

April 19, 1927.

1,624,951

H. B. HOLTHOUSE
HIGH TENSION CIRCUITS

Filed July 15, 1922

2 Sheets-Sheet 1

Fig. 1

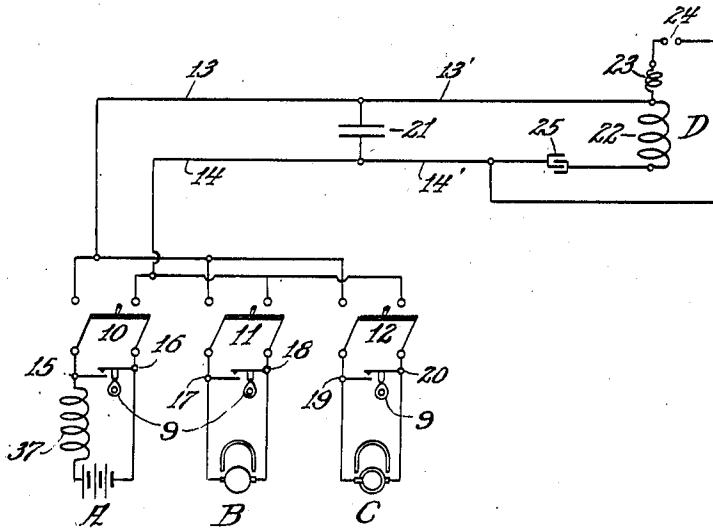
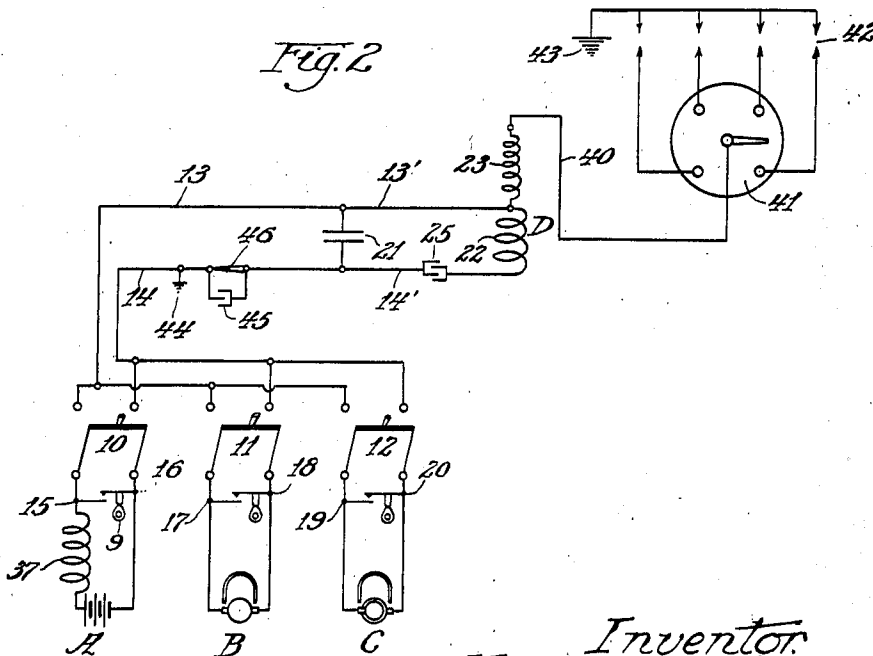


Fig. 2



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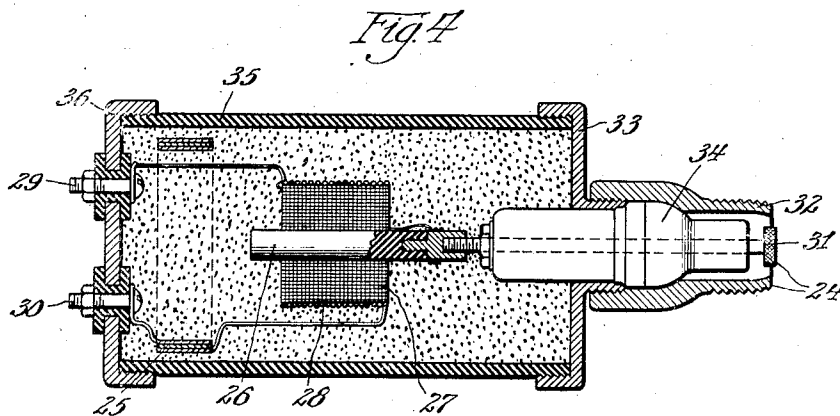
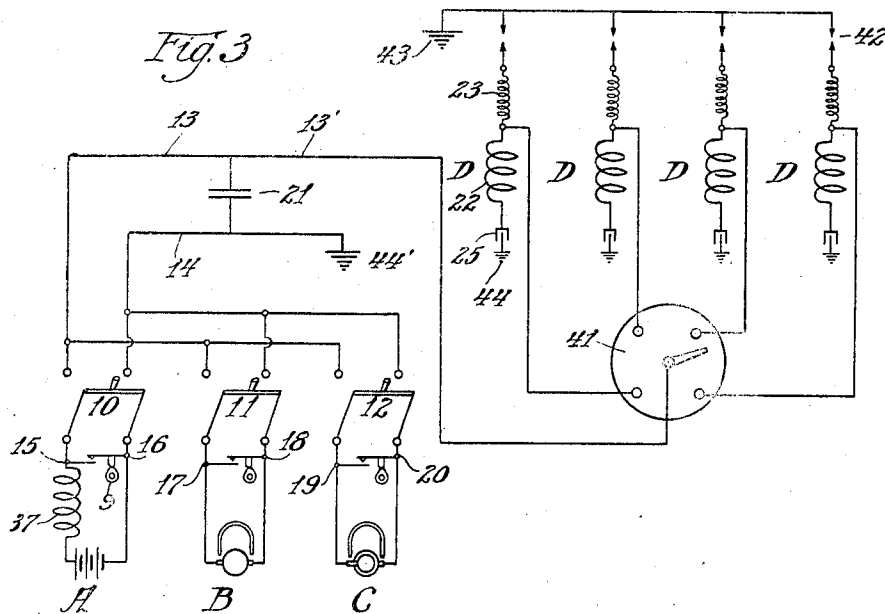
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HIGH TENSION CIRCUITS

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2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE.

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HIGH-TENSION CIRCUITS.

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My invention relates to electrical circuits and has to do more particularly with high frequency oscillating circuits adapted for use in ignition circuits or for excitation of X-ray tubes, vacuum electrodes, ultra violet ray generation, etc.

One of the features of my invention is the provision in a circuit having breaker points across a source of current, of a fixed spark gap with the circuit so arranged that the spark gap eliminates entirely, or to a substantial degree, the sparking at the points when they are operated so as to prevent burning up of these contacts. Furthermore, the provision of such a gap in such a circuit, I find, aids and prolongs the duration of the arc caused by the operation of the breaker points. Another feature of my arrangement is that the resistance of the oscillating circuit is reduced thereby causing a much higher frequency and heavier and more continuous discharge from the secondary of the oscillation transformer by effecting more complete trains of oscillations due to the longer time element and fixed spacing of the spark gap where the arc forms. The gap also determines the secondary voltage.

Another feature of my arrangement is that higher frequencies of oscillations are obtained as the gap prevents damping of the oscillations because they start earlier, thus allowing a greater period of time for oscillations. Also, the gap forms a fixed sparking point of definite and lower resistance and thus trains of oscillations are more constant than where they may vary due to their beginning at different periods of operation in the breaker points.

There are other features and advantages of my improved circuit arrangement and these will be pointed out in the ensuing part of the specification and accompanying claims.

For a better understanding of my invention reference is to be had to the accompanying drawings in which—

Fig. 1 shows one form of my invention more particularly adapted for the excitation of X-ray tubes, vacuum electrodes, ultra violet ray generation, etc., with various interchangeable ways of exciting the circuit;

Fig. 2 shows another form of my invention arranged more particularly for igni-

tion purposes with the distribution in the high potential or secondary circuit;

Fig. 3 is another form of my invention arranged more particularly for an ignition circuit and with the distribution in the primary circuit; and

Fig. 4 is a cross sectional view of an oscillation transformer adapted for use in my circuit and with a spark plug directly connected therewith.

Referring now more in detail to the form of my invention as shown in Fig. 1, a suitable source of exciting current is provided and I have shown three different sources adapted to be interchangeably connected by way of illustration. These three sources comprise a direct current or battery source A, a direct current generator B having a separately excited field which may be by way of a permanent magnet or electrically excited, and a third source C in the form of an alternating current generator having a permanent magnet or separately excited field. I may also employ an alternating current from the usual alternating current feed, in place of the battery A, using the coil 37 as with A, but, of course, synchronizing the points 15, 16 with the current wave. Switches 10, 11 and 12 are adapted to connect these sources across the conductors 13—14 which conductors are adapted to extend to the point of use such as to an oscillation transformer D. Across the conductors which extend from the source of current to the point of use I connect breaker points suitably timed and adjusted as hereinafter more particularly described. For the source A, I provide breaker points or contacts 15—16 shown as being operated by a rotatable cam 17 suitably timed according to the use to which current is to be put. Across source B, I provide breaker points 17—18 also suitably timed and adjusted according to their use. Across the alternating current source C I provide suitable breaker points 19—20 operating in synchronism with the generator C so that they will break on the peak of the wave and close substantially at zero.

It will thus be seen the breaker or contact points may be electromagnetically or mechanically operated and may be synchronized or not depending upon the character of the exciting current source.

Across the conductors 13—14 leading from

the current source and breaker contacts is a fixed spark gap 21 adjustable so as to be set according to the adjustment of the breaker contacts and the other circuit characteristics and out-put desired.

The conductors 13—14 may, of course, be extended to the desired point of use and I have shown an oscillation transformer D connected across these conductors having a primary winding 22 and secondary winding 23 with a spark gap 24 connected in circuit. A suitable condenser 25 is also shown connected in the primary circuit.

In Fig. 4 I have shown an oscillation transformer which I have found suitable for use in my improved circuit, this device comprising a non-magnetic core 26 supporting a secondary winding 27 and primary winding 28. The primary winding is preferably on the outside and a few turns as compared to the inner or secondary winding 27 which is of comparatively great number of turns, the proportion varying, of course, according to the various circuit characteristics or results desired. The primary winding is connected across the binding posts 29—30 and the secondary winding is connected to one terminal of the primary winding with the other terminal extending to the central electrode 31 of the sparking points 24. The other electrode, that is 32, is shown as the sleeve portion of a spark plug secured to a cap 33 so as to hold a suitable porcelain 34 in which the central electrode is carried. A non-metallic insulating case or sleeve 35 is supported between the cap 33 and cap 36, the inside being filled with an insulating compound or insulating oil. In Fig. 4 I have shown the oscillation transformer as connected directly with a spark plug for internal combustion engines. It will be understood, however, that the transformer is to be connected according to the use to which it is to be put, and may have the usual sparking points connected therewith such as are ordinarily employed for high frequency spark oscillations. When the sparking device is a spark plug as in Fig. 4, the electrodes are preferably very heavy and I ordinarily employ a larger gap than usual because I have found the ordinary spark plug electrodes quickly burn away. A circular condenser 25 is also inserted.

Operation of Figure 1.

Now as to the operation of Fig. 1, when supplied with current from source A I preferably insert an inductance coil 37 in the line so as to raise the breaking voltage and effect a lag in the circuit at the time the breaker contacts 15—16 are interrupted. Assuming that switch 10 is closed and contacts 15—16 closed, upon their next interruption, the self induced voltage of inductance coil 37 rises but contacts 15—16 inter-

rupt fast enough to prevent any substantial sparking at their points of separation and the self induced voltage is not sufficient to jump across the spark gap 21 until the contacts 15—16 have reached a point of separation greater than that of the spark gap. At this time the circuit including the spark gap 21, conductor 13', primary winding 22, condenser 25 and conductor 14' is in a closed oscillating circuit started by the sparking at gap 21. This, of course, sets up a high voltage, high frequency oscillating circuit through the secondary winding 23 and sparking points 24 thus providing a low resistance path across the contacts 24 for the exciting source A. Thus, in this circuit I have a high and low frequency, high and low voltage and heavy secondary current characteristic. With the breaker points 15—16 working at the ordinary high speed the oscillations across 24 continue until the source A is again short circuited by the closing of the points 15—16 and upon their next interruption excitation of the oscillation transformer and spark points 24 is again effected, this cycle of operations continuing upon each operation of the breaker points.

I have found that by the use of the circuit arrangement described, substantially all, if not all, of the sparking at the breaker points 15—16 is eliminated; the effective oscillations are more constant due to the fixed spark gap 21; and the period of oscillations is increased. With the spark gap 21 eliminated the oscillations do not commence until the contacts 15—16 are closing after their separation, while with the spark gap 21 provided I allow the oscillations to begin as soon as the self induced voltage has reached preferably a maximum where it jumps the gap 21.

In connection with this circuit it will be understood, of course, that the gap 21 is adjusted to substantially the lowest voltage produced by the exciting source through the inductance coil 37. Thereby I make the time element more constant because the initial oscillations are effected by the beginning of the sparking at gap 21, the breaker points moving fast enough, and far enough apart, so as to prevent effectual sparking at said points 15—16.

Assuming that direct current source B is connected to the circuit through the switch 11, the breaker points 17—18 are operated the same as points 15—16. Generator B is a direct current generator with a separately excited field which may be electrically excited or by a permanent magnet and of a type in which the direct short circuit by the breaker contacts is permitted. In this circuit as in where the source A is used, the breaker points 17—18 interrupt to permit the beginning of the oscillations by the spark gap 21.

With the alternating current source C 130

connected to the circuit by the switch 12, breaker points 19—20 are operated in synchronism with the current wave preferably breaking at the peak of the wave. The spark gap 21 is, of course, adjusted relative to the breaker points as before, that is so that it is closer than the greatest opening of the breaking points and at a distance to take care of the highest voltage of the generator.

Figure 2.

In Fig. 2 I have shown another form of my invention applied to an ignition circuit for a four cylinder internal combustion engine. The source of exciting current switches, breaker points and spark gap are shown as in Fig. 1 and numbered the same. The secondary winding of the oscillation transformer, however, instead of being connected directly to a spark electrode extends over a conductor 40 and then through a distributor 41 to the various spark plugs 42 to ground 43 to the return ground 44. In this type of circuit the secondary or high potential is distributed to the sparking plugs which, of course, may be of any number depending upon the number of cylinders in the engine. The breaker points must, of course, be in synchronism with the engine and where the alternating or magneto current is used the various elements must be properly timed so that the plugs spark at the proper time.

In using my improved circuit arrangement for ignition purposes, various advantages are secured in that the gap 21 being adjusted to the lowest breaking voltage, gives a constant timing to the starting of the sparking oscillations. Without the fixed sparking gap 21 the timing varies on account of being started by the moving breaker points. This results in uneven timing as the breaking current jumps the gap at different times. With the fixed gap the timing is more constant. Also the gap being of the usual large area maintains perfect adjustment and aids in the formation of an arc, thus giving a more constant low resistance oscillating circuit which, of course, increases the out-put of the oscillation transformer secondary and increases and prolongs the oscillations.

In the operation of the circuit of Fig. 2, the initial surge through the primary of the transformer D is effected for each operation of the breaker points, resulting in a flow through the secondary 23, the distributor 41, the connected spark plug 42, and grounds 43—44. This initial high frequency oscillation or sparking across the spark plug electrodes 42 sets up a low resistance path so that the current from the exciting source immediately flows over conductors 13—13', secondary 23, conductor 40, distributor 41, spark plug 42 and grounds 43—44 to the

return side of the exciting source, thus providing a circuit for the primary current. It will thus be seen that the initial high potential current jumps the spark plug gap breaking down the resistance at this point so that a heavy surge of primary current of a comparatively low voltage, flows over the spark gap of the plug, being limited only by the resistance of the secondary winding 23 of the transformer, which is unusually low.

In Fig. 2 I have shown a condenser 45, and switch 46 for cutting in the condenser to time the circuit to secure the proper phase relation or resonance between secondary discharge and the primary current surge. Without the condenser the initial sparking is in advance of the primary current surge; with the condenser they are in phase. I find this of advantage in high compression engines.

Figure 3.

In Fig. 3 I have shown another form of my invention differing from Fig. 2 in that instead of distributing the high potential or secondary current as in Fig. 2, I distribute the low potential or primary current and then connect a coil for each of the spark plugs instead of using the individual coil as in Fig. 2. Thus by distributing the low potential or primary current I eliminate the troubles arising from a high tension distribution where the connections and conductors are not properly insulated or maintained.

In the circuit of Fig. 3 the spark plugs 42 are grounded as before through the frame of the engine, but instead of being connected directly to the distributor as in Fig. 2 are connected to the secondary winding 23 of the transformer, the primary winding 22 of which is connected through the condenser 25 to ground or frame of the car. This ground 44 then leads to the ground 44' extending back to the exciting source of current. The middle or common point of connection of the primary and secondary winding of the transformer is then connected through the distributor 41. Although I have shown individual condensers 25, it will be apparent that the primary winding 22 may be connected in common through a single condenser to ground.

As to the operation of Fig. 3, it is thought that this will be readily understood in view of the description of the operation of Fig. 2.

I claim:

1. In an oscillation transformer and spark plug unit, an oscillation transformer coil, an insulating casing having a chamber with said transformer coil suspended therein, a bottom head for the casing, a spark plug having a central electrode and supporting insulating porcelain therefor extending into the chamber through said head and

said plug having a metallic sleeve second electrode for attaching the plug to the casing head in sealed relation thereto and also hold the central electrode and porcelain in the casing, means for connecting the coil to said central electrode, and an insulating compound in the chamber of said casing surrounding the coil and the central electrode in the casing to insulate the central electrode from the sleeve electrode.

2. In an oscillation transformer and spark plug unit, an oscillation transformer having a casing in which the transformer is suspended and filled with an insulating element, a spark plug having a threaded metallic sleeve and a central electrode and insulating cover thereof the latter extending into the casing from an end thereof and connected with the coil of the transformer, and a head for the casing through which said plug electrode extends into the compound filled chamber in the casing, said

head having a threaded boss on which said plug sleeve is threaded and by which said plug is supported, whereby the entire unit is supported by the plug.

3. In an oscillation transformer and spark plug unit, an oscillation transformer, an insulating casing therefor in which said transformer is suspended, a head for said casing, a spark plug having a threaded portion threaded on to the head to form a sealed connection to the casing and having an electrode extending into the casing and connected with said transformer to mechanically support the transformer coil independent of the casing, and an insulator in said casing filling in the space between the spark plug and transformer so as to prevent sparking between exposed elements thereof.

In witness whereof, I hereunto subscribe my name this 12th day of June A. D., 1922.

HARRY B. HOLTHOUSE.