Aug. 6, 1940. B. MILLER 2,210,324

IGNITION COIL TESTING APPARATUS

Filed April 7, 1939

Fig. 1.

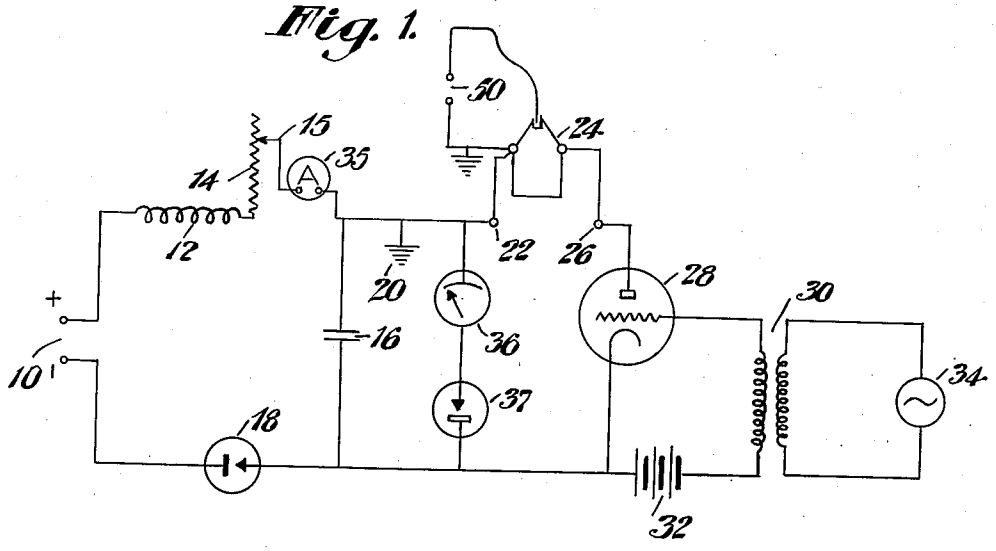
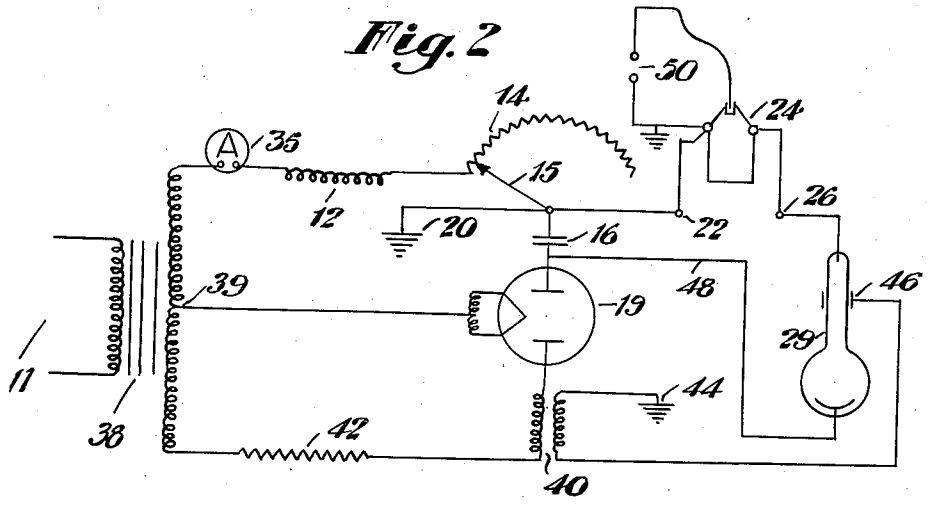


Fig. 2



INVENTOR
BENJAMIN MILLER
BY Edmund J. Borden
ATTORNEY

Patented Aug. 6, 1940 2,210,324

UNITED STATES PATENT OFFICE

2,210,324

IGNITION COIL TESTING APPARATUS

Benjamin Miller, Richmond Hill, N. Y., assignor to Power Patents Company, Hillside, N. J., a corporation of Maine

Application April 7, 1939, Serial No. 266,479

7 Claims. (Cl. 175—183)

The present invention relates to electrical testing apparatus and more particularly to apparatus adapted for testing ignition coils.

Ignition coils must be in first class condition in order to meet the demands which are put on them by the ignition systems of high speed internal combustion engines. Thus the circuit breaker of an eight-cylinder automobile engine operating at a speed to develop 80 miles per hour is actuated 266 times per second. At best only about two thirds of the elapsed time between successive circuit breaker openings (i. e. about .0025 second) is available in which to build up sufficient energy storage in the primary winding of the ignition coil to develop the necessary high potential in the secondary winding by the flux collapse which occurs in the coil when the charging circuit of the primary winding is opened by the circuit breaker. The secondary peak voltage which must be developed to insure satisfactory ignition sparks on the spark plug gaps normally ranges between 20,000 and 25,000 volts.

Objects of the present invention are to provide apparatus adapted for testing ignition coils to determine: (*a*) the energy input required to make the coil produce a suitable spark; (*b*) the quality factor of the coil or its ratio of inductance to resistance when operating to produce a suitable spark; (*c*) the quality of the insulation, as by raising the energy input to a factor of safety point at which a spark jumps a safety gap or the coil insulation breaks down.

With the above and other objects and features in view, the invention consists in the improved electrical testing apparatus which is hereinafter described, and more particularly defined by the accompanying claims.

In the following description of the invention, reference will be had to the attached drawing, in which:

Fig. 1 is a wiring diagram illustrating an ignition coil testing apparatus illustrative of the broader aspects of the present invention; and

Fig. 2 is also a wiring diagram of a preferred coil testing apparatus assembly.

Referring to the apparatus illustrated in Fig. 1, a source of electric energy 10 has been shown having one of its terminals connected through an inductance 12, and a variable resistance 14 having a slider 15, with one terminal of a condenser 16. The other terminal of energy source 10 is connected through a rectifier tube 18 with the other terminal of condenser 16. One terminal of condenser 16 is grounded at 20. This same terminal of the condenser 16 is connected through a terminal 22 with one terminal of the primary winding of an ignition coil 24 which is to be tested. The other terminal of the primary winding of coil 24 is connected through a terminal 26 with the anode of a trielectrode trigger tube 28. The cathode of trigger tube 28 is connected to the negative terminal of condenser 16. The grid of trigger tube 28 has been illustrated as connected through the secondary winding of a transformer 30 and a bias battery 32 with the cathode of the trigger tube. The primary winding of transformer 30 is connected in circuit with an alternating current generator 34. Resistance 14 may be calibrated, and an ammeter 35 may be included in the condenser charging circuit. An electrostatic voltmeter 36 may be connected through rectifier 37 across the condenser 16.

In the apparatus illustrated in Fig. 2, the energy source for charging condenser 16 has been illustrated as a transformer 38 having its primary winding connected to an ordinary A. C. source 11. One end of the secondary winding of transformer 38 is connected through inductance 12, variable resistance 14, and an ammeter 35, with a grounded terminal of condenser 16. The other terminal of condenser 16 is shown as connected to one anode of a two-anode rectifier tube 19. The other anode of tube 19 is connected through the primary winding of a transformer 40 and through a resistance 42 with the opposite end of the secondary winding of transformer 38. The secondary winding of transformer 38 has a center tap 39 which is connected to the cathode of tube 19. In Fig. 2, the cathode of tube 19 is shown as a hot filament, and the connection from transformer center tap 39 is made to a center tap on the heater winding. One end of the secondary winding of transformer 40 (which may be a small neon sign transformer) is grounded at 44. The other end of the secondary winding is connected to a trigger electrode 46 of a neon lamp trigger tube 29. The cathode of lamp 29 is connected by a lead 48 to that terminal of condenser 16 which is connected to one anode of rectifier 19. The anode of trigger tube 29 is connected through terminal 26 with one end of the primary winding of coil 24 under test. The other end of the primary winding of the coil is in turn connected through terminal 22 with the grounded adjustable arm 15 of the variable resistance 14.

In making the test of an ignition spark coil, the primary winding of the coil 24 is connected as illustrated between the terminals 22 and 26

in the discharge circuit of the condenser 16. The secondary winding of the coil 24 is connected to a suitable spark gap 50. Spark gap 50 may be a spark plug mounted in a pressure chamber such as is commonly used for spark plug testing, or it may be a calibrated spark gap which is set for the voltage which the coil 24 must produce in service.

The frequency of the alternating current supplied by generator 34 (Fig. 1) and source 11 (Fig. 2) should be within the range of ignition coil practice, which is normally between 10 and 300 cycles. Also the trigger tube which is embodied in the condenser discharge circuit (tubes 28 and 29) must have a low resistance, in order that the principal resistance of the condenser discharge circuit may be that of the primary winding of the ignition coil 24. The constants of condenser discharge circuit will then be such that it is an oscillatory circuit. Also the constants of the condenser charging circuit should preferably be such as to insure that flow of charging current has ceased therein before a discharge initiating stimulus is applied to the trigger tube. The various conducting elements which make up the condenser charging circuit should possess inductance and resistance of such magnitude with respect to the capacity of the condenser that the charging circuit is an oscillating circuit when including the highest resistance 14 at which the apparatus is operative to supply the necessary energy to produce sparks at gap 50. A condenser charging circuit of the type illustrated in Fig. 2 will be found to operate satisfactorily when embodying an energy source 11 developing a potential of 325 volts between the center tap and the outside of transformer 38, when including an inductance 12 of 30 henries, a total resistance of 5500 ohms of which 5000 ohms is embodied in variable resistance 14, and a condenser 16 of 0.25 microfarad capacity.

In testing a coil 24 to determine the energy which must be supplied to its primary winding in order to make the secondary of the coil produce the desired spark at gap 50, the adjustable arm 15 of resistance 14 is first moved to a point to include the maximum resistance between the adjustable arm and inductance 12. Assuming that the primary of transformer 38 in Fig. 2 is connected to a 60-cycle A. C. main 11, the apparatus operates as follows: During one half wave, current flows through the upper half of the secondary of transformer 38, ammeter 35, inductance 12, and resistance 14, to charge condenser 16. On the next half wave, current flows through the lower half of the secondary of transformer 38 and through resistance 42 and primary winding of transformer 40, inducing a voltage in the secondary of this transformer which when applied to trigger electrode 46 induces discharge of condenser 16 through the primary winding of coil 24 and through the neon lamp 29. This operation is repeated sixty times per second, or once for each cycle of the A. C. supplied to the primary of transformer 38. If no spark is developed across the spark gap 50, the slider 15 of resistance 14 is moved to reduce the resistance in the charging circuit of condenser 16 until steady and strong sparking occurs across the spark gap. The energy input to the condenser 16, and hence to the primary of coil 24, which is necessary to produce the desired sparking at gap 50, is measured by the position of the slider of resistance 14, or alternatively by the reading of ammeter 35. The greater the amount of resistance in the condenser charging circuit, or the lower the current reading of ammeter 35, the more efficient is the coil 24. Thus the position of the slider of resistance 14, or the reading of ammeter 35, may be used as a measure of the input energy which is required by an ignition coil of particular make and model which is known to be satisfactory, and any other coil of that make and model which when hooked up with the testing apparatus is found to require substantially less resistance or substantially more current, to give a duplicate spark at gap 50 may be rejected as not suitable for use in the service for which gap 50 has been calibrated.

In order to determine the quality factor of a coil 24, i. e. its ratio of inductance to resistance when operating to produce the desired sparks at gap 50, the resistance 14 is entirely removed from the charging circuit of condenser 16 by moving the slider arm 15 to the end of the resistor which is connected to inductance 12. When this is done, the current which flows in the condenser charging circuit increases to a value which is limited by the ratio of resistance to inductance in both the charging and discharging circuits of the condenser 16.

With the resistance 14 cut out of the condenser charging circuit the constants of the condenser charging circuit are fixed. Accordingly it is the condenser discharge circuit which contains the variables affecting the current flow. The higher the inductance in the condenser discharge circuit, the greater is the potential to which condenser 16 will charge and the greater is the current required for charging the condenser. The primary winding of the spark coil 24 constitutes practically the entire inductance in the discharge circuit of condenser 16. Therefore a high current in the condenser charging circuit or a high potential on the condenser indicates high inductance in the coil under test. High inductance is a bad feature in an ignition coil because it limits the number of sparks per second which can be obtained in an ignition system embodying the coil, thereby limiting the speed of any engine the ignition impulses of which are derived from the coil. Therefore, the higher the inductance of the coil, the less desirable it is for use in the ignition system.

To test the coil 24 for the quality of its insulation, the slide arm of the resistance 14 is moved to the right (see Figs. 1 and 2) to include all of the resistance in the condenser charging circuit, and the secondary winding of the coil 24 is disconnected from spark gap 50. If the coil is not equipped with a safety gap, the secondary is connected to a safety gap and the resistance arm is gradually moved to the left until the safety gap breaks down. If the safety gap does not break down, there is either a break down of the coil insulation at which sparking is taking place, or the coil cannot develop a voltage sufficient to break down the safety gap. If a coil is satisfactory on the tests first described for determining energy input and quality factor, and does not break down the safety gap, it may still be a good coil. This may be demonstrated by repeating the energy input test first described. If the result of repeating the energy input test is substantially the same as on the original energy test, the coil is in good condition. But if the coil cannot produce sparks on the repeated energy input test, or if it requires substantially more current in order to produce sparks than

on the original energy input test, it is defective as the result of an insulation breakdown.

It will be recognized that the principal difference between the apparatus of Fig. 1 and that of Fig. 2, is in the different means employed in the two layouts for impressing discharge initiating stimuli on the respective trigger tubes **28** and **29**. In the apparatus of Fig. 1, the source of energy **34** for the electric impulses which are impressed on the grid of tube **28** to initiate discharge thereof, is entirely separate from the source of energy **10** for the charging circuit of condenser **16**. However, in the case of the apparatus illustrated in Fig. 2, the same 60-cycle A. C. source of energy **11** which supplies current to the condenser charging circuit, also supplies energy for the impulses which are impressed on the triggering electrode **46** to initiate discharge of the trigger tube **29**.

The invention having been thus described, what is claimed as new is:

1. In ignition coil testing apparatus, a condenser, means for discharging the condenser including a low resistance trigger tube, means for connecting in the condenser discharge circuit the primary winding of a coil to be tested, means for initiating discharge of the condenser through the trigger tube and primary winding at selected intervals by impressing discharge initiating stimuli on said trigger tube at a preselected rate, and means for charging the condenser comprising a source of current, a rectifier and a conductor having inductance and resistance of such magnitude with respect to the capacity of the condenser that the charging circuit is an oscillating circuit.

2. Apparatus as defined in claim 1 together with a calibrated spark gap connected in series with the secondary winding of the coil.

3. Apparatus as defined in claim 1 together with means for varying the resistance in the condenser charging circuit.

4. Apparatus as defined in claim 1 together with means for measuring the average current flowing in the condenser charging circuit.

5. Apparatus as defined in claim 1 together with means for measuring the peak potential to which the condenser is charged.

6. In apparatus for testing an ignition coil having a primary and secondary winding, a condenser, means for discharging the condenser comprising a low resistance trigger tube, means for connecting the primary winding of the coil to be tested in the condenser discharge circuit, an A. C. source of energy, means including a rectifier and a conductor having inductance and resistance of such magnitude with respect to the capacity of the condenser that the condenser charging circuit is an oscillating circuit for charging the condenser on the one-half wave of the alternating current from the A. C. source, and means for discharging the condenser on the next half wave of the alternating current through the trigger tube and primary winding by impressing discharge initiating stimuli on said trigger tube at the frequency rate of the alternating current.

7. Apparatus as defined in claim 6 together with means for varying the resistance in the condenser charging circuit.

BENJAMIN MILLER.