

Feb. 16, 1943.

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SYSTEMS AND THE LIKE
Filed April 25, 1941

2,311,270

2 Sheets-Sheet 1

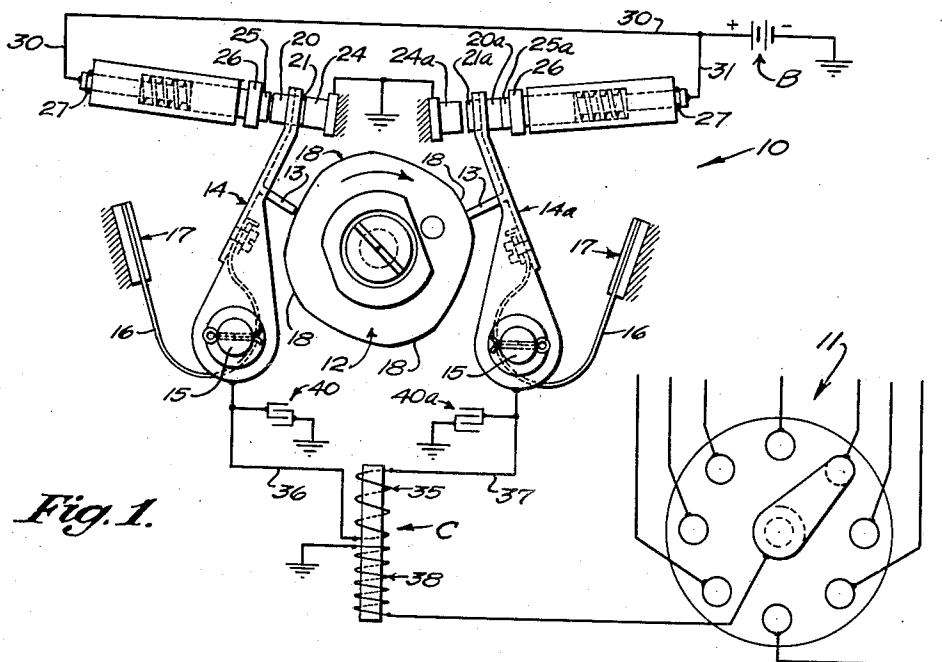
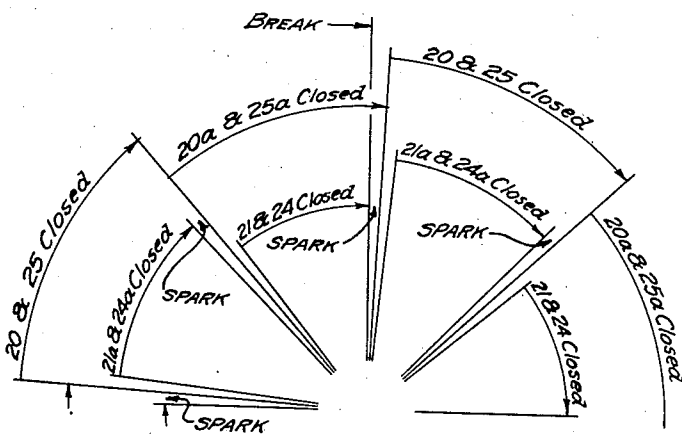


Fig. 2.

Inventor
Albert G. H. Vanderpoel.

Mulken & Kautsky

Attorneys.

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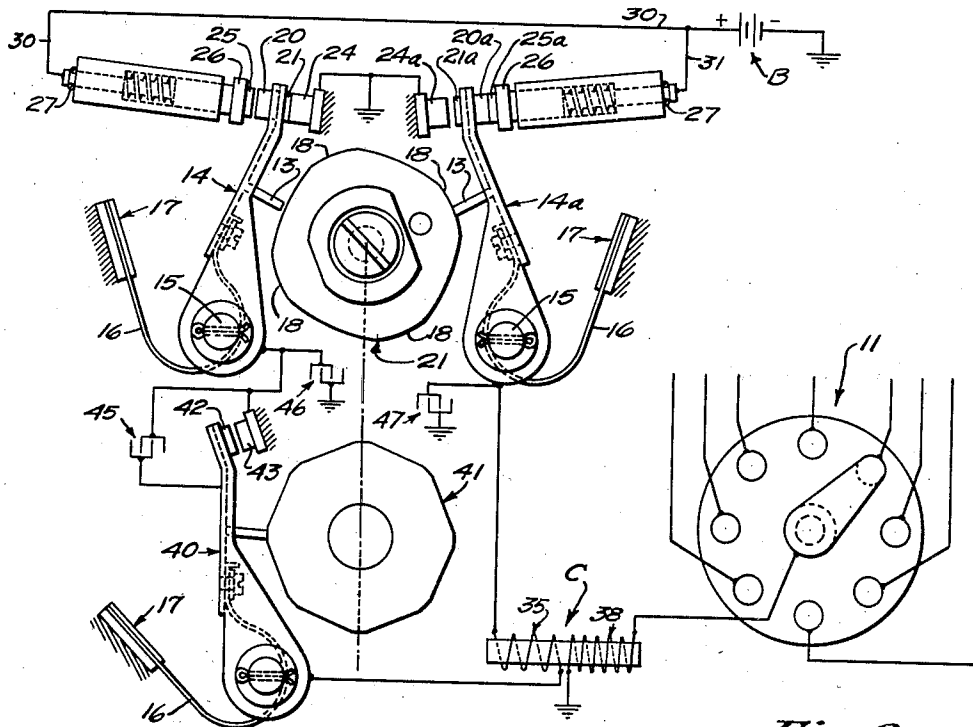


Fig. 3.

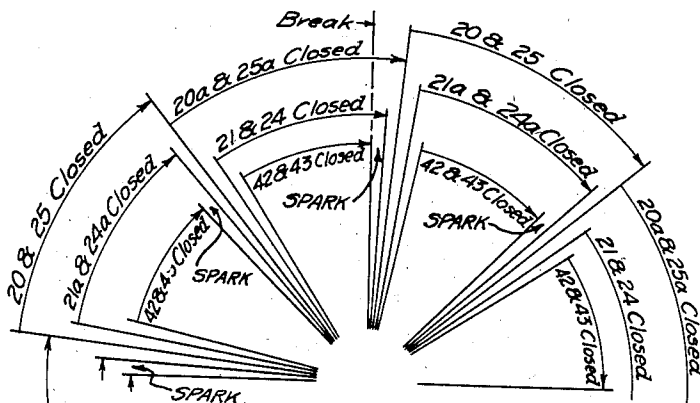


Fig. 4.

Inventor
Albert G.H. Vanderpoel.

Michael & Leachman

Attorneys.

UNITED STATES PATENT OFFICE

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ELECTRICAL CIRCUIT BREAKER SYSTEM
FOR IGNITION SYSTEMS AND THE LIKE

Albert G. H. Vanderpoel, Los Angeles, Calif., assignor to California Machinery & Supply Co., Ltd., Los Angeles, Calif., a corporation of Delaware

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2 Claims. (Cl. 123—148)

This invention relates to electrical systems of the type in which an induced current is generated by abrupt change of current flow in a primary winding of an induction coil. The typical instance of such systems is the ignition system for an internal combustion engine. As applied to such a system, the general purposes of the invention include improvement in the timing of the high tension spark, especially at higher speeds, and improvement of the spark by providing a system using a heavy duty coil, and therefore passing relatively heavy current, without necessary increase in the size of the condenser, while at the same time increasing breaker point life.

In prior breaker systems, the separation of the breaker points causes the magnetic field of the previously magnetized coil to collapse, with the result that a momentary current flow is produced, in the same direction as the current flow that magnetized the coil, and this momentary current flow charges a condenser connected across the breaker points. This condenser then discharges, causing a current flow in the reverse direction. This reversed condenser discharge current assists in demagnetizing the coil, and the rapidly collapsing field induces a high voltage in the secondary winding of the coil, sufficient to produce a spark at the spark plug. The breaker points then close and current flows through the coil in the same direction as before, again magnetizing the coil, in readiness for the next separation of the breaker contacts. A certain definite time, however, is required for saturating the coil, and at high engine speeds, the coil may not be completely saturated before the breaker points again separate.

In accordance with the present invention, the current flow utilized to magnetize the coil flows through the coil alternately in one direction and then the other for successive sparks, and it always flows through the coil in the same direction as the immediately preceding condenser discharge current. The beneficial result is thus gained that the condenser discharge current assists not only in collapsing the field of the coil, but in building it up again, the coil being magnetized with a polarity the reverse of before, and the condenser discharge current being in the right direction to contribute to this reverse magnetization of the coil. The field of the coil is thus more quickly and strongly built up, and there is assurance that when the breaker points then separate, there will be a maximum voltage induced in the coil, with the result of maxi-

mum charging and discharging of the condenser, and hence a high tension spark of maximum intensity.

In one form of my invention, the breaker points are in series circuit with the coil. Since the current flow is in reverse directions in the coil circuit for successive sparks, the arc between the points reverses direction on each successive break, and thus compensates for the well known tendency for the metal of one point to be carried across the gap to the other.

The invention will be better understood from the following detailed description of certain present illustrative embodiments thereof, reference for this purpose being had to the accompanying drawings, in which:

Fig. 1 is a diagrammatic view of one form in which my invention has been successfully embodied in practice;

Fig. 2 is a timing diagram of the embodiment of Fig. 1, corresponding to one-half revolution of the operating cam;

Fig. 3 is a diagrammatic view of a modification of the invention; and

Fig. 4 is a timing diagram of the embodiment of Fig. 3, corresponding to one-half revolution of the operating cam.

In Fig. 1, the breaker mechanism is designated generally in diagrammatic form at 10, and a conventional distributor at 11. Breaker mechanism 10 is shown to embody a usual four-lobed rotating cam 12 which operates on fibre or other insulation shoes 13 carried by a pair of pivoted breaker arms 14 and 14a. Arms 14 and 14a are pivotally mounted at 15, and are spring urged to move towards cam 12 by means of flat springs 16 anchored at 17. Assuming an eight-cylinder internal combustion engine, cam 12 has four lobes 18 as illustrated, and the two breaker arms 14 and 14a are, in effect, spaced apart by 45°. That is to say, when the mid-point of a cam lobe is in engagement with the shoe 13 of one breaker arm, the shoe 13 of the other breaker arm will be in engagement with a low point of the cam, midway between two lobes. In the particular embodiment here illustrated, the two breaker arms 14 and 14a are so located that their shoes 13 engage points on the cam 12 which are 135° apart, which satisfies the conditions stated above.

The swinging ends of the two breaker arms 14 and 14a carry oppositely facing contact points, the arm 14 carrying points 20 and 21, and the arm 14a carrying points 20a and 21a. When the respective breaker arm shoes 13 are in register with low points on the cam, as is arm 14 in Fig.

1, the contacts 21 and 21a of the two arms engage with stationary contact points 24 and 24a, respectively, here shown as electrically grounded. During the respective times the shoes 13 ride over the cam lobes 18, the breaker arms are swung out and their contacts 20 and 20a make with contacts 25 and 25a, respectively.

Contact points 25 and 25a may be stationarily mounted, though I prefer to mount them on spring urged plungers 26, provided with suitable stops 27 preventing them from advancing beyond positions in which a proper gap is established between the contact points 25 and 25a and the contact points 20 and 20a, respectively, when the breaker arms are moved in the directions of the points 24 and 24a. An advantage of the plunger mounted contact points 25 and 25a is that a shorter gap between points for a given movement of the breaker arm is obtainable.

The usual storage battery is indicated at B, its negative terminal grounded, and its positive terminal connected by branching leads 30 and 31 to the contact points 25 and 25a.

A usual coil, though preferably one of "heavy duty" character, is indicated at C, its primary winding 35 connected at one end by lead 36 to breaker arm 14, and therefore to contact points 20 and 21, and at the other end by lead 37 to breaker arm 14a, and therefore to contact points 20a and 21a. The high tension secondary winding 38 of coil C is here shown as connected at one end to ground and at the other end to the conventional distributor 11.

In the instant form of my invention the pairs of contacts 21, 24 and 21a, 24a serve as alternately used breaker points, and a condenser is connected across each such pair of points. The indicated condensers 40 and 40a, shown as connected between leads 36 and 37, respectively, and ground, will be seen to be across the two pairs of contact points mentioned. It was stated above that the coil C is preferably a heavy duty one. By this is meant a coil having a resistance sufficiently low that, using a battery B of 6 volts, there will be a current flow of say from 12 to 14 amperes in the primary circuit of the coil when the battery circuit is closed. Despite the use of this heavy duty coil, I find it preferable, in my system, that the condensers 40 and 40a be of ordinary size, or of about .025 mf.

The sequential operation of the contact points as the operating cam 12 rotates is as follows, reference being had to the timing diagram of Fig. 2, in which the arrow lengths represent the periods of closure of the cooperating pairs of points, and the arrowheads represent the times of separation of the points. Starting with the position of Fig. 1, in which contact point 21 is against contact point 24, and contact 20a is against contact point 25a, rotation of the cam right handedly first causes outward movement of breaker arm 14 to separate contact point 21 from contact point 24. A few degrees of cam rotation later, breaker arm 14a has moved inwardly sufficiently far to separate point 20a from point 25a, and by this time breaker arm 14 has moved sufficiently far in an outward direction to close contact 20 with contact 25. Arm 14a continues to move inwardly, and a few degrees later, closes contact 21a with contact 24a. Continued rotation of the cam starts breaker arm 14a to move in an outward direction, separating point 21a from point 24a. Breaker arm 14 is by this time moving inwardly, and a few degrees following separation of points 21a and 24a, the arm

14 separates point 20 from point 25. At this time, arm 14a moving outwardly closes point 20a with point 25a, and shortly after, arm 14, still moving inwardly, closes point 21 with point 24. The breaker arms are then back in the assumed starting position. Thus, as here embodied, the pairs of points 21, 24 and 21a, 24a both close and separate while the respective pairs of points 20a, 25a and 20, 25 are closed.

When the points are in the position of Fig. 1 (points 21, 24 closed and points 20a, 25a closed), current flows from the positive terminal of battery B via lead 31, points 25a and 20a, breaker arm 14a, and lead 37 to the primary winding of coil C, thence via lead 36 to breaker arm 14, and through contacts 21 and 24 to ground. This current flow magnetizes the coil, and the breaker mechanism is in position for immediate separation of points 21, 24 to break the circuit and cause a high tension spark, as later to be more fully described. When the points are in the opposite position, that is, with points 21a and 24a closed and points 20, 25 closed, current then flows from battery B via lead 30, contacts 25, 20, breaker arm 14 and lead 36 to the primary winding of the coil, and from there via lead 37, breaker arm 14a, and contacts 21a and 24a to ground. It will be seen that the current flow through the coil is then reversed, and the coil will accordingly be magnetized with reverse polarity. The breaker mechanism is at this time in readiness for separation of contacts 21a and 24a, which will break the circuit and cause the high tension spark.

The described contact points thus function as a pole changing switch, causing the polarity of the coil to be reversed with each magnetization by reversing the direction of current flow through the coil. As will be evident, the points are operated to break the circuit at points 21, 24 when the coil is magnetized with one polarity, and to break it at points 21a, 24a when the coil is magnetized with the opposite polarity.

Assume again that the contact points are in the position of Figure 1, and that battery current is therefore flowing through the coil in a direction from lead 37 through the primary of the coil toward lead 36. The primary of the coil is thus energized. As contact point 21 then separates from contact point 24, the circuit is suddenly broken, and the field of coil C collapses. The collapsing field induces a current flow in the same direction as the current flow which originally magnetized the coil, and this current flow charges the condenser 40, the side of said condenser connected to ground being negatively charged and the side of the condenser connected to lead 36 assuming a positive charge, as will be evident. The condenser 40 then immediately discharges, and the condenser discharge current is in a direction through the primary of coil C the reverse of the current which originally magnetized the coil. This condenser discharge current therefore assists in demagnetizing the coil, causing a complete collapsing of the field in a shorter time than would otherwise be possible as is well understood. It will further be understood how this collapsing of the field of coil C induces a high tension current in the secondary winding 38 of the coil, producing a high tension spark at the spark plug to which the coil is then connected by the distributor 11.

The condenser discharge current through the coil not only reduces the magnetization of the coil to zero, but begins to build up the mag-

netization of the coil in the reverse direction before the circuit is opened by separation of contacts 20a and 25a. Separation of contacts 20a and 25a is accompanied by closure of point 20 with point 25, which is followed immediately by closure of point 21a with point 24a, as previously described. Battery current now again flows through the coil, but in the reverse direction, as before stated. Thus the coil C is now again magnetized, but with its polarity reversed. And it will be seen that the current flow which has just magnetized the coil C has been in the same direction through the primary of the coil as the discharge current from the condenser 40, the condenser discharge current first having acted to completely demagnetize the coil and then to magnetize it partially with reversed polarity, and the battery current then following along to build up the magnetization of the coil in the direction in which it was started by the condenser discharge current.

Similar events occur as cam 12 causes, first, separation of contact point 21a from contact point 24a, then separation of point 20 from point 25, together with closing of points 20a and 25a, and finally closing of points 21 and 24. Thus, the breaking of points 21a and 24a first causes a collapsing of the field of the coil, which induces a voltage charging the condenser 40a, the direction of current flow being the same as the current which magnetized the coil. The condenser 40a then discharges, producing a current in the reverse direction which assists in the demagnetization of coil C, and in initiating the building up of the magnetization of said coil in the reverse direction, to be completed, upon closing of points 20a and 25a and of points 21 and 24, by battery current flowing in the same direction as the described discharge current of condenser 40a.

Thus it is a novel characteristic of my system that the current flow through the coil is in reverse directions for successive magnetizations; so that its polarity is reversed each time it is magnetized. And further, the condenser discharge current, which is responsible for the high tension spark in the secondary circuit, is always in the direction in which the next magnetizing current is to flow, so as to assist in the next magnetization of the coil. This provision assures proper and maximum magnetization of the coil, even at highest engine speed, and therefore assures development of maximum voltage when the breaker contacts are separated.

In the form of Fig. 1, the described cam operated contact points serve as a pole changing switch and also as the circuit breaker. Fig. 3 shows a modification, in which the mechanism and circuiting as shown in Fig. 1 are again employed, but in which the function of breaking the battery-coil circuit is delegated to a third breaker arm 40, operated by a second cam 41 rotating synchronously with cam 12, breaker arms 14 and 14a retaining the function of pole changing switch. It will be understood that the sequence of makes and breaks of the contact points controlled by the breaker arms 14 and 14a will be the same as described in connection with Fig. 1. Arm 40 carries a contact point 42, adapted to make with stationary contact point 43, and the points 42 and 43 are in series with the primary winding of the coil C, as indicated. The points 42 and 43 being the main breaker points, a condenser 45 is connected across them, as indicated, and if necessary to avoid arcing, con-

densers 46 and 47 may be connected across the pairs of contacts 21, 24 and 21a, 24a, being here shown as between breaker arms 14 and 14a, respectively, and ground.

Cam 41 has twice the number of lobes as cam 12; for an eight cylinder engine, cam 12 will have four lobes and cam 41 eight lobes.

Operation is as represented in the timing diagram of Fig. 4. Fig. 3 shows the mechanism in a position with points 42 and 43 separated, and points 21 and 24 just about to separate, Fig. 4 showing that the contacts 21 and 24 separate several degrees of rotation of the cams after separation of points 42 and 43. The separation of points 42 and 43 opens the circuit magnetizing the primary winding of coil C, allowing the magnetic field to collapse. This induces a current in the coil circuit in the same direction as the battery current which magnetized the coil, which current charges the condenser 45. The condenser 45 then discharges, and the condenser discharge current is in the reverse direction in the circuit, and hence assists in collapsing the field of the coil C. The rapidly collapsing field induces a high tension current in coil secondary winding 38, causing a high tension spark at the spark plug.

Shortly after the break of the points 42 and 43, there follows, in succession, as a result of the action of cam 12, separation of points 21 and 24, separation of points 20a and 25a and closing of points 20 and 25, and closing of points 21a and 24a. Points 42 and 43 also close, preferably after closing of points 21a and 24a. This succession of operations sends battery current again through the coil C, but in reversed direction, the same as in the system of Fig. 1. The primary winding of coil C is accordingly again magnetized, but with reversed polarity. And again, as with the system of Fig. 1, the condenser discharge current that flows following the above described breaking of points 42 and 43 is in a direction the reverse of the current which magnetized the coil on the immediately preceding magnetization, but is in the same direction as the battery current next to flow through the coil, and therefore is in a direction not only to demagnetize the coil, but to contribute to the next succeeding magnetization of the coil.

The difference between the system of Fig. 1 and that of Fig. 3 resides in the fact that the main breaker points 42 and 43 are directly in the circuit of the coil, and that the current flow through said points reverses direction for each break. This constant reversal prevents the metal from being carried from one point to the other, and substantially increases the lives of the points.

In Fig. 3, as well as in Fig. 1, the two breaker arms 14 and 14a engage points on the cam 18 which are in effect, spaced apart by 45°, being spaced apart in the illustrated embodiments by 90° plus 45°, or 135°. By this arrangement one breaker arm moves outwardly while the other moves inwardly, and vice versa. It will be understood that this is not essential, however, since by spacing the engagement points between the cam and the two arms either 90° or 180° apart, so that the breaker arms would then move alternately apart and towards one another, and at the same time cross-connecting the contact points, for instance, by connecting inside point 24 and outside point 25a to the positive terminal of the battery, and inside point 24a and outside point 25 to ground, the same sequence of events

is obtained, the arrangement being a full equivalent of that illustrated in Figs. 1 and 3.

I claim:

1. In ignition systems or the like, a coil having primary and secondary windings and a magnetizable core, a source of current for energizing the primary winding of said coil, electric circuiting including a power operated pole changing switch for conducting current from said source to the primary winding of the coil, said pole changing switch being movable between two positions to reverse the direction of current flow to the coil, and said pole changing switch operating to break the circuit at two points successively in moving in either direction between said two positions, and condensers connected across the points at which the circuit is first broken as the switch is moved between said positions.

2. In ignition systems or the like, a coil having primary and secondary windings and a magnetizable core, a source of direct current for energizing the primary winding of said coil, electric circuiting including a single combination power operated pole changing switch and circuit breaker for conducting current from said source to the primary winding of the coil, said pole changing switch and circuit breaker being adapted to periodically reverse the direction of current flow to the coil, and to break the circuiting at two points successively in each reversal of the current flow to the coil, and condensers connected across the points at which the circuit is first broken as the switch operates to reverse the current flow.

ALBERT G. H. VANDERPOEL.