Oct. 14, 1941. F. R. F. RAMSAY 2,259,213

IGNITION APPARATUS FOR INTERNAL COMBUSTION ENGINES

Filed April 21, 1939 4 Sheets-Sheet 1

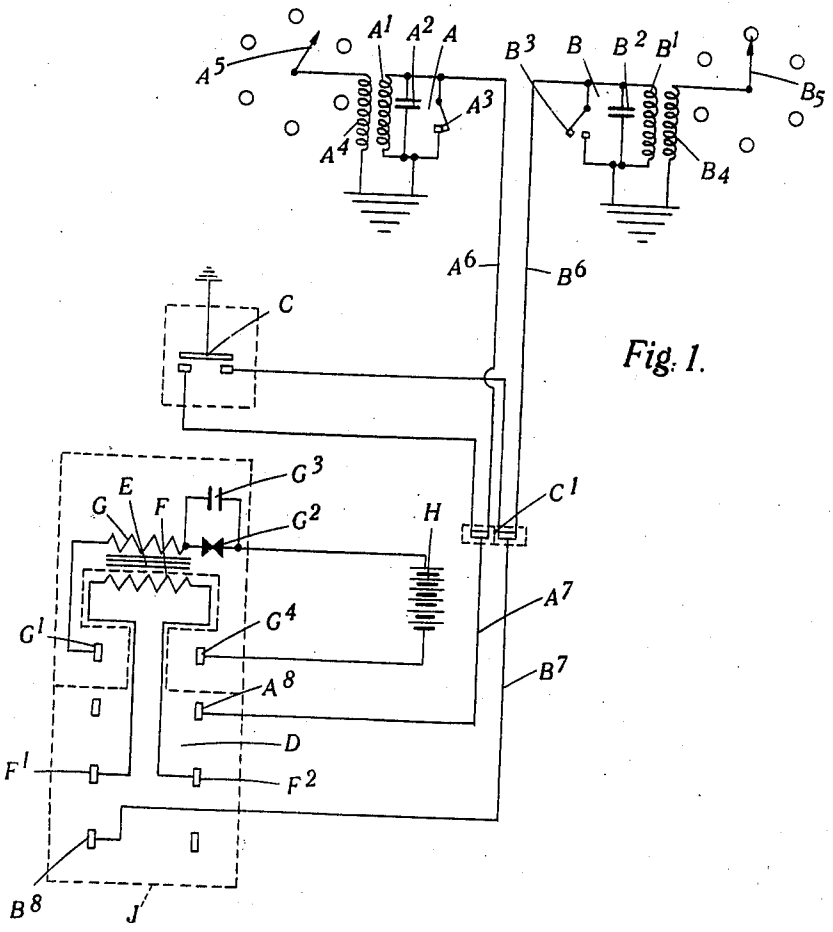
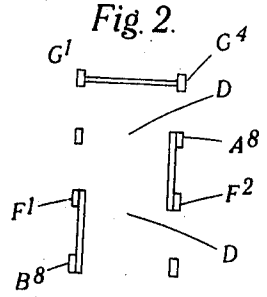


Fig. 1.

Fig. 2.



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IGNITION APPARATUS FOR INTERNAL COMBUSTION ENGINES

Filed April 21, 1939 4 Sheets-Sheet 2

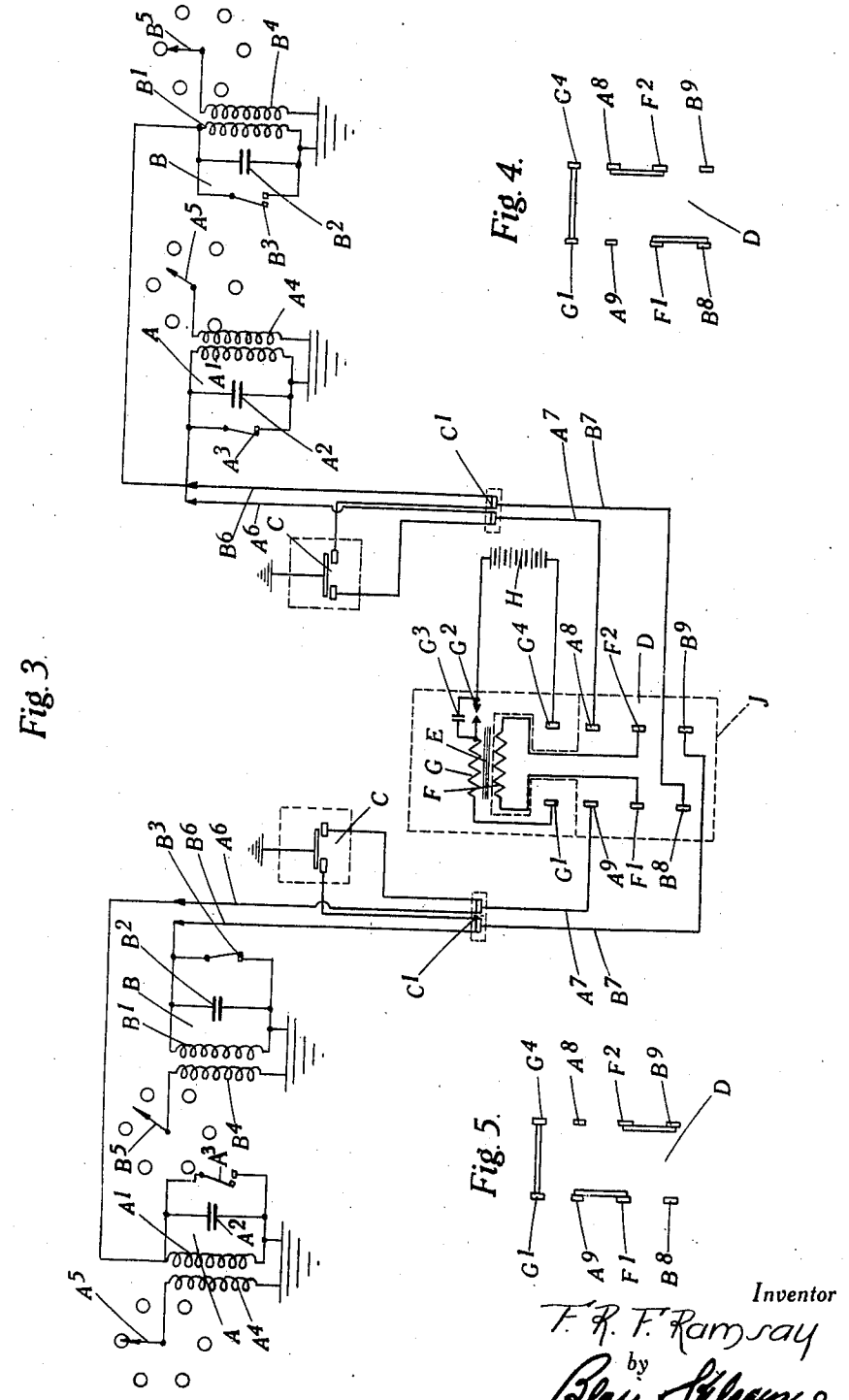

Fig. 3.

Fig. 4.

Fig. 5.

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IGNITION APPARATUS FOR INTERNAL COMBUSTION ENGINES

Filed April 21, 1939 4 Sheets-Sheet 3

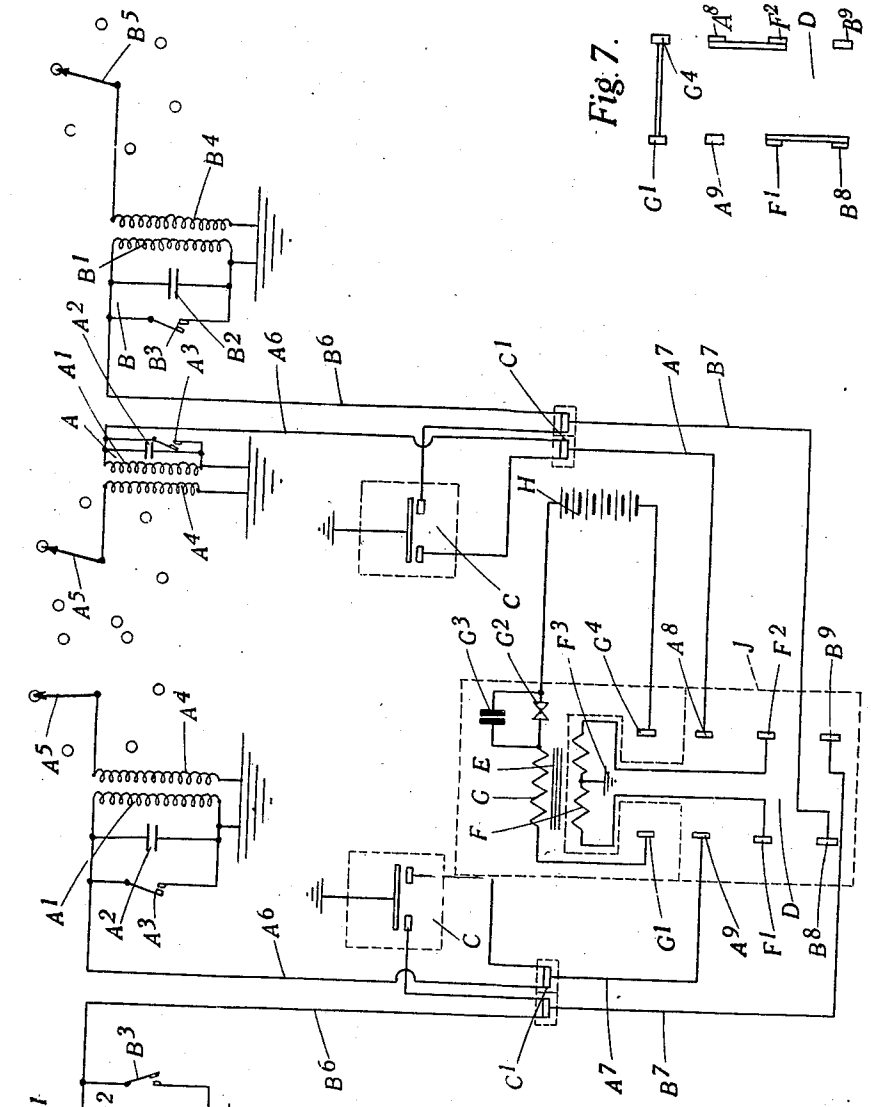

Fig. 6.

Fig. 7.

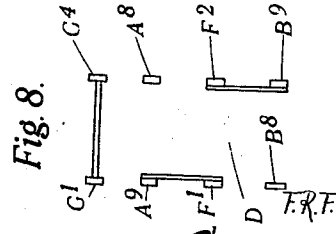

Fig. 8.

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IGNITION APPARATUS FOR INTERNAL COMBUSTION ENGINES

Filed April 21, 1939 4 Sheets-Sheet 4

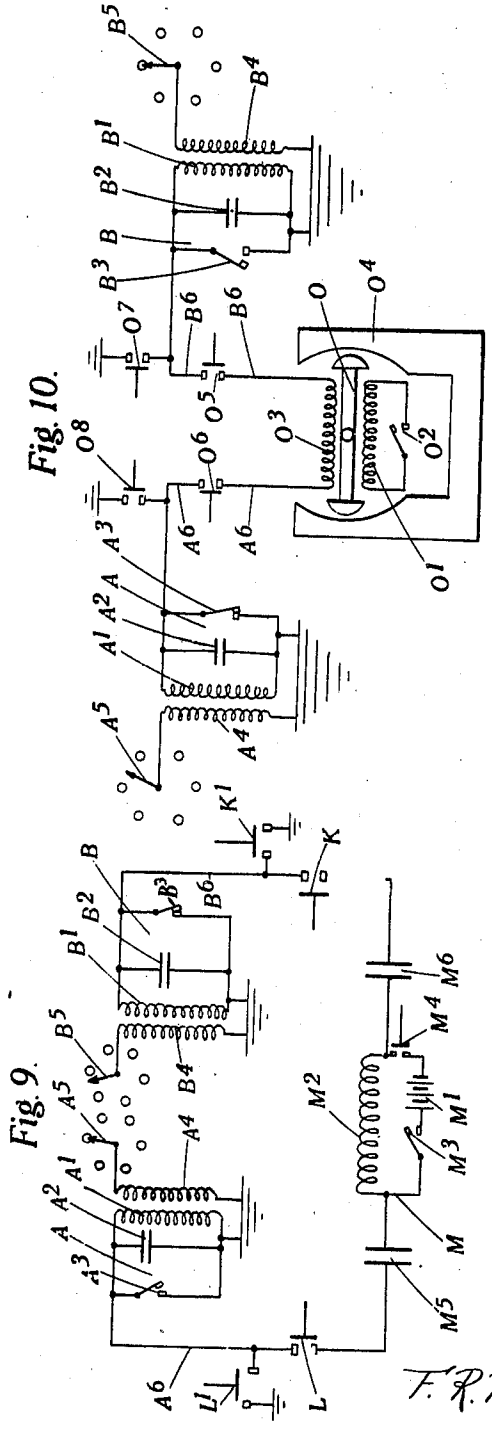

Fig. 10.

Fig. 9.

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UNITED STATES PATENT OFFICE

2,259,213

IGNITION APPARATUS FOR INTERNAL COMBUSTION ENGINES

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Application April 21, 1939, Serial No. 269,256
In Great Britain May 6, 1938

14 Claims. (Cl. 123—148)

This invention relates to ignition apparatus for internal combustion engines and is particularly but not exclusively applicable to engines for use on aircraft.

It has been proposed in internal combustion engines for aircraft to use for starting purposes a hand-operated starting magneto or a high tension ignition coil adapted to supply a series of high tension impulses and connected to an electrode on the distributor rotor which lies behind the normal electrode and will be hereinafter called a trailing electrode. In such an arrangement the timing of the ignition during starting is determined merely by the moment at which the trailing electrode reaches a position sufficiently near each fixed electrode in the distributor for a spark to pass to such fixed electrode. The trailing electrode must however be placed at a certain minimum distance behind the main electrode of the distributor in order to prevent a spark flashing back during normal running from the main electrode to the trailing electrode, particularly at high altitude, and this in practice means that the trailing electrode must be so far behind the main electrode that the spark supplied by the starting magneto or the high tension coil is considerably retarded as compared with the spark from the magneto. This retardation is between 30° and 60° depending upon conditions and in adverse circumstances such as cold weather and poor carburetion, the explosions obtained are practically ineffective and may be too feeble to accelerate the engine to a speed at which the main magnetos can supply the spark.

In order to overcome this difficulty, it has been proposed to dispense with the trailing electrode in the distributor and to obtain the necessary sparks for starting by supplying a low tension current from a battery to the primary winding of the magneto, the magneto then functioning as a sparking coil. In such an arrangement, the low tension current is generally interrupted by means of an interrupter of the automatic electromagnetic type, commonly known as a buzzer, so as to obtain a stream of sparks as long as the magneto contact-breaker is open.

This arrangement, however, suffers from the disadvantage that the supply of an excess of current by the battery due, for example, to the buzzer sticking or other causes, will demagnetize the magneto while moreover in such circumstances fusing of the wires and thus risk of fire may occur. Further, if a buzzer is not used, only single sparks are obtained, while moreover alternate sparks are suppressed as soon as the engine turns at a sufficient speed since alternate cycles of the magneto voltage then oppose the battery voltage.

According to the present invention energising apparatus for the ignition apparatus of an internal combustion engine employing a high tension magneto comprises an energy-storing circuit, means for supplying current to or generating current in the energy-storing circuit, an interrupter in the primary or energy-storing circuit operating independently of the high tension magneto, and an electromagnetic or electrostatic coupling adapted to connect the primary circuit to the primary winding of the magneto so as to transmit current impulses from the energising apparatus to this primary winding while preventing the transmission of direct current to the primary winding.

Preferably a transformer (hereinafter termed the coupling transformer) is provided to connect the primary circuit to the primary winding of the magneto, in which case the primary winding of the coupling transformer is arranged in the primary circuit so as to be energised by the independent source of current and the interrupter, while means are provided for connecting the secondary winding of the coupling transformer to the primary winding of the high tension magneto.

Alternatively, however, a condenser may be employed as the coupling to connect the primary circuit to the primary winding of the magneto.

In most cases the independent source of current is preferably a battery and in this case the interrupter is conveniently of the automatic electromagnetic type known as a buzzer which, when a coupling transformer is used, may be operated by the stray field from the transformer or may be operated from a separate coil. Alternatively, however, the magnetic system of the transformer may be formed as an armature adapted to be rotated by hand in a permanent magnetic field, in which case the interrupter is mechanically operated by rotation of the armature so that the apparatus constitutes a magneto with a low tension secondary winding.

The invention may be applied to arrangements for use with a single high tension magneto, in which case, when a coupling transformer is used, one end of the secondary winding thereof is conveniently earthed while the other end is connected to the unearthed end of the primary winding of the magneto. Alternatively, the invention may be applied to two or more high tension magnetos and when an internal combustion engine has two high tension magnetos the conductors

from the coupling, for example from the two ends of the secondary winding of the coupling transformer, are conveniently connected respectively to the unearthed ends of the primary windings of the two magnetos. If in such an arrangement the two high tension magnetos supply high tension spark impulses alternately the contact-breaker of each high tension magneto can serve to connect to earth the appropriate end of the secondary winding of the coupling transformer when a current impulse is being delivered to the primary winding of the other high tension magneto and, in this arrangement, the characteristics of the coupling, that is to say the ratio of the coupling transformer, where this form of coupling is used, can be the same as that employed in the case where only a single high tension magneto is employed.

If, on the other hand, the two high tension magnetos supply spark impulses simultaneously, the characteristics of the coupling are appropriately modified and, in the case of a coupling transformer, the centre of the secondary winding is conveniently earthed.

In any case a switch is preferably provided for disconnecting the high tension magneto or each high tension magneto from the energising apparatus, this switch conveniently being of the kind which is maintained closed by a manually controlled member against the action of a spring which opens the switch automatically upon the manually operated member being released. Further, when, as is generally preferred, the primary circuit is energised by a battery, the switch controlling the primary circuit is preferably so interconnected with the switch or switches for disconnecting the high tension magneto or magnetos from the energising apparatus that all such switches are opened and closed simultaneously by a single switch-controlled member. This may be effected by providing a suitable gang switch or alternatively, where this is not convenient, an electromagnetically operated switch for connecting the energising apparatus to the high tension magneto or magnetos may be arranged so as to be closed automatically when the primary circuit is energised, for example by being connected to the battery.

The invention may be carried into practice in various ways but five arrangements according to the invention together with a modification thereof are illustrated diagrammatically by way of example in the accompanying drawings, in which

Figure 1 shows an arrangement employing a coupling transformer applicable to an engine having two high tension magnetos arranged to supply spark impulses alternately,

Figure 2 is a diagram showing the operation of a conventional multiple circuit rotary switch for bringing the energising apparatus shown in Figure 1 into and out of operation,

Figure 3 is a similar view to Figure 1 of an arrangement employing a coupling transformer applicable to two engines each having two magnetos arranged to supply spark impulses alternately,

Figures 4 and 5 are similar views to Figure 2 showing two positions of the switch used in the arrangement shown in Figure 3,

Figure 6 shows an arrangement employing a coupling transformer applicable to two engines each having two magnetos arranged to supply spark impulses simultaneously,

Figures 7 and 8 are similar views to Figures 4 and 5 of the switch used in the arrangement shown in Figure 6,

Figure 9 shows diagrammatically an arrangement employing coupling condensers, and

Figure 10 shows diagrammatically an arrangement employing a hand-operated device for energising the primary circuit.

In the construction shown in Figures 1 and 2 the two high tension magnetos of the engine, which are arranged to supply alternate sparks, are indicated at A and B, each magneto being of normal type comprising a primary winding A^1, B^1 earthed at one end, arranged in parallel with a condenser A^2, B^2 and a contact-breaker A^3, B^3, and a secondary winding A^4, B^4 earthed at one end and connected at its other end to the rotating electrode A^5, B^5 of a distributor, the fixed contacts of which are connected to the sparking plugs. The usual ignition switch C is provided for earthing the normally unearthed side of the primary winding through conductors A^6, B^6. The energising apparatus according to the present invention is adapted to be connected to the leads A^6, B^6 through a junction box C^1, leads A^7, B^7 and terminals A^8, B^8 of a gang switch D and comprises a coupling transformer E the ends of the secondary winding F of which are connected respectively to two contacts F^1, F^2 of the gang switch D. One end of the primary winding G of the coupling transformer E is connected direct to a contact G^1 of the gang switch D while its other end is connected through an interrupter G^2 conveniently of the buzzer type in parallel with a condenser G^3 to one terminal of a battery H. The other terminal of the battery is connected direct to a contact G^4 of the gang switch D.

The gang switch D is so constructed that when open all the contacts A^8, B^8, F^1, F^2, G^1, G^4 are isolated from one another. When, however, the gang switch is closed, it connects contact A^2 to contact F^2, contact B^8 to contact F^1 and contact G^1 to contact G^4, as indicated in Figure 2. It will thus be seen that when the gang switch D is closed the primary winding G of the coupling transformer F will be connected in circuit with the battery H through the interrupter G^2 and condenser G^3 and will thus be energised by a series of current impulses so that a series of current impulses will be supplied to the secondary winding F which is now in circuit through the contacts F^1, B^8 and F^2, A^8 and the leads A^7, A^6 and B^7, B^6 and earth with primary windings A^1, B^1 of the two magnetos. Since the two magnetos supply alternate sparks, the contact-breaker of one magneto or the other will always be closed and one side or the other of the secondary winding F^1 will thus always be earthed directly through the closed contact-breaker. Thus a series of low tension current impulses will be passed through the primary winding of whichever of the two magnetos at the moment has its contact-breaker in the open position, these low tension current impulses being transformed by the magneto into high tension current impulses in the secondary winding thereof which thus pass through the distributor to the appropriate sparking plug.

The energising apparatus, that is to say the apparatus enclosed in the dotted line J, is conveniently mounted in an appropriate casing which may be fireproof and can be secured to the dashboard or other part of an aeroplane, motor vehicle or the like with the operating member for the gang switch D readily accessible.

In the alternative arrangement shown dia-

grammatically in Figures 3, 4 and 5 for use with two engines each having two magnetos supplying alternate sparks, the energising apparatus is similar to that described above with reference to Figure 1 and the gang switch D is constructed so that the energising apparatus may be coupled to the magnetos of one engine or the other as desired. For the sake of convenience the parts of the two magnetos of each engine are designated by the same reference letters as in Figure 1.

In the arrangement shown in Figures 3 and 4 each pair of magnetos is provided with the normal ignition switch C for earthing the two conductors A^6, B^6 and while the conductors A^7, B^7 from one pair of magnetos lead to the contacts A^8, B^8 respectively of the gang switch D, those from the other pair of magnetos lead to contacts A^9, B^9 of the gang switch.

This gang switch is formed so that in one closed position as indicated in Figure 4 it connects the contact A^8 to F^2, the contact B^8 to F^1 and the contact G^1 to G^4 so as to supply low tension impulses to the primary windings of the magnetos of one engine, while in another closed position as indicated in Figure 5 it connects the contact A^9 to the contact F^1, the contact B^9 to the contact F^2 and, as before, the contact G^1 to the contact G^4 so as to supply low tension current impulses to the primary windings of the magnetos of the other engine.

In the arrangement shown diagrammatically in Figures 6, 7 and 8 for use with two engines each having two magnetos supplying sparks simultaneously, the arrangement is the same as that shown in Figures 3, 4 and 5, except that the secondary winding F of the coupling transformer is earthed at its centre, as shown at F^3, so that a series of similar current impulses is transmitted through the primary windings of both magnetos of the engine to which the energising apparatus is at any moment coupled by the gang switch D whenever the contact-breakers of the magnetos are open.

As in the construction shown in Figures 1 and 2, the energising apparatus enclosed in the dotted line J is conveniently mounted within a fireproof or other casing adapted to be secured to the dashboard or other suitable part of an aeroplane, motor vehicle or the like.

In the arrangement shown diagrammatically in Figure 9 the energising apparatus is shown for use with two magnetos adapted to supply alternate sparks. For convenience the parts of the magnetos and the conductors leading to the primary windings thereof are designated by the same reference letters as in Figure 1. In the construction shown in Figure 9 the conductors A^6 and B^6 communicate through manually controlled switches K and L with the energising apparatus and are also provided with the usual earthing ignition switches K^1 and L^1. The energising apparatus comprises an energy-storing circuit M including a battery M^1, a coil M^2 and an interrupter M^3 of the buzzer type, a manually-operated switch M^4 being provided for closing this circuit. The energy-storing circuit is adapted to be coupled to the conductors A^6 and B^6 respectively by condensers M^5 and M^6.

In this arrangement it will be understood that the switches K, L and M^4 may be incorporated in a gang switch as in the construction shown in Figure 1 so that they are operated by movement of a single operating member.

In the arrangement shown diagrammatically in Figure 10, the energising apparatus is shown as applied to two magnetos adapted to supply alternate sparks and the parts of these magnetos and the conductors by which they are coupled to the energising apparatus are designated by the same reference letters as in Figure 1.

In the construction shown in Figure 10 the energising apparatus is in the form of a hand-operated magneto comprising an armature indicated at O constituting the core of a transformer comprising a primary winding O^1 the circuit of which constitutes the primary circuit and is provided with an interrupter or contact-breaker indicated at O^2, and a secondary winding O^3 adapted to supply low tension current impulses through the conductors A^6 and B^6. The armature O is arranged to rotate within a permanent magnetic field constituted by a permanent magnet diagrammatically indicated at O^4. Manually-operated switches O^5, O^6 are provided in the conductors A^6 and B^6 which are also provided with the usual earthing ignition switches O^7, O^8.

In this construction the switches O^5, O^6 may be arranged as a gang switch so as to be operated by a single operating member.

In some cases, for example where it is not desired or convenient to mount the apparatus according to the invention in a readily accessible place or where it is desired that the apparatus shall be capable of being readily brought into and out of operation from a distance, an electromagnetically operated switch for connecting the energising apparatus to the appropriate conductors may be incorporated in the apparatus and arranged so as to close automatically when the energy-storing circuit is energised. Such an electromagnetically operated switch may thus, where a coupling transformer is used, be actuated by the stray field of the coupling transformer or by a separate coil but in any case it will be seen that it enables the apparatus to be brought into operation by the closing of a single switch which may be placed in any convenient position.

With energising apparatus according to the invention employing a battery to energise the primary circuit, it will be seen that since the battery is not connected directly to the magnetos, no possible failure of the energising apparatus can affect the operation of the magnetos.

Moreover, it will be seen that two magnetos can be supplied from a single energising apparatus, there is no loss of energy when the internal combustion engine or engines are mounted remotely from the energising apparatus, as is the case if a high tension hand-operated starting magneto is used, and greater efficiency can be obtained in the energising apparatus, whether a battery or a low tension magneto is used, since the characteristics of the coupling between the energising apparatus and the high tension magneto or magnetos can be such as to give the correct voltage for the transfer of the maximum amount of energy to the primary winding of the magneto or magnetos.

Moreover, if in the case of aircraft engines the energising apparatus is arranged in or near the cockpit or other point from which the engine or engines are controlled, no extra wiring between the cockpit and the engine is needed since the wires leading to the normal magneto-controlling switches can be used to connect the primary windings of the two magnetos to the energising

apparatus. As compared with the employment of a high tension hand-operated starting magneto, the weight of the high tension cable then needed is thus saved. Again, the energising apparatus can be considerably lighter than an ordinary high tension starting magneto and no modification of the distributors of the high tension magnetos is necessary.

What I claim as my invention and desire to secure by Letters Patent is:

1. Energising apparatus for a high tension magneto of an internal combustion engine including a primary circuit, means for supplying current to the primary circuit, an interrupter in the primary circuit arranged to operate independently of the high tension magneto, and an indirect coupling device adapted to transmit current impulses from the primary circuit to the primary winding of the magneto.

2. Energising apparatus for a high tension magneto of an internal combustion engine including a coupling transformer, an electromagnetically operated interrupter in the circuit of the primary winding of the coupling transformer, and switch apparatus for connecting the secondary winding of the coupling transformer to the primary winding of the magneto and for connecting the circuit of the primary winding of the coupling transformer to a battery.

3. Energising apparatus for a high tension magneto of an internal combustion engine including a primary circuit, means for supplying current to the primary circuit, an interrupter in the primary circuit arranged to operate independently of the high tension magneto, and a condenser for transmitting current impulses from the primary circuit to the primary winding of the magneto.

4. Energising apparatus for a high tension magneto of an internal combustion engine including an armature adapted to be manually rotated within a permanent magnetic field, a transformer the windings of which are arranged upon the armature, an interrupter in the circuit of the primary winding of the transformer and operated mechanically by rotation of the armature, and switch apparatus whereby the secondary winding of the transformer can be connected to the primary winding of the magneto.

5. Energising apparatus for two high tension magnetos of an internal combustion engine arranged to supply alternate high tension current impulses including a coupling transformer, an electromagnetically operated interrupter in the circuit of the primary winding of the coupling transformer, switch apparatus for connecting the ends of the secondary winding of the coupling transformer respectively to the normally unearthed ends of the primary windings of the two high tension magnetos, and means for connecting the circuit of the primary winding of the coupling transformer to a battery.

6. Energising apparatus for two high tension magnetos of an internal combustion engine arranged to supply simultaneous high tension current impulses including a coupling transformer, means for earthing an intermediate point in the secondary winding of the coupling transformer, an electromagnetically operated interrupter in the circuit of the primary winding of the coupling transformer, switch apparatus for connecting the ends of the secondary winding of the coupling transformer respectively to the normally unearthed ends of the primary windings of the two high tension magnetos, and means for connecting the circuit of the primary winding of the coupling transformer to a battery.

7. Energising apparatus for the high tension magnetos of two internal combustion engines including a primary circuit, means for supplying current to or generating current in the primary circuit, an interrupter in the primary circuit arranged to operate independently of the high tension magnetos, an indirect coupling device adapted to transmit current impulses from the primary circuit, and a change-over switch whereby the indirect coupling can be connected at will to the primary winding of at least one magneto of either one of the two internal combustion engines.

8. Energising apparatus for the high tension magnetos of two internal combustion engines including a coupling transformer, an electromagnetically operated interrupter in the circuit of the primary winding of the coupling transformer, means for connecting the circuit of the primary winding of the coupling transformer to a battery, and change-over switch apparatus whereby the secondary winding of the coupling transformer can be connected at will to the primary winding of at least one magneto of either one of the two internal combustion engines.

9. Ignition apparatus for an internal combustion engine including a high tension magneto, a primary circuit, means for supplying current to the primary circuit, an interrupter in the primary circuit arranged to operate independently of the high tension magneto, and an indirect coupling device adapted to transmit current impulses from the primary circuit to the primary winding of the magneto.

10. Ignition apparatus for an internal combustion engine including a high tension magneto, a coupling transformer, an electromagnetically operated interrupter in the circuit of the primary winding of the coupling transformer, and switch apparatus for connecting the secondary winding of the coupling transformer to the primary winding of the magneto and for connecting the circuit of the primary winding of the coupling transformer to a battery.

11. Ignition apparatus for an internal combustion engine including a high tension magneto, a primary circuit, means for supplying current to the primary circuit, an interrupter in the primary circuit arranged to operate independently of the high tension magneto, and a condenser for transmitting current impulses from the primary circuit to the primary winding of the magneto.

12. Ignition apparatus for an internal combustion engine including a high tension magneto, an armature adapted to be manually rotated within a permanent magnetic field, a transformer the windings of which are arranged upon the armature, an interrupter in the circuit of the primary winding of the transformer operated mechanically by rotation of the armature, and switch apparatus whereby the secondary winding of the transformer can be connected to the primary winding of the magneto.

13. Ignition apparatus for an internal combustion engine including two high tension magnetos arranged to supply alternate sparks, a coupling transformer, an electromagnetically operated interrupter in the circuit of the primary winding of the coupling transformer, switch apparatus for connecting the ends of the secondary winding of the coupling transformer respectively to the normally unearthed ends of the primary wind-

ings of the two high tension magnetos, and means for connecting the circuit of the primary winding of the coupling transformer to a battery.

14. Ignition apparatus for an internal combustion engine comprising two high tension magnetos arranged to supply simultaneous sparks, a coupling transformer, means for earthing an intermediate point in the secondary winding of the coupling transformer, an electromagnetically operated interrupter in the circuit of the primary winding of the coupling transformer, switch apparatus for connecting the ends of the secondary winding of the coupling transformer respectively to the normally unearthed ends of the primary windings of the two high tension magnetos, and means for connecting the circuit of the primary winding of the coupling transformer to a battery.

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