Oct. 7, 1952 E. G. MACKAY 2,612,887

IGNITION SYSTEM FOR INTERNAL-COMBUSTION AND LIKE ENGINES

Filed Aug. 18, 1949 3 Sheets-Sheet 1

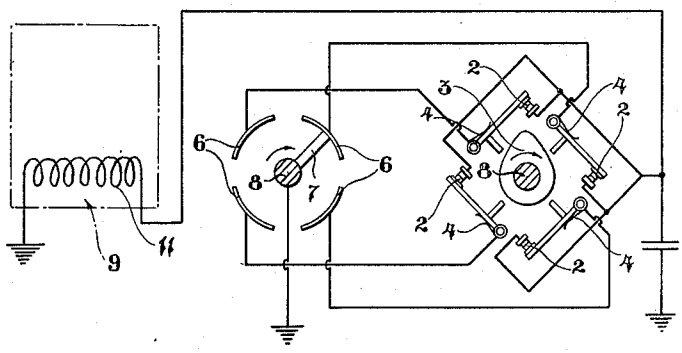


Fig.1.

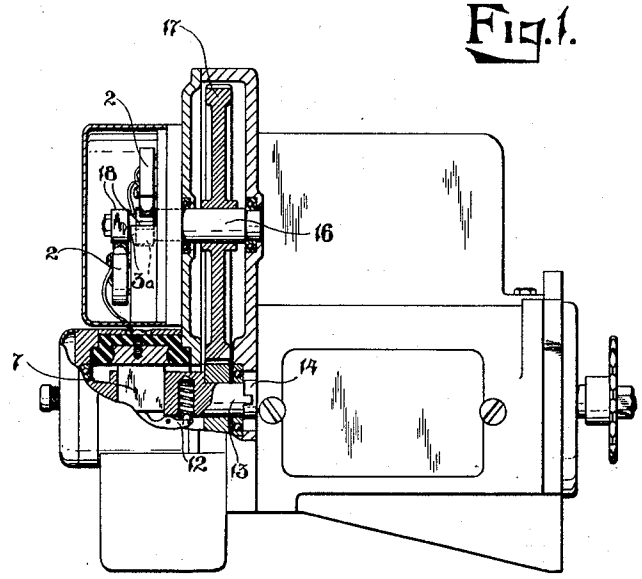


Fig.2.

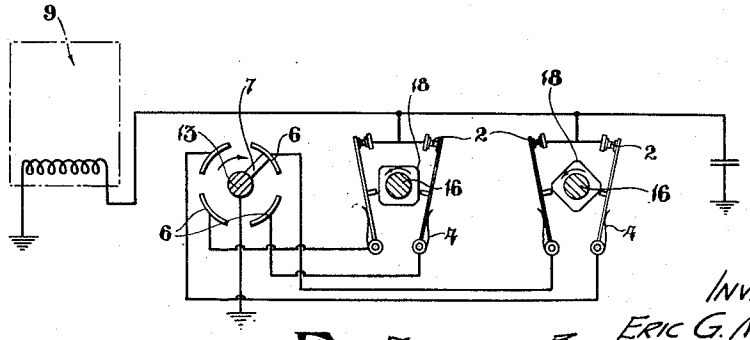


Fig.3.

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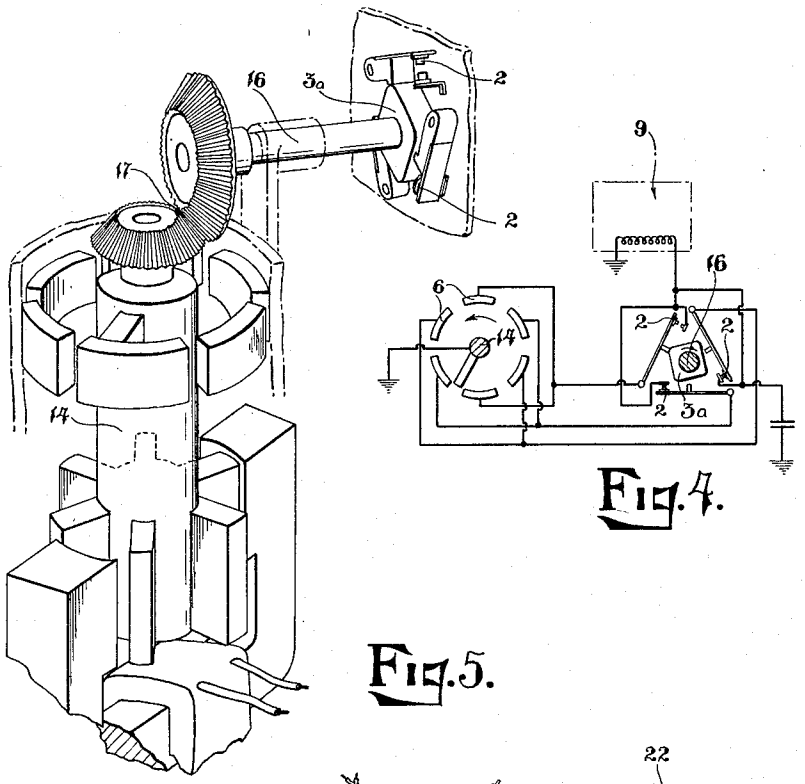


Fig. 4.

Fig. 5.

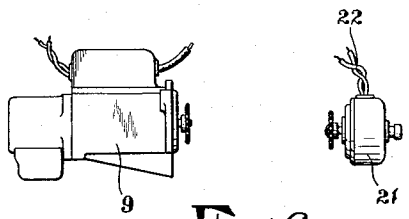


Fig. 6.

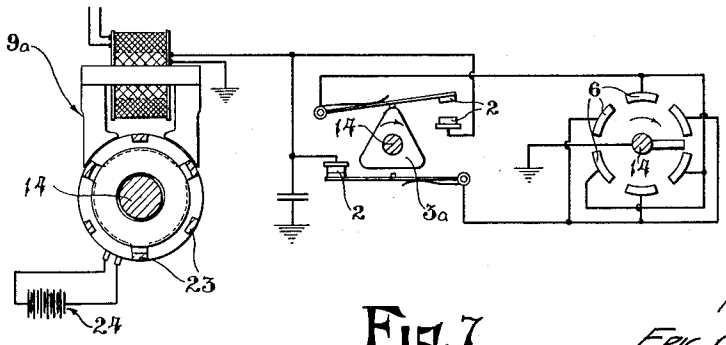


Fig. 7.

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IGNITION SYSTEM FOR INTERNAL-COMBUSTION AND LIKE ENGINES

Filed Aug. 18, 1949 3 Sheets-Sheet 3

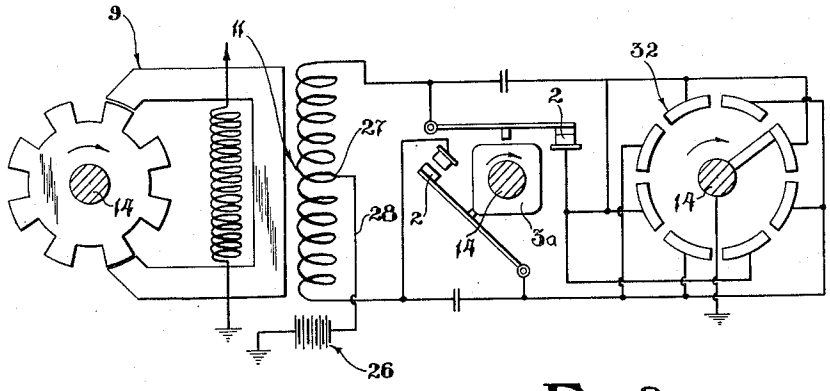


Fig. 8.

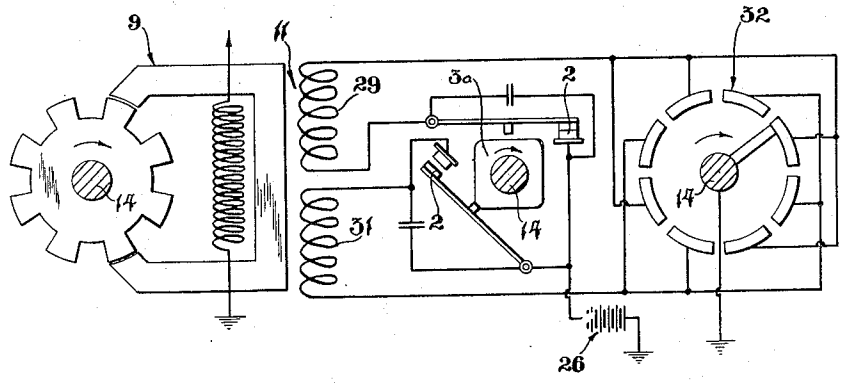


Fig. 9.

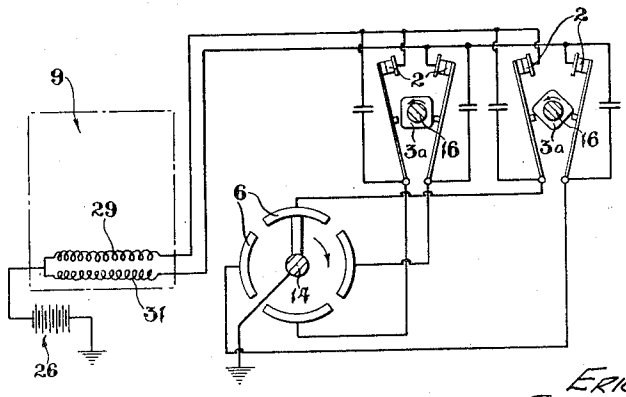


Fig. 10.

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Patented Oct. 7, 1952

2,612,887

UNITED STATES PATENT OFFICE

2,612,887

IGNITION SYSTEM FOR INTERNAL-COMBUSTION AND LIKE ENGINES

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Application August 18, 1949, Serial No. 111,036
In Australia September 17, 1948

13 Claims. (Cl. 123—148)

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This invention relates to ignition systems for internal combustion engines and particularly magneto ignition systems for multi-cylinder internal combustion and like engines.

With the continued increase in the number of cylinders employed in aircraft engines, the problem of providing efficient ignition therefor has become increasingly difficult. For example a 28 cylinder engine running at approximately 3,000 R. P. M. would require a total of approximately 42,000 ignition sparks per minute from a 28 point magneto. Known types of magnetos are not able to provide such a high output and consequently it has previously been necessary to employ two 14 point magnetos in order to obtain the desired total output. As it is customary for safety purposes, to provide aircraft engines with dual ignition systems, it follows that it is necessary to fit four such magnetos to each engine in order to obtain the desired performance.

It is well recognised that known types of magnetos are normally limited to a maximum output of approximately 30,000 ignition sparks per minute. At this figure however, efficiency is relatively low and consequently it is usually considered essential to limit the output to approximately 25,000 ignition sparks per minute for satisfactory performance.

The factor which prevents a higher efficient output is not electrical or magnetic but mechanical. When the output of the magneto approaches 30,000 ignition sparks per minute, the usual single set of cam operable and spring influenced contacts commonly known as "breaker points," employed for making and breaking the primary coil circuit, rapidly lose efficiency in that they are not allowed sufficient time to close, due inter alia, to the inertia of the movable parts thereof.

The primary object of the present invention is to provide an improved ignition system for multi-cylinder internal combustion and like engines which materially increases the effective output of each magneto in accordance with requirements without increasing its normal breaker speed. For example, in accordance with the present invention, the effective output of each magneto operating within the same breaker speed range as hitherto, may be raised to the order of about 50,000 to 100,000 or more ignition impulses or sparks per minute which thus enables a single magneto to easily meet the requirements for example, of a 28 cylinder engine operating at approximately 3,000 R. P. M.

Another object is to provide an improved magneto for the purpose indicated which has a much greater effective output than hitherto.

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A further object is to provide an improved battery ignition system incorporating cam operable relatively reciprocatory contacts and which is capable of a materially increased output if desired at a slower cam speed than hitherto.

If desired the improved magneto ignition system may incorporate a booster battery so as to provide an adequate supply of current for both starting as well as at high engine speed without having to cut off the battery current whilst in addition the effective output of the magneto is materially increased without any increase of its normal breaker speed.

Other objects and various novel constructional features of the invention will be more readily apparent from the following description of several practical embodiments.

Referring to the drawings which form part of this specification:

Figure 1 is a diagrammatic view of an ignition system incorporating four pairs of relatively reciprocatory contacts operable by a common cam and a rotatable contact selector in accordance with one embodiment of the present invention.

Figure 2 is a part sectional, side elevation of an improved magneto for incorporation in the new ignition system.

Figure 3 is a wiring diagram of an ignition system in accordance with a modification which involves the use of four pairs of relatively reciprocatory contacts operable by two multi-lobe cams.

Figure 4 is a wiring diagram of a magneto ignition system in accordance with a further embodiment which includes the use of an odd number of pairs of relatively reciprocatory contacts and a commutator having a greater number of segments.

Figure 5 is a semi-diagrammatic, perspective view of part of a magneto showing one suitable arrangement for operatively connecting the pairs of contacts and the commutator seen in Figure 4.

Figure 6 is a side elevation, on a reduced scale, of a still further embodiment in which the magneto and the plurality of pairs of reciprocatory contacts and commutator associated therewith are constructed as separate units so that they may be located remote from each other in accordance with requirements.

Figure 7 is a diagrammatic view of a magneto ignition system in accordance with a further modification in which the magneto is of the type in which an electromagnet is employed.

Figure 8 is a diagrammatic view of a still further embodiment in which provision is made for wiring a battery in circuit with the primary wind-

ing of the magneto induction coil to facilitate engine starting.

Figure 9 is a modification of the ignition system seen in Figure 8 and in which the primary winding of the induction coil consists of a pair of separate coils.

Figure 10 is a diagrammatic view of a still further modification of Figure 8.

According to the several embodiments illustrated in the drawings, the improved ignition system includes an induction coil having at least a primary or low tension winding which is common to a plurality of circuits, a plurality of pairs of circuit breaker contacts which are relatively reciprocatory and mechanically operable with each pair of contacts included in at least one of said circuits, separate circuit maker means which are also common to said circuits for completing each of them in sequence to the exclusion of all others, and means for synchronizing the movements of said pairs of circuit breaker contacts and said circuit make means whereby a greater output of electrical impulses is obtainable than would be possible if the ignition sytem included a single pair of contacts only for both making and breaking the primary circuit. This desirable result is obtained without reducing the minimum time required for ensuring effective closing of each of the plurality of pairs of contacts. In this regard it is generally recognized that the maximum speed at which a pair of such contacts is capable of operating efficiently is of the order of 25,000 opening movements per minute.

Any suitable type of either high or low tension magneto may be employed in that the ignition system may be readily adapted to include a magneto of the rotating armature, polar inductor or rotating magnet types. Alternatively, a magneto of the type employing electro magnets instead of the conventional permanent magnets may be adopted if so desired.

The aforesaid circuit maker means preferably consists of a commutator or like rotary switch device which is particularly suitable for high speed operation. The segments of such a commutator preferably correspond in number with the magnetic poles of the magneto in which case the brush of the commutator and magneto rotor shaft are operatively connected together so as to rotate at the same speed and thus enable the segments to periodically change the pairs of contacts as hereinafter described.

In some instances the number of the commutator segments may also correspond with the number of pairs of contacts employed and a common single lobe cam may be provided for actuating these contacts. The latter arrangement is however not essential and may be varied.

In the embodiment illustrated in Figure 1, four pairs of contacts **2** are arranged in circumferentially spaced relationship around a common rotatable cam **3** so that the pairs of contacts are opened by the cam in rotation, one of the contacts of each pair being spring influenced as at **4** so as normally to maintain each pair of contacts closed.

In this case four commutator segments **6** are provided so as to correspond with the number of pairs of contacts employed. Consequently the cam **3** and the commutator brush **7** rotate at the same speed and therefore may be carried by the magneto or any other common shaft **8** although for convenience of illustration it has been desirable to show the cam and the brush on separate shafts. Assuming that the maximum speed for effective operation of each set of points would be limited to approximately 25,000 breaks per minute, it will be appreciated that in this case the output from the single magneto **9** would be approximately 100,000 impulses per minute. Furthermore as the four pairs of contacts and the commutator segments have been wired in series with the low tension winding **11** of the magneto and a single lobe cam is employed, it will be apparent that each pair of contacts **2** is open during a relatively short movement of the lobe tip such for example as 20° in which case 340° of cam movement are provided for the contacts to close.

The length of each commutator segment **6** is such that each pair of contacts has adequate time to open whilst the brush is traversing its respective segment. Normally the brush is adapted to make and each pair of contacts is adapted to break the circuit although it will be appreciated that at very high speed the brush may have commenced to traverse each segment before the respective contacts have actually closed in which case the contacts are adapted to both make and break the circuit.

Experience has shown however that if the cam and commutator brush are adapted to operate at the same speed and a single lobe cam is employed, undesirable hammer or bounce is likely to develop in the opening and closing movements of the contacts at high speed. In order to avoid this objection, the commutator brush and the cam are preferably mounted on separate shafts which are geared or otherwise operatively connected so that their speed may be synchronised in accordance with requirements. This also enables a multi-lobe cam to be employed.

A suitable arrangement is illustrated in Figure 2 where the commutator and the plurality of contacts and the parts associated therewith are embodied in any suitable type of magneto so as to form a single unit. For example, the commutator brush **7** may be spring influenced as at **12** and carried by an axial extension **13** of the magneto shaft **14** with the segments arranged in circumferentially spaced relationship around the shaft extension. The cam may be carried by a suitable lay shaft **16** with the pairs of contacts **2** arranged in circumferentially spaced relationship around the cam. The lay shaft and magneto shaft extension may be operatively connected together by any suitable reduction gearing **17**. Instead of using a common cam to operate all of the pairs of contacts, two or more cams **3a** may be provided and arranged in longitudinally spaced relationship on their shaft with their lobes **18** out of registry.

The latter type of arrangement is illustrated diagrammatically in Figure 3 of the drawings although it will be appreciated that the cams have been shown as mounted on separate shafts for convenience of illustration. In this case four pairs of contacts **2** and a commutator having four segments **6** are employed, the contacts being arranged in two assemblies, each of which has its own multi lobe cam. If four lobe cams are employed, the brush and cam shafts **13, 16** are connected together by four to one reduction gearing. It will be appreciated that by employing reduction gearing as aforesaid the cam speed is materially reduced and undesirable hammer and bounce as aforesaid is eliminated.

If desired provision may be made for periodically reversing the polarity of the aforesaid contacts. As seen in the embodiment shown in Figures 4 and 5 this may be achieved by employ-

ing an odd number of pairs of contacts and a comutator which has a greater number of segments and is adapted to rotate at a relatively higher speed. The number of segments employed constitute a multiple of the number of contacts. In the embodiment illustrated, three circumferentially spaced pairs of contacts 2 are provided and the commutator has six segments, the contact cam 3a being mounted on a separate shaft 16 which is geared to the brush shaft by two to one reduction gearing 17. As seen in Figure 5, the brush is also carried by the rotary magneto shaft 14 and the arrangement is such that the polarity of the contacts is changed at each successive opening movement and thus effectively prevents the undesirable transfer of metal therebetween.

The invention is not limited to ignition systems in which a new type of magneto as illustrated in Figure 2 is employed. Obviously existing types of magnetos 9 may be incorporated in the system and in this case the commutator and the plurality of contacts and parts associated therewith may be formed as a separate unit. As illustrated in Figure 6, the last mentioned parts may be housed in a separate casing 21 connected by flexible or any other suitable leads 22 with the primary winding of the magneto so that the separate casing may be remotely located in relation to the magneto if found necessary.

Another embodiment is shown in Figure 7 wherein the system includes a magneto 9a of the type in which electro magnets are employed instead of the usual permanent magnets. For example, the rotary magnets or inductor bars 23 may be energised by a battery 24 through appropriate slip rings. The circuit in this case includes a commutator having six segments 6 whilst a three lobe cam 3a may be employed for actuating two pairs of contacts 2. In this case, as the magneto shaft, cam and brush all rotate at the same speed, the cam and the brush may be conveniently mounted on the magneto shaft.

It will be appreciated from the foregoing that those embodiments of the invention illustrated in Figures 1 to 7 are equally applicable to either magneto or battery ignition systems. In either case a materially increased output is obtainable if desired at a slower cam speed than that normally required for use in similar ignition systems but in which a single pair of contacts only is employed.

Although the invention has been described and illustrated as incorporating a plurality of independent pairs of reciprocatory contacts as aforesaid, it will be appreciated that the pairs of contacts may be electrically connected in tandem or in any suitable manner if so desired in order to reduce the weight of the contact breaker arms and the spring pressure thereon.

In accordance with a modification as illustrated in Figures 8, 9 and 10 provision is made for including both a magneto 9 and a battery 26 in the circuit in order to ensure an effective supply of current for starting purposes as well as when the engine is running at high speed without having to cut off the supply of battery current. For this purpose, it is essential to alternately reverse the flow of the unidirectional battery current through the primary winding 11 in order that it may match the alternating current of the magneto therethrough. An arrangement for this purpose is described and illustrated in my copending Australian patent application No. 22,258/48 in which the primary winding of the magneto consists of two sections which are wired in circuit with a battery. As seen in Figure 8, the primary winding may consist of a single coil provided with a substantially central tap 27 connected to a common lead 28 from the battery circuit so as to electrically divide the primary winding into two sections.

Alternatively the primary winding may consist of two separate and substantially identical coils 29, 31 as illustrated in Figure 9. In this case the coils are preferably wound in longitudinally spaced relationship upon a common core so as to ensure substantial matching of the coils and thus minimize undesirable interference therebetween.

In both of the embodiments illustrated in Figures 8 and 9, the battery circuit includes a plurality of pairs of contacts 2 and an associated commutator 32 as aforesaid. In this case however the commutator in addition to serving as the contact circuit maker also performs the additional function of serving as circuit changing means for alternately including the said sections in the battery circuit in such a manner that the battery current flows first in one direction in one of the sections and thence in the opposite direction in the other section to thereby alternately reverse the battery current flux in the induction coil to match the alternating magneto flux therein.

In the embodiments illustrated in Figure 8, the commutator is adapted to change the battery circuit to the primary coil through the pre-selected contacts whilst in the modification shown in Figure 9 the commutator functions to change the breaker circuit through the pre-selected separate primary coils.

It is generally recognised that normal types of battery ignition systems are limited to an output of approximately 18,000 impulses per minute. Also that conventional types of magneto ignition systems are limited to an output of approximately 28,000 impulses per minute. By way of comparison the output of the ignition system above described with reference to Figures 7, 8 or 9 is capable of an efficient output of approximately 48,000 to 50,000 impulses per mintue. Such a performance would adequately meet the requirements of a multi cylinder internal combustion engine of the type used in high speed automobiles.

In the embodiments illustrated in Figures 8 and 9 the eight pole magneto rotor may be adapted to rotate at the same speed as both the commutator and the cam for actuating the pairs of contacts. In this case the system would be capable of meeting the requirements of a four stroke eight cylinder engine operating at 12,000 R. P. M. which would necessitate the provision of 48,000 impulses per minute at a magneto rotor speed of 6000 R. P. M.

A still further modification involving the use of a pair of matched primary coils 29, 31 wired in circuit with a battery 26, is illustrated in Figure 10 and in which the plurality of contact points 2 are arranged in two assemblies and adapted to be operated by two multi lobe cams 3a and in which the lobes are out of registry as aforesaid.

In the last mentioned embodiment, the magneto is assumed to include a four pole rotor. A four segment commutator and two four lobe cams are also employed. The cams are operatively connected with the rotor and commutator shafts in such a manner that the speed of the rotor and commutator brush is four times that of the cam shaft. This system is capable of providing ef-

ficient ignition to a forty-two cylinder four stroke internal combustion engine operating at 3,000 R. P. M. which necessitates the provision of 63,000 impulses per minute at a magneto rotor speed of 15,750 R. P. M. Due to this relatively high rotor speed the magneto may be driven directly by gearing or in any other suitable manner by the cam ring of a radial engine. In addition the weight of the magneto may be reduced to a minimum. The approximate maximum capacity of an ignition system in accordance with the last mentioned embodiment would be approximately 100,000 impulses per minute at a rotor speed of 25,000 R. P. M.

It will also be readily apparent that the embodiments illustrated in Figures 8, 9 and 10 not only provide a materially increased output as aforesaid but also are adapted to furnish an efficient supply of current for starting as well as throughout the whole of the engine speed range without having to cut off the supply of supplementary battery current.

In order to meet the requirements of dual ignition, a common rotor may be employed to flux two adjacent induction coil cores in any suitable manner and a common commutator may be operatively connected to two series of reciprocatory contacts functioning as breaker points as aforesaid.

Various alterations, modifications and/or additions may be introduced into the foregoing construction and arrangement of parts without departing from the ambit of the invention as defined by the appended claims.

Having now described my invention, what I claim as new and desire to secure by Letters Patent is:

1. An improved ignition system for internal combustion and like engines comprising a magneto fitted with an induction coil having a primary winding common to a plurality of circuits, a plurality of cam operable and independent pairs of relatively reciprocatory contacts included in at least one of said circuits, rotatable circuit maker means which are also common to said circuits and are capable of being electrically connected in series with any one of said pairs of contacts for successively including not more than one at a time of said pairs of contacts in circuit with the primary winding, said cam being rotatable and operatively connected to said rotatable circuit maker means so that their speeds are synchronised whereby a greater output of electrical impulses is obtainable than would be possible if the ignition system included a single pair of contacts only for making and breaking the primary circuit and without reducing the minimum time required for ensuring effective closing of each of said plurality of contacts.

2. An ignition system according to claim 1 wherein said contact selector means consists of a commutator the segments of which correspond in number with the magnetic poles of the magneto rotor and are each electrically connected through at least one of said pairs of contacts with one end of said primary winding, the other end of which is electrically connected to the brush of said commutator, said brush and the magneto rotor shaft being operatively connected together so as to rotate at the same speed.

3. An improved ignition system for internal combustion and like engines comprising an induction coil having a primary winding which is common to a plurality of circuits, a plurality of pairs of circuit breaker contacts which are relatively reciprocatory and mechanically operable, each pair of contacts being included in at least one of said circuits, separate circuit maker means which are also common to said circuits for completing each of them in sequence to the exclusion of all others, and means for synchronizing the movements of said pairs of circuit breaker contacts and said circuit maker means whereby a greater output of electrical impulses is obtainable than would be possible if the ignition system included a single pair of contacts only for both making and breaking the primary circuit.

4. An ignition system according to claim 3 wherein said contact selector means consists of a commutator the segments of which correspond in number with the number of said pairs of contacts, each segment being electrically connected to a contact of one of said pairs of contacts which are adapted to be actuated by a cam operable at the same speed as the brush of said commutator.

5. An ignition system according to claim 3 wherein said contact selector means consists of a commutator the segments of which are greater in number than the number of said pairs of contacts each of which is electrically connected to two or more segments, said pairs of contacts being adapted to be actuated by a cam which is operatively connected to said commutator in such a manner that the commutator brush speed is greater than that of said cam.

6. An ignition system according to claim 3 wherein said pairs of contacts are arranged in two or more assemblies each of which is operable by a separate cam, the lobes of said cams being out of registry.

7. An ignition system according to claim 3 wherein said means for energising said primary winding includes a magneto, said contact selector means consists of a commutator and a rotatable cam is provided for actuating said plurality of contacts, the brush of said commutator and said cam being operatively positioned in longitudinally spaced relationship on the rotor shaft of said magneto.

8. An ignition system according to claim 3 wherein said means for energising said primary winding includes a magneto, said contact selector means consists of a commutator and a rotatable cam is provided for actuating said plurality of contacts, the brush of said commutator being mounted upon the magneto rotor shaft whilst said cam is carried by a separate shaft which is geared or otherwise operatively connected with said rotor shaft so that the speeds of said commutator brush and cam may be synchronised.

9. An ignition system according to claim 3 wherein said means for energising said primary winding includes a magneto, said contact selector means consists of a commutator and a rotatable cam or cams is or are provided for actuating said plurality of contacts, said commutator, the plurality of pairs of contacts and the rotatable cam or cams associated therewith being mounted in a casing separate from said magneto to the primary winding of which the commutator segments and the plurality of contacts are electrically connected.

10. An ignition system according to claim 3 wherein both a magneto and a battery are provided for energising said primary winding which consists of at least two sections, said contact selector means being also adapted to perform the additional function of alternately including said sections in the battery circuit in such a manner that the battery current flows first in one direc-

tion in one of said sections and thence in the opposite direction in the other section to thereby alternately reverse the battery current flux in said induction coil, the movements of said contact selector means and said pairs of contacts being synchronised with the movements of the magneto shaft to thereby substantially match the reversing battery current flux in said induction coil with the alternating magneto flux therein thus providing efficient ignition for engine starting as well as through the rest of the engine speed range without having to cut off the battery current.

11. An ignition system according to claim 3 wherein both a magneto and a battery are provided for energising said primary winding which consists of two separate and substantially identical coils wound in longitudinally spaced relationship upon a common core so as to ensure substantial matching of said coils and minimise undesirable interference therebetween, said contact selector means being also adapted to perform the additional function of alternately including said said sections in the battery circuit in such a manner that the battery current flows first in one direction in one of said sections and thence in the opposite direction in the other section to thereby alternately reverse the battery current flux in said induction coil, the movements of said contact selector means and said pairs of contacts being synchronised with the movements of the magneto shaft to thereby substantially match the reversing battery current flux in said induction coil with the alternating magneto flux therein thus providing efficient ignition for engine starting as well as through the rest of the engine speed range without having to cut off the battery current.

12. An ignition system according to claim 3 wherein both a magneto and a battery are provided for energising said primary winding which consists of a single coil provided with a substantially central tap connected to a common lead from said battery circuit so as to electrically divide the primary winding into said sections, said contact selector means being also adapted to

perform the additional function of alternately including said sections in the battery circuit in such a manner that the battery current flows first in one direction in one of said sections and thence in the opposite direction in the other section to thereby alternately reverse the battery current flux in said induction coil, the movements of said contact selector means and said pairs of contacts being synchronised with the movements of the magneto shaft to thereby substantially match the reversing battery current flux in said induction coil with the alternating magneto flux therein thus providing efficient ignition for engine starting as well as through the rest of the engine speed range without having to cut off the battery current.

13. For use in an ignition system according to claim 3 a magneto incorporating a plurality of pairs of relatively reciprocatory contacts capable of being wired in circuit with the primary winding of the induction coil of said magneto, a rotatable cam for actuating said contacts and a commutator forming rotatable contact selector means, the brush of said commutator and said cam being operatively connected with the magneto rotor shaft so that their speeds may be synchronised.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
685,960	Wirt	Nov. 5, 1901
915,389	Varley	Mar. 16, 1909
960,598	Springer	June 7, 1910
2,089,696	Gough et al.	Aug. 10, 1937
2,197,114	Rabezzana et al.	Apr. 16, 1940
2,215,106	Lefebvre	Sept. 17, 1940
2,217,232	Nowosielski	Oct. 8, 1940
2,377,353	Messerschmidt	June 5, 1945