Sept. 4, 1923. 1,466,720

A. HOWARD

IGNITION APPARATUS

Filed Jan. 22, 1923 2 Sheets-Sheet 1

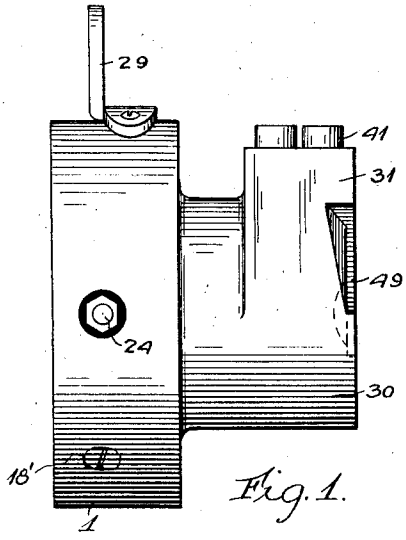


Fig. 1.

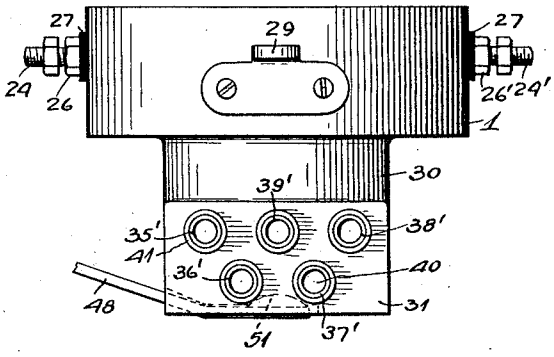


Fig. 2.

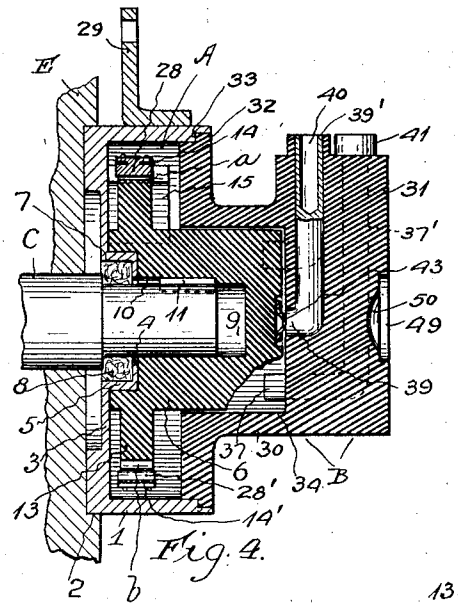


Fig. 4.

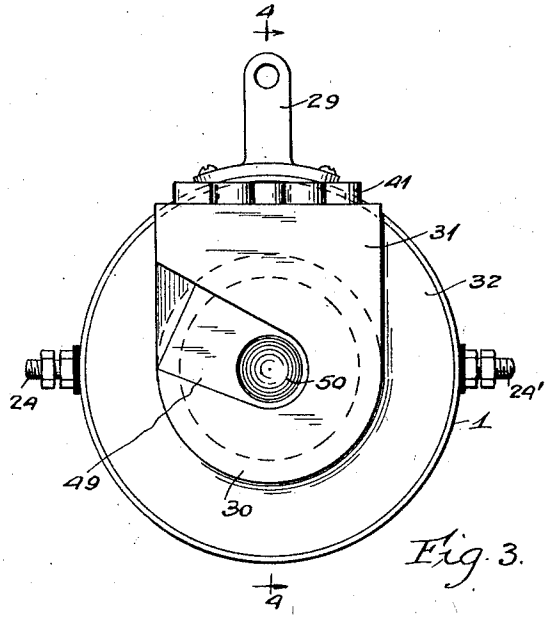


Fig. 3.

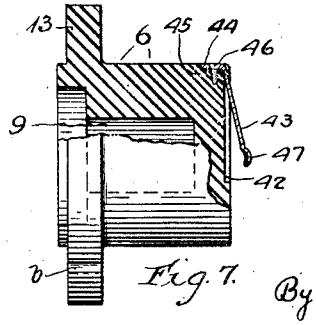


Fig. 7.

Inventor;
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Fig. 5.

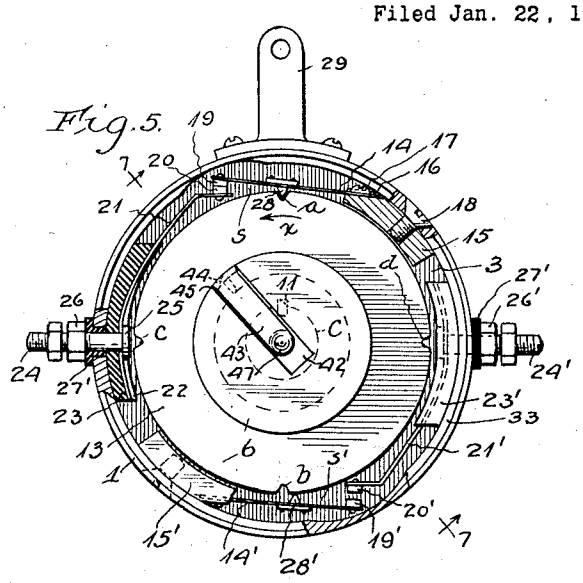


Fig. 6.

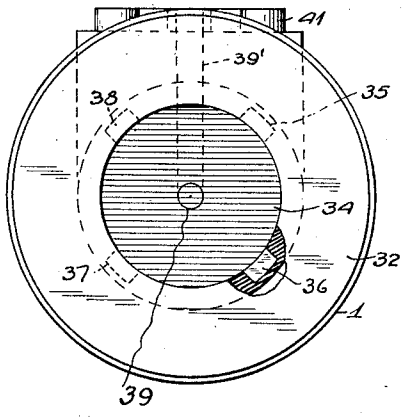


Fig. 8.

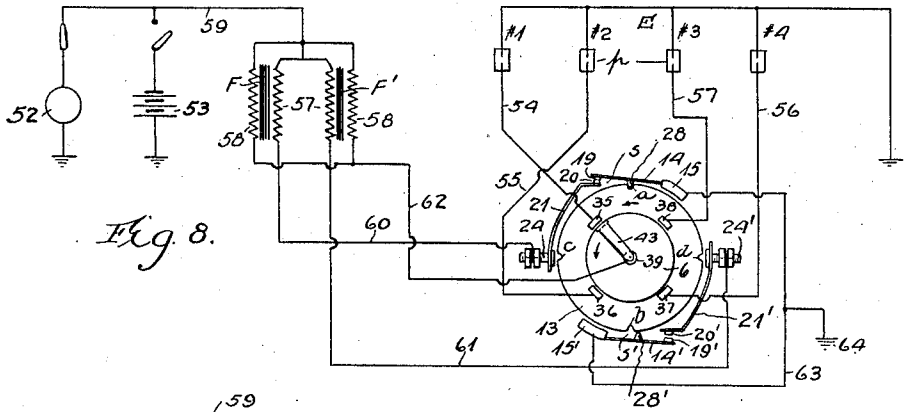
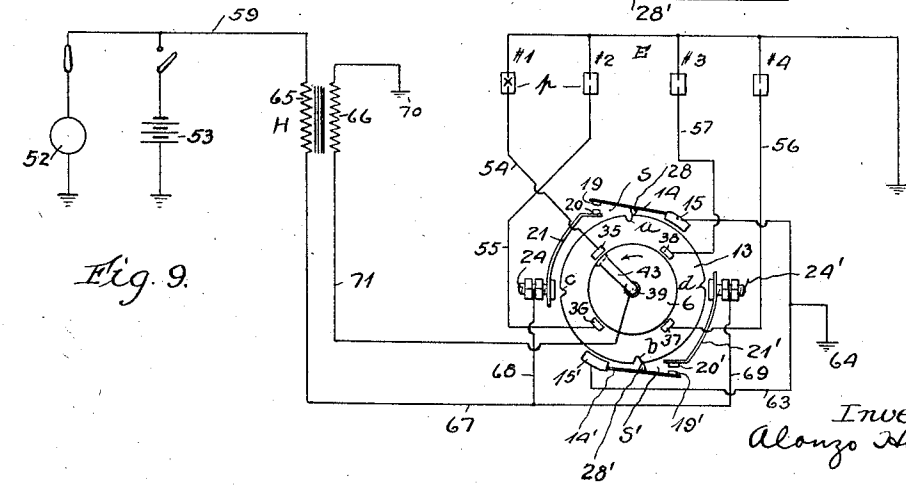


Fig. 9.



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Patented Sept. 4, 1923. 1,466,720

UNITED STATES PATENT OFFICE.

ALONZO HOWARD, OF CHICAGO, ILLINOIS.

IGNITION APPARATUS.

Application filed January 22, 1923. Serial No. 614,059.

To all whom it may concern:

Be it known that I, ALONZO HOWARD, a citizen of the United States, and a resident of Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Ignition Apparatus, of which the following is a specification.

My invention relates to ignition apparatus for explosive engines, particularly those in automotive vehicles. The object of the invention is to provide improved construction and arrangement for producing a succession of distinct sparks at each spark plug of any engine for each charge of gas in the cylinder served by such plug, so that full and complete explosion will result.

Another object of the invention is to construct my apparatus of only a few simple and efficient parts which can be readily assembled and applied to automobile engines or substituted for the original ignition apparatus of the engine and which can be applied without requiring any changes in the construction and arrangement of the engine or the addition of any new parts.

My present invention may be considered an improvement over the invention disclosed in my co-pending application, Serial No. 573,401 filed July 7, 1922.

On the accompanying drawing I show my improved apparatus and its operation, the particular apparatus shown being designed for use on Ford cars. On the drawing—

Fig. 1 is a side elevational view,

Fig. 2 is a plan view,

Fig. 3 is a front view,

Fig. 4 is a sectional view on plane 4—4, Fig. 3,

Fig. 5 is a front elevational view with the distributor cap removed.

Fig. 6 is a rear view of the distributor cap,

Fig. 7 is a side elevational view of the cam member partly in section on plane 7—7, Fig. 5,

Fig. 8 is a diagram showing the circuit connection and operation of the parts, and

Fig. 9 is a diagram showing a modified arrangement.

The apparatus and arrangement shown on the drawing is particularly adaptable for use on Ford cars although it could be readily modified for equally efficient use in connection with other types of engines. The frame of the Ford engine is represented by E, and C represents the cam shaft whose end extends a distance in front of the frame to ordinarily receive the timer which forms a part of the regular engine equipment. My improved mechanism is designed to be applied to the shaft end in place of the regular Ford timer. It consists of the primary circuit controlling mechanism designated as a whole A, and the ignition current distributor mechanism designated as a whole B. The housing 1 for the primary circuit controlling mechanism is cylindrical and of a diameter to fit at its rear end in the cylindrical pocket 2 which is provided in the frame of the Ford engine concentric with the cam shaft. The base 3 of the housing has the central opening 4 through which the end of the cam shaft extends into the housing, the middle section of the base being deflected inwardly a distance to provide a seating boss 5 for the cam member 6 and also to provide a pocket 7 for stuffing material 8 for keeping oil, dust and dirt from entering the housing 1.

The body of the cam member 6 is cylindrical and has the axial bore 9 to fit and receive the end of the cam shaft. The cam member has also the longitudinal keyway 10 for receiving the key 11 which locks the cam member to the shaft for rotational movement therewith, the cam member bore at its inner end being enlarged to receive the boss 5. Adjacent its inner end the cam member has the cylindrical cam flange 13 provided at its periphery with transversely extending cam notches, four such notches *a*, *b*, *c*, and *d* being shown, the notches being spaced ninety degrees apart. The number of notches depends upon the number of cylinders of the engine. A Ford engine having four cylinders four notches will be provided as shown. The housing 1 may be of metal but the cam member is of some good insulating material as for example bakelite or redmonal.

The cam notches *a*, *b*, *c* and *d* cooperate with sets of circuit controllers to control the primary circuit of the ignition system. I have shown two sets of circuit controllers *s* and *s'* arranged at opposite sides of the housing 1 adjacent the cam flange and in the path of the cam periphery. The circuit controller *s* comprises a flat spring 14 anchored at one end to a block 15, the spring end seating in a channel 16 in the block and secured by a screw 17. The block abuts against the

wall 3 of the housing and against the cylindrical wall thereof and is secured by means of a screw 18. The block is thus accurately secured and the spring 14 extends therefrom over the periphery of the cam flange and at its free end has the contact point 19 secured thereto. This contact point cooperates with the contact point 20 at the inner end of the terminal spring or bracket 21 which is seated in the longitudinal channel 22 provided in the block 23 of insulating material which at its inner side abuts against the wall 3 of the housing and which also fits against the cylindrical wall of the housing, it being held in place by the terminal post 24, this post extending outwardly through the block and housing, and the block and housing being clamped between the head 25 of the post and the nut 26 engaging the threaded section of the post. An insulating thimble or bushing 27 is inserted between the post and the housing so that the post will be fully insulated from the housing but electrically connected with the terminal spring or bracket 21.

Intermediate its ends the contact spring 14 has secured thereto the cam wedge or projection 28 which extends transversely and parallel with the cam notches *a*, *b*, *c* and *d*. When the cam flange periphery between notches is traveling under the spring in engagement with the cam projection the spring will be raised and the contact points 19 and 20 will be separated, but when a notch comes in place under the projection the projection will drop into the notch and permit the contact point to come into engagement. The notches are comparatively short and during rotation of the cam members the closure period of the points 19 and 20 will be very short and, as will be explained later, the primary circuit of the ignition system will be closed during such engagement on the contact points to permit magnetic saturation of the induction coil so that a secondary current flow of high pressure will result when the contact points are again disengaged and the primary circuit opened. The position of the cam member on the shaft and the location of the spring 14 is such that the circuit controller *s* will be opened four times for each revolution of the cam shaft, that is, an opening for each cylinder of the engine and at the proper ignition time for such cylinder.

Sometimes a single spark during an ignition period is not sufficient to produce full explosion, or sometimes the gases are not yet in proper condition for explosion when the spark is produced. I therefore provide the second circuit controller *s'* which is arranged with reference to the circuit controller *s* to control the primary circuit for a second flow of ignition current through the same spark plug after sparking has been produced at the plug by virtue of the controller *s*, so that if the first spark does not fully and efficiently ignite the gas charge the second spark will do so. The relative operation of the circuit controllers *s* and *s'* should be such that the primary windings of the induction coils will be given ample time to fully saturate the induction coils so that efficient secondary current flow will result, but at the same time the operations of the controller should be sufficiently close together so that the sparks, particularly the follow up spark controlled by the circuit controller *s'* will take place sufficiently close to the normal ignition time to cause effective and efficient explosion.

In some prior ignition systems on the market a single circuit controlling mechanism for the primary circuit is provided and during each ignition period a series of teeth cooperates with a contact spring to produce a series of sparks. In such systems the mechanical arrangement is not efficient, because where a row of close together teeth cooperates rapidly with a spring or other movable contact member the inertia and momentum of the contact member will prevent such member from fully following the teeth and the result is that there is not a succession of distinct complete sparks but rather an imperfect spark wave of varying intensity.

With my improved apparatus I avoid this by providing the separate and distinct circuit controllers each of which will cause the production of a full, complete and powerful spark, and with the timing of the sparks at each plug such that the most efficient ignition is accomplished without the sparks in any way overlapping or interfering with each other.

The circuit controller *s'* is similar to the circuit controller *s*, its parts being designated by corresponding but primed reference characters. It is placed in the housing 1 diametrically opposite to the controller *s*, the spring supporting block 15' being diametrically opposite block 15, and the spring 14' extending below the cam flange to cooperate with the terminal spring or bracket 21' which is supported against the insulating block 23' by the terminal post 24'. The contact points 19' and 20' are separated except when the cam ridge or projection 28' engages in one of the cam notches. As before stated the cam notches are spaced ninety degrees apart, the notches *a* and *b* being diametrically opposite and the notches *c* and *d* being diametrically opposite.

Depending upon the interval of time desired between the two succeeding sparks at each spark plug the cam ridge 28' is offset circumferentially with reference to the cam flange 13 and relative to the cam ridge 28. With the cam member rotating in the direc-

tion of the arrow x, Fig. 5, the offset will be such that the cam ridge 28 will first move into and then out of a cam notch to cause closure and re-opening of the circuit controller s before the cam ridge 28′ will cooperate with the opposite cam notch to close and re-open the circuit controller s'. The respective circuit controllers are open except when the corresponding cam ridge engages momentarily in a cam notch, and one circuit controller will have been re-opened after a closure thereof before the other controller is closed. This will insure the passage of induced secondary current flow entirely through the respective spark plug and will prevent short circuiting of the current to ground through the induction coil primary circuit. The arm 29 extending upwardly from the housing 1 is connected in any suitable manner with the spark lever at the steering wheel of the machine so that the circuit controllers can be shifted with the housing relative to the cam member to advance or retard sparking as desired.

The distributor member B has the cylindrical body part 30 from whose outer end the rectangular projection 31 extends radially upward. At its inner end the member has the seating flange 32 which seats in the mouth of the housing 1, the housing being preferably provided with the seating step 33 as shown in order to form a sealed joint to prevent moisture and dirt from entering into the housing 1. The member B has the cylindrical bore 34 for receiving the outer end of the cam member 6. Extending radially in the wall of the cylindrical body 30 and terminating at the inner face of the pocket 34 near the bottom thereof are the distributing commutator segments 35, 36, 37 and 38 spaced ninety degrees apart, and extending axially in the part 31 and terminating at the inner face of the pocket 34 is the segment 39. Conductor bars 35′, 36′, 37′, 38′ and 39′ lead from the respective segments through the part 31 and at their upper ends are bored out to form sockets 40 for receiving the terminal pins (not shown) of the spark plug leads and other circuit conductors. The distributing member B is preferably formed of some insulating material such as bakelite or redmonal moulded around the commutator segments and conductor bars, and the projecting upper ends of the bars preferably have collars 41 of the insulating material around them forming seats for sleeves (not shown) which rigidly support and protect the lead connections with the terminal pins engaging in the sockets 40.

In the outer end of the cam member 6 is a radially extending groove or channel 42 for receiving the distributing brush or spring 43. The base 44 of the brush extends down the side of the cam member and is rigidly held in the channel 45 by means of a screw 46. The brush is normally sprung away from the end of the cam member so that when the distributor cap is applied to the housing 1 the brush will be compressed into the channel 42 to be held thereby against lateral displacement, while the projected and rounded end 47 of the brush engages against the central segment 39. During rotation of the cam member the brush end will be maintained in electrical contact with this central segment while the base section 44 of the spring will travel successively past the distributing commutator segments 35, 36, 37 and 38. The high tension secondary current generated during operation of the circuit controllers s and s' is distributed by the brush successively to the segments and from there to the respective spark plugs of the engine as will be described more fully in detail later. To avoid friction the brush does not physically engage with the distributing segments and the high tension secondary current will readily jump the short gap between the brush and segments.

To hold the parts A and B securely together and the entire apparatus against the engine frame the clamping bar or spring 48 is provided. This may be the regular clamping bar or spring usually provided with Ford engines to hold the Ford clamping mechanism in place or it may be a special bar. I have shown the ordinary Ford bar, and in order that it will securely engage with the distrubutor cap and hold such cap against rotation during adjustment of the housing 1 to advance or retard the spark I provide a transverse notch or channel 49 which extends from the center of the cap radially and slightly diagonally to one side thereof to so receive the bar 48 that the cap will be held in proper position vertically. Centrally of the cap the concavity 50 is provided for receiving the convex projection 51 at the end of the bar. After the parts of my improved distributor are applied to the engine the bar is applied in the channel with its end 51 engaging in the concavity 50 in the cap and the parts A and B will be securely held together, while the force of the brush spring 43 will cause the cam member 6 to be securely held in its place on the end of the cam shaft.

In Figs. 8 and 9 I have diagrammatically shown the apparatus and the circuit connections. In the arrangement of Fig. 8 two induction coils are used while in the arrangement of Fig. 9 only one coil is used. For supplying the necesary primary current the regular Ford magneto or any other magneto 52 can be used, or a battery 53 may be employed. Through the leads 54, 55, 56 and 57 the commutator segments 35, 36, 37 and 38 are connected with the respec-

tive spark plugs *p* of the engine cylinders Nos. 1, 2, 3 and 4, one terminal of all these spark plugs being connected with the engine frame E which is grounded. In Fig. 8 I have shown two induction coils F and F' each of which has a primary winding 57 and a secondary winding 58. The primary windings are connected together at one end and through conductor 59 either with the generator 52 or the battery 53. The primary winding of the coil F is connected by conductor 60 with the terminal post 24 of the circuit controller *s*, while the primary winding of the coil *s'* is connected by conductor 61 with the terminal post 24' of the circuit controller *s'*. The secondary windings 58 are connected together at one end and with the conductor 59 while at their other ends these windings connect with conductor 62 which leads to the central commutator segment 39 of the distributor mechanism. The spring supporting blocks 15 and 15' being in electrical contact with the housing 1 are grounded and this is represeted by the conductor 63 which is shown grounded at 64. With the positions of the part shown in Figs. 1 to 8 the cam member 6 has just brought the notch *a* into position to receive the cam ridge 28 to permit the spring 14 to close the contact points 19 and 20, while the cam ridge 28' of the spring 14' is just in advance of the diametrically opposite cam notch *b*. The generator 52 being connected in for service the current will flow therefrom through conductor 59, the primary winding of the coil F, conductor 60, binding post 24, terminal spring 21, spring 14, and conductor 63 to ground, one terminal of the generator being grounded. During the short period of closure of this primary circuit the induction coil F will be charged so that when the circuit is abruptly opened when the notch *a* is moved away from the spring 14 an induced charge of high tension current will flow through the secondary circuit as follows: from the secondary winding of coil F through conductor 62, segment 39, brush 43, commutator segment 35, conductor 54 to the spark plug of cylinder No. 1, from thence to ground and through the grounded generator 52, and through conductor 59 back to the secondary winding. The first spark will therefore be produced at cylinder No. 1. Shortly after reopening of the primary circuit at circuit controller *s* the cam notch *b* will receive the cam ridge 28' and circuit controller *s'* will close so that the primary circuit thru coil F' will be closed as follows: from the generator 52, to the primary winding of coil F', conductor 61, terminal spring 21', contact points 19' and 20', spring 14', conductor 63 to ground, and back to the generator. The coil F' is now charged and when the cam ridge 28' is moved out of the notch *b* and the circuit controller *s'* is opened a charge of secondary current will flow from the secondary winding of the coil F' through conductor 62, segment 39, brush 43, segment 35, spark plug of cylinder No. 1, and thence to ground and back to the secondary winding through the generator and conductor 59. Thus immediately after the first complete and efficient spark has been produced in cylinder No. 1 a second complete, distinct and efficient spark is produced at the same spark plug, and though each of these sparks is entirely complete and distinct the sparks are close enough together so that they occur well within the period allotted to ignition in the engine cycle and at or close to the peak of the alternating current secondary wave. The apparatus is preferably applied to the engine so that one of the circuit controllers, say *s*, will function to cause the first spark at a plug at the normal time for ignition or when the ignition wave is at its peak, and the circuit controller *s*, will then operate to cause the second spark after a sufficiently short interval to keep such second spark close to the wave peak. Certain conditions may interfere with proper synchronism of the sine wave with the apparatus, but even though one of the sparks should occur when the wave is at zero the other spark will occur at a time sufficiently close to peak current strength that efficient ignition will be produced.

The brush 43 and the commutator segments are of adequate area so that the brush will present sufficient area to each distributor segment while the set of two sparks is sent to the respective cylinder plugs. This is clearly shown in connection with the ignition for cylinder No. 1 in Figs. 8 and 9. After the two sparks have been produced in cylinder No. 1 both circuit controllers are open and the primary circuit will remain open until the next diametrically opposite notches *d* and *e* cooperate with the circuit controllers to set up the necessary sparking conditions for cylinder No. 2.

In Fig. 9 I show only one induction coil H having the primary winding 65 and the secondary winding 66. One terminal of the primary winding is connected by conductor 59 with either the generator 52 or the battery 53, while the other terminal of the winding is connected by conductor 67 and branch conductors 68 and 69 respectively with the terminal springs 21 and 21' of the circuit controllers *s* and *s'*, the contact springs 14 and 14' being connected by conductor 63 with ground at 64. One terminal of the secondary winding is grounded as shown at 70 while the other terminal is connected through conductor 71 with the center segment 39. In the arrangement shown the circuit controller *s* has been opened by withdrawal of the notch *a* from the spring 14. Just before such opening the primary circuit

was closed through the branch conductor 68 and the circuit controller s so that when this circuit was opened as shown the induced secondary current flowed from the secondary winding 66 through the brush and commutator segments to the plug of cylinder No. 1. Shortly after this current flow the notch b will receive the cam ridge of the spring 14' so that the primary circuit will be closed through the branch conductor 69 and the circuit controller s', and then upon reopening of this circuit the resulting induced secondary current will flow through the spark plug of cylinder No. 1 to produce the second or follow-up spark. One circuit controller does not function until the other has been reopened after a closure thereof and the secondary current has been given time to efficiently produce a distinct and complete spark. The two sparks should be sufficiently close together so as to occur at or near the peak of the ignition wave, but the interval between sparks should be sufficient to permit the primary winding to fully charge the induction coil between the operations of the circuit controllers.

I thus produce an improved arrangement which will give a set of complete, distinct and efficient sparks in each cylinder during its ignition period so that the most efficient explosion results. My improved apparatus is very simple and comprises a very small number of parts which can be readily assembled and quickly applied to the engine.

I do not desire to be limited to the exact construction and arrangement shown and described as changes and modifications can be made which will still come within the scope of the appended claims.

I claim as follows:

1. In an ignition system, the combination of inductively related primary and secondary circuits, a spark plug connected in the secondary circuit, a source of current for the primary circuit, a plurality of circuit controllers for said primary circuit normally holding said circuit open, and means for successively operating said circuit controllers during each ignition period of the engine with which the spark plug is associated, the operation of each circuit controller causing a short closure of the primary circuit and reopening thereof to cause induced current flow through the secondary circuit and said spark plug whereby a plurality of distinct sparks is caused at said plug during each ignition period.

2. In an ignition system for explosive engines, the combination of inductively related primary and secondary circuits, a spark plug connected in the secondary circuit, a source of current for the primary circuit, a plurality of circuit controllers connected serially in said primary circuit and in parallel with each other, said circuit controllers normally opening said primary circuit, and means for successively operating said circuit controllers during the ignition period of the engine cylinder with which the spark plug is associated, each circuit controller when operated controlling the primary circuit to cause an induced flow of current through the secondary circuit and the spark plug whereby a plurality of distinct sparks are caused at said plug during each ignition period.

3. In an ignition system, the combination of primary and secondary circuits inductively related, a source of current in the primary circuit, a spark plug connected with the secondary circuit, a cam member adapted to be driven in timed relation with the engine cylinder with which the spark plug is associated, a plurality of circuit controllers arranged around said cam member and connected with said primary circuit, said circuit controllers being normally kept open by said cam member whereby the primary circuit is normally open, and cam formations on said cam member cooperating successively with said circuit controllers during each ignition period of the engine to cause successive operation of said circuit controllers to control the primary circuit, the operation at each circuit controller involving a momentary closure thereof and reopening and each controller closing and reopening before the next controller is closed, whereby said primary circuit will cause a succession of induced current flows through said secondary circuit and a succession of complete, distinct and powerful sparks at said spark plug during each ignition period of the engine cylinder with which the plug is associated.

4. The combination with an explosive engine having a plurality of cylinders each provided with a spark plug, of an ignition system comprising inductively related primary and secondary circuits, a source of current for the primary circuit, a cam member connected to be driven in timed relation with said engine, a plurality of circuit controllers arranged around said cam member and normally held thereby to open the primary circuit, a commutator brush carried with said cam member and connected with said secondary circuit, a plurality of distributor segments arranged around said cam member in the path of said brush, there being one segment for each engine cylinder connected with the respective spark plug thereof, said cam member cooperating successively with said circuit controllers during each closure of the secondary circuit at said brush and one of said commutator segments, the operation of each circuit controller involving momentary closure thereof and reopening and one controller being reopened before the next is closed, whereby said primary

circuit will cause a succession of induced current flows through said secondary circuit during each connection of a spark plug therein and a consequent succession of sparks at said plug during each ignition period controlled thereby.

5. In an ignition system, the combination of inductively related primary and secondary circuits, a spark plug connected in the secondary circuit, a source of current for the primary circuit, a plurality of circuit controllers connected serially in said primary circuit and in parallel with each other, and means for successively operating said circuit controllers during each ignition period of the engine with which the spark plug is associated, each circuit controller when operated controlling the primary circuit to cause an induced flow of current through the secondary circuit and the spark plug, whereby a plurality of distinct sparks is caused at said spark plug during each ignition period.

In witness whereof, I hereunto subscribe my name this 19th day of January, A. D. 1923.

ALONZO HOWARD.