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F. DAUSINGER
IGNITION DEVICE FOR INTERNAL COMBUSTION ENGINES
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Fig. 1

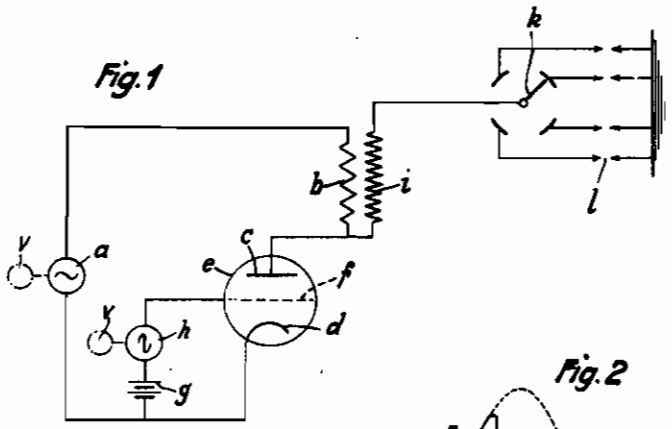
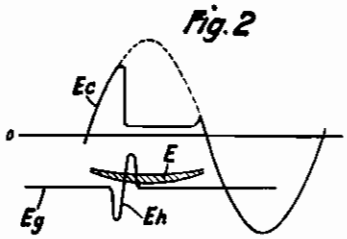


Fig. 2



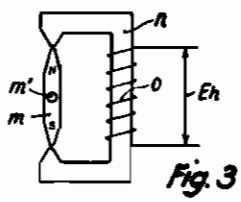


Fig. 3

Inventor
Franz Dausinger
By Roy F. Steward
His Attorney

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IGNITION DEVICE FOR INTERNAL COMBUSTION ENGINES

Franz Dausinger, Stuttgart, Germany; vested in the Alien Property Custodian

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This invention relates to electric ignition devices for internal combustion engines comprising a gas discharge tube acting as a control valve.

Ignition devices for internal combustion engines usually comprise mechanically operated switching devices for controlling the firing or ignition point in the cylinders of the engine. In order to avoid the disturbances produced by wear of the mechanical contacts, it has been suggested already to replace the mechanical switching devices by electrical means, i. e., by gas discharge tubes acting as control valves. In practice, however, it was found difficult to carry out this proposal, because neither the ignition voltages of various tubes of the same type nor the voltages of the sources of current used for the supply of ignition devices for internal combustion engines are sufficiently constant. It has been attempted to avoid this drawback, at least with tubes comprising control grids, by the provision of a grid bias which changes in the ignition point, but in this case, mechanically operated switching means were again required for connecting the control voltage to the grid and for disconnecting it therefrom. Such switch means, of course, are electrically relieved, since they do not carry the working current, but still they show the inherent defects of any mechanically operated switch.

It is an object of the invention to provide means for eliminating this defect of the known ignition devices comprising gas-discharge tubes.

With this and further objects in view, as may become apparent from the within disclosures, the invention consists not only in the structures herein pointed out and illustrated by the drawings, but includes further structures coming within the scope of what hereinafter may be claimed.

The character of the invention, however, may be best understood by reference to certain of its structural forms, as illustrated by the accompanying drawings in which:—

Fig. 1 is a circuit diagram of a four-cylinder internal combustion engine having the invention applied thereto.

Fig. 2 is a diagram showing the voltage conditions in the ignition device and

Fig. 3 is a diagrammatic view of an impulse generator for use in connection with the invention.

The invention contemplates the provision in the tube circuit of an impulse generator which produces a voltage impulse for igniting the gas discharge tube in the firing point. This impulse generator may be interpolated in the plate circuit where a gas discharge tube is used having two electrodes only, or in the grid circuit of a grid-controlled gas discharge tube.

Referring now to the drawings in greater detail, and first to Fig. 1, it will be seen that one pole of a source of alternating current *a* is connected to the anode *c* of a gas discharge tube *e*, through the primary *b* of an ignition coil *b, i*, while the other pole is connected to the cathode *d* thereof. The grid *f* of the tube *e* is negatively biassed by the voltage of a storage battery *g* to block the tube against the passage of current from the source *a*. Moreover, an alternating current generator *h* is interconnected in the grid circuit which generates voltage impulses having a very steep wave front, at a frequency corresponding to the ignition frequency, said impulses being superposed to the negative grid bias. With each voltage impulses E*h* generated by the impulse generator *h* the bias E*g* is reduced to an amount which is lower than the critical grid voltage E indicated by the hatched surface and varies with the working conditions, so that the tube *e* is not blocked any more by the grid bias. The anode voltage Ec is thereby reduced to the burning voltage of the tube, (which is the characteristic voltage of the ionised gas path) whereby an anode current and a current through the primary *b* of the ignition coil *b, i*, is caused which in turn induce a voltage in the secondary *i* of the ignition coil applied to the spark plugs *l*, through a distributor *k*. As a result, an ignition spark jumps over at the spark plugs *l*. After the current has passed through zero, the tube is blocked again by its bias.

It will be understood that in place of the direct current voltage derived from the storage battery *g*, for example, an alternating current voltage having a certain phase displacement with respect to the voltage of the source of alternating current *a* and having an impulse voltage superimposed to it may be applied to the grid *g* of the tube *e*.

While any suitable impulse generator may be used on principle to produce the voltage impulse E*h* which are superimposed to the grid bias, I have shown a particularly suitable and simple device in Fig. 3 in which a permanent magnet *m* is fixedly mounted on the shaft *m'* which rotates in synchronism with the crank shaft of the internal combusiton engine.

A coil o is wound upon an iron core *n* and inserted, for example, in the grid circuit of the tube *e*, at *h*. It will thus be understood that a volt-

age impulse E*h* is induced in the coil o with each change of the direction of the lines of magnetic force produced by the rotating magnet and passing through the coil o, whereby the tube *e* is ignited. Where a magnet *m* having one pair of poles is used, two changes of the direction of flux occur in the magnetic circuit of the coil o with each full revolution of the shaft *m'* and, as a result, two voltage impulses are produced per revolution. Therefore, in case of a four cylinder engine, the impulse generator shown in Fig. 3 should be driven with the speed of the crank shaft of the engine. On the other hand, where a magnet *m* having two pairs of poles is employed in a four cylinder engine, the impulse generator may be driven with the speed of the control shaft, the same as the shaft of the ignition distributor *k*.

In some instances it may be useful to provide a speed-controlled device for adjusting the ignition point, of known type, in the drive of the alternating current generator *a* or in the drive of the impulse generator, or where the impulse generator and the source of alternating current are constructed as an integral unit, in the common drive for the two devices. Such devices for adjusting the ignition point are indicated at V in Fig. 1, by dash and dot lines.

The method and apparatus of the present invention have been described in detail with reference to specific embodiments. It is to be understood, however, that the invention is not limited by such specific reference but is broader in scope and capable of other embodiments than those specifically described and illustrated in the drawing. More particularly, the invention is not restricted to the use of an ignition plant fed by alternating current. For example, a thyratron circuit producing relaxation oscillations may be used instead, comprising a condenser which is charged from a source of direct current and discharged in the ignition point of the engine through a valve and an ignition transformer. Also in this case the impulse for the discharge may come from an impulse generator interpolated in the anode or grid circuit of the gas discharge tube.

FRANZ DAUSINGER.