection with the assembly of FIGS. 1, 2, and 3.

FIG. 6 shows a plan view of another embodiment of the advance mechanism in accordance with the invention;

FIG. 7 is an isometric view of a pole piece, a rotor, and a core pin such as employed in FIGS. 1, 2, and 3 to better show the structural relation of the elements;

FIG. 8 shows a pole piece in a T-shape;

FIG. 9 shows a structure wherein the pole piece comprises a vertical member and the core pin comprises a T-shape;

FIG. 9B shows the air gap between the pole piece and a core pin;

FIG. 9C shows a T-shape pole piece mounted vertically above the core pin;

FIGS. 10A and 10B show the positioning of the pole pieces for use with a three cylinder engine;

FIG. 11 shows curves useful in explaining the operation of an assembly such as in FIGS. 1, 2, and 3;

FIG. 12 shows the different peripheral positioning of a pole piece to provide either uniform, increasing, or decreasing air gaps;

FIG. 13 shows curves useful in explaining the operation of the pole pieces of FIG. 12; and,

FIG. 14 illustrates the peripheral position or relationship of the pole pieces for use in either 2, 3, or 4 cylinder engines.

DESCRIPTION OF THE INVENTION

Referring to FIGS. 1 and 2, an ignition assembly 11, in accordance with the invention, includes a pulser rotor 13 mounted for rotation on a shaft, not shown which is attached to a conventional flywheel, also not shown. The pulser rotor 13 is formed of a magnetic material and comprises a unique construction wherein the periphery 15 of the rotor 13 is formed in the approximate configuration of a convolution of a spiral. The periphery 15 of pulser rotor 13 includes a peak or maximum diameter point A and a minimum diameter point B, which two points A and B are joined by an inwardly angled surface 17. A pair of diametrically spaced permanent magnets, 21 and 23, each comprising a foreshortened semi-circle and having a magnetization as shown, are suitably mounted on rotor 13. Air spaces 25, and 27 may be formed between the ends of the magnets 21 and 23. The foregoing magnet system could comprise other suitable alternatives such as a single ring magnetized in a radial direction.

A pair of diametrically spaced triggering coils, 29 and 31, are mounted on the circular casing 14 of the assembly 11. The coils 29 and 31 include respective trigger coil cores 33 and 35.

A timing ring 12 which may be an aluminum casting is movably mounted on a suitable support 22 in casing 14. The timing ring 12 includes a throttle linkage 18 which is connected to a manually adjustable handle or knob (not shown) to permit movable rotatable adjustment of timing ring 12, as will be explained. In one embodiment, timing ring 12 is movable about an approximate arc of about 36° indicated by the arrowed line 20 in FIG. 1.

Timing ring 12 is mounted to provide an arc gap, as at 26 and 28 between the inner surface of the ring and the outer surface of the pulser rotor 13. An air gap 34 and 36 may also be provided for mechanical clearance between the trigger coils 33 and 35.

Timing ring 12 includes similar magnetic pole pieces, (two L-shaped pole pieces being shown and numbered 37, 39 in the embodiment of FIG. 1), which are positioned intermediate the associated coils 29 and 31 and rotor 13, as will be explained in more detail hereinafter. The pole pieces each include a pole shoe 47 and a flux conductor section 49, as will be explained, (see FIG. 2). As indicated in FIG. 1, one or more pole pieces could be utilized in the inventive assembly, with two

pole pieces 37 and 39 being shown in FIG. 1 and four pole pieces 37, 39, 41, and 43 being indicated in FIG. 2.

The timing ring 12 is movable between two extreme positions as indicated by the arrow 20, and regardless of the position of ring 12, a portion of the pole shoe 47 is always adjacent to the core of the associated trigger coil; for example, shoe 47 of pole piece 39 is always adjacent core 35 of trigger coil 31 regardless of the position of the ring 12; within limits of timing ring travel.

Thus, the relative position at which the maximum diameter point A of the rotor 13 passes adjacent to axially extending flux conductor 49 is dependent upon the position of the timing ring 12, which is adjustable by a throttle linkage to thereby control the timing (advance or retard) of the engine.

As is known, when the throttle is actuated, the speed of the engine increases and thereby causes an increase in the speed of rotation of rotor 13 and an increase in the voltage generated in trigger coils 29 and 31. Also, as the rotor 13 is rotated at a higher speed, the period of the cycle is shortened. Therefore, the selective positioning of the pole pieces 37 and 39 varies the time at which the trigger pulse is generated; a normal variation being approximately 36° of the input cycle; that is, for a given speed and given output waveform, movement of the pole pieces 37 and 39 causes the time of the triggering pulse to be changed.

The coils 29 and 31 are connected to a suitable electronic circuit, such as, for example, shown in FIG. 5 wherein the coil 29 is connected through a diode 57, a triac 59 and the primary winding 61 of a transformer ignition coil to capacitor 63. The secondary winding 65 of the ignition coil is connected to an associated spark plug, indicated by the arrowhead P.

The particular construction of the rotor 13 of FIGS. 1 and 2 provides the features and advantages disclosed and claimed in the U.S. Pat. application Ser. No. 220,065 filed Jan. 24, 1972, in the name of K. Reddy entitled: "Pulser Rotor For Ignition Systems" and assigned to the same assignee as the present invention. As disclosed in application Ser. No. 220,065, when the rotor 13 is rotated in a first direction (clockwise direction in FIG. 1), a suitable unidirectional triggering pulse (say of a relative positive polarity is provided for energizing the associated spark plug. However, should the rotor 13 be rotated in a relative reverse direction, the pulses developed will be of minimal amplitude in the positive polarity and insufficient to energize the associated spark plugs.

Referring again to for example FIGS. 2 and 3, the pole pieces 37, 39, 41, and 43 are formed in essentially an L-shape with a peripherally extending pole shoe, generally labeled 47, which is formed to conform to the radial periphery of the timing ring 12, and an axially flux conductor section, generally labeled 49. As shown in FIG. 2, the pole pieces may be embedded in suitable recesses in timing ring 12. In FIG. 1, the flux conductor section 49 is approximately the same thickness as ring 12, and the shoe 47 is approximately one half the thickness of ring 12, while in FIGS. 2 and 3, the pole pieces 37, 39, 41, and 43 are approximately three-quarters of the thickness of ring 12.

An additional ring or flange 12A of a flux conductive material such as of aluminum is mounted on an edge of ring 12 and functions as a noise reducing shield by shunting away from the trigger coils any spurious flux which may be generated in the system. Ring 12A functions as a magnetic shield for external circuits; and, in effect provides a magnetic shielding circuit since the flux lines extending through the aluminum ring create Eddy currents which produce opposing ampere turns.

Note also that the magnets which are positioned to be in rotor 13 in FIG. 1 can be anywhere in the flux path. For example, the pole pieces or the steel of the timing ring, 12 could be magnets.

Another embodiment of the invention is shown in FIG. 6 wherein the triggering coils are mounted on a spider 13A. The timing ring 12 and the pole pieces 37 and 39 function the same as in FIGS. 1 and 2. As shown in FIG. 6, the assembly indicated is adapted to provide triggering voltage to the spark plugs of the four cylinders of the associated engine.

Refer now to FIG. 7 for an understanding of the relative structural orientation of the assembly of FIGS. 1, 2, 3, and 6. FIG. 7 shows only one pole piece 39, a portion of the rotor 13, trigger coil core 35 and a portion of coil 31. The trigger coil core 35 is positioned to be adjacent to the steel of the peripherally extending leg 47 of pole piece 39 throughout the range of movement of the timing ring 12. Accordingly, regardless of the operating position of ring 12 (the two extreme positions being indicated by FIGS. 1 and 7), leg 47 is always adjacent the trigger coil 35 thereby providing a precise accurate control of the firing point of the engine, and a more uniform firing spark. Note that the rotor 13 and its firing point A rotates along a path flux conductor section 49 of pole piece 39. Firing will occur when point A moves past edge T on flux conductor section 39. Obviously, by moving the timing ring 12 and hence pole piece 39, the firing point will be advanced or retarded relative to the rotation of rotor 13, causing the firing point of the spark plug to be changed.

A modification of the pole piece 39 of FIG. 7 is shown in FIG. 8 wherein the pole piece is labeled 39A. Pole piece 39A forms an inverted T-shape, and is positioned in the same relative relation as the L-shaped pole piece 39 of FIG. 7. In FIG. 8, the trigger coil core 35 is positioned outwardly of pole piece 39A.

In FIG. 8, the peripherally extending leg 47A is relatively longer than the peripherally extending leg 47, of FIG. 7 and hence leg 47A will permit a greater movement of the associated timing ring 12 while still maintaining a portion of the leg 47A at a position adjacent the trigger pin 35.

FIG. 9A shows another modification of the pole piece and trigger coil core pin structure of the invention wherein the pole piece 39B comprises an axially elongated, rectangularly shaped, member and the trigger coil core 35A comprises a T-shape with the pole shoe portion 47J of the T-shape extending adjacent the periphery of the associated ring. Note in FIG. 9B that an air gap 36A is formed between the bottom surface of pole piece 39B and the trigger coil core 35A. In FIG. 9A the rotor (not shown) would be positioned as indicated in FIG. 7 to pass adjacent the upper portion of the pole piece 39B.

Another modification of the pole piece and trigger coil core structure of the invention is shown in FIG. 9C wherein the pole piece 39A is similar to that shown in FIG. 8; however, in the modification of FIG. 9C the trigger coil core 35B is positioned relatively underneath the horizontally extending leg 47A of pole piece 39A.

Note, of course, that the terms vertically, horizontally etc., are used for relative reference purposes when explaining the figures and specific limitation to these orientations is not intended.

As shown above, the embodiments of the pole pieces disclose an L-shape, a T-shape and a rectangular structure; however, other pole piece shapes can conceiveably be utilized. It should be understood, that a basic concept of the invention is that the ferromagnetic portion of the timing ring remains adjacent pole shoe of a pole piece at all positions of the engine advance or retard. Thus, the air gap between the timing ring and the magnetic pole piece remain essentially constant; or varies in a definite controlled manner as will be explained. The timing ring is positioned such that the break or trigger point of the rotor relates to the timing ring at the proper ignition or firing point for each cylinder.

As also stated above, a feature of the present invention is that a common timing ring can be used for two or four cylinder engines. Further, with modification, the timing ring can be used with a three cylinder engine.

FIG. **10** shows an embodiment of the invention for use with an engine having three cylinders. In FIG. **10A** the pole pieces are formed in a T-shape with the pole pieces **39F** and **39G** being essentially as shown in FIG. **8**; and, being placed at 0° and 120° respectively. The third pole piece labeled **39H** is positioned at approximately 270°. Pole piece **39H** has its axial leg **49H** positioned at a point displaced from the center of the peripherally extending leg **47H**. The offset of axial leg **49H** has been found convenient for providing a necessary adjustment for a three cylinder engine. FIG. **10B** shows another embodiment of the invention for use with an engine having three cylinders. In this instance, the rotor **13B**, having three arms is rotated by three L-shaped pole pieces **39J**, **39K**, and **39L** positioned at 0°, 120°, and 240° respectively.

FIG. **14** indicates an embodiment of the invention having pole pieces for the timing ring which are adjustable in position as well as in shape. For explanation purposes, the pole pieces of FIG. **14** are depicted along a linear graph which indicates circumferential degrees.

In FIG. **14** the pole pieces **39D**, **41D**, **37D** and **43D** are shown as having an L-shape and having adjustable axial flux conductor sections **49D** of pole piece **39D** may be adjustably positioned along the peripherally extending pole shoe **47D** from an extreme position on the left side (as oriented in FIG. **14**) to a position on the right side of the leg **47D**. In this manner, the timing ring, such as that of FIG. **6**, can be made common for **2**, **3**, and **4** cylinder engines.

For a four cylinder engine, the four pole pieces the axial flux conductor section of each of the pole pieces is at the left side of the peripherally pole shoe and the four pole pieces are located at 0°, 90°, 180°, and 270° respectively.

For a two cylinder engine, two pole pieces are used and the axial flux conductor section of each of pole pieces is positioned at the left side of the peripherally extending pole shoe **47D**; and, the two pole pieces are located at the 0° and 180° respective positions of the assembly.

For a three cylinder engine, three pole pieces are used and the axial flux conductor section of, say **49D**, of one pole piece (say **39D**) is located at the left edge of the peripheral pole shoe **47D**. The axial flux conductor section **49E** of the second pole piece **41D** is positioned to have its center approximately two-thirds of the distance from the left edge of peripheral pole shoe **47E**; and, the axial flux conductor section of the third pole piece **37D** is positioned at the left edge of the peripheral pole shoe; and, the pole pieces are positioned at the 0°, 120°, and 240° respectively.

Slots or recesses are formed in timing ring **12** into which the moveable pole pieces can be adjustably placed.

As shown in FIGS. **1**, **2**, **3**, and **6**, the pole pieces indicated are mounted to be a fixed distance from the trigger coil core. In most assemblies, this is the desired construction. However, for some applications, a modified positioning of the pole piece is useful. More specifically, depending on whether the peripherally extending pole shoe **47** of the pole piece is useful. More specifically, depending on whether the peripherally extending pole shoe **47** of the pole piece **39** is formed or positioned to gradually increase the spacing between the inner surface of the trigger coil core **35** and the outer surface of the pole piece (measured along the length of the pole piece movement past the trigger coil core) the amount of advance for a given speed can be pre-selected.

As indicated in FIG. **12**, the magnetic pole pieces, generally labeled **39L**, can be constructed to have a uniform spacing between the coil pin **35** and the outer surface of the peripherally extending pole shoe of a pole piece; or, each pole piece can be arranged to have a gradually varying spacing between the surface of the pole shoe and the trigger coil core **35**. In FIG. **12**, the solid line A indicates a uniform spacing between the pin **35** and the magnetic pole piece **39A**; line B indicates a gradually decreasing spacing and line C indicates a gradually increasing spacing. The curves of the graph of FIG. **13** show the change in the voltage output relative to the advance with the pole piece **39L** in the respective positions indicated in FIG. **12**.

FIG. **11** depicts two important features of the invention, the first having been mentioned hereinabove. This one feature indicated by the light solid line in FIG. **11** relates to the fact that as the throttle is moved toward a higher speed position, the timing ring **12** of FIG. **11** will be moved to advance the timing cycle. As the timing is advanced the voltage produced by the output coils will decrease and be less than what is required to fire the engine. As stated, this is an important safety feature to prevent the engine from starting unless the throttle is at an idle or slow speed position.

Another feature of the invention indicated in FIG. **11** is that the timing ring **12** of FIG. **1** enables the advance and speed characteristics of the engine to be adjusted to provide a uniform voltage output from the coils. This is indicated by the heavy solid line in FIG. **11** which in effect combines the speed curve indicated by the dotted line and the advance curve indicated by the light solid line.

Still another feature and advantage of the present invention is depicted in FIG. **1** which indicates the mechanical linkage **18** of the timing ring **12** to the associated throttle. The throttle linkage arrangement generally labeled **52** is such that as the throttle is moved from an idle position toward its high speed position, the timing ring **12** is moved to advance the firing point. At a selected point past the angle θ (and as is known in the

art), farther movement of the throttle toward a maximum speed condition will cause a relatively reverse movement of throttle linkage to move the timing ring 12 back toward a reduced advance position. It has been found that for speeds above a selected point, say the crusing speed of the engine, the engine operates in a superior manner if the advance is reduced.

While the invention has been particularly shown and described with reference to preferred embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention.

What is claimed is:

1. A timing mechanism for a breakerless ignition system, comprising, in combination, a rotor, means for providing a magnetic flux field, a flux responsive means including a triggering coil, a triggering core for the coil, a mechanically adjustable element movable to a selected angular position relative to said triggering core, magnetic pole piece means mounted with said element, said pole piece means including a flux conductor section and a pole shoe section, said rotor including a discrete triggering point on its periphery, said rotor moving past the flux conductor section and thereby developing a triggering signal, the manually adjustable element being movable to move the pole piece means, and said pole piece means when moved being effective to change the point at which triggering occurs, while still maintaining a section of the pole shoe adjacent said triggering core so as to develop a trigger voltage of a selected amplitude.

2. A timing mechanism as in claim **1** wherein said adjustable element comprises a ring mounted intermediate said triggering core for the coil and the rotor, and wherein flexing of the electrical wires connected such as to the coil is eliminated.

3. A timing mechanism as in claim **1** wherein said adjustable element comprises a timimg ring of a nonmagnetic material and the pole piece means are embedded therein.

4. A timing mechanism as in claim **1** wherein said pole piece means are arranged such that relative movement thereof changes the effective air gap between the rotor and the trigger core for the coil as a function of the angular position of said adjustable element.

5. A mechanism as in claim **1** wherein said means for changing said triggering point comprise an arcuate pole shoe having a portion defining a variable air gap between the rotor and said shoe, and said mechanism means for moving said pole piece relative to the periphery of said rotor.

6. A timing mechanism as in claim **1** wherein the flux conductor section extends to a position for maximum interaction with said rotor and said pole shoe remains in a position for maximum interaction with said trigger core for the coil.

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