

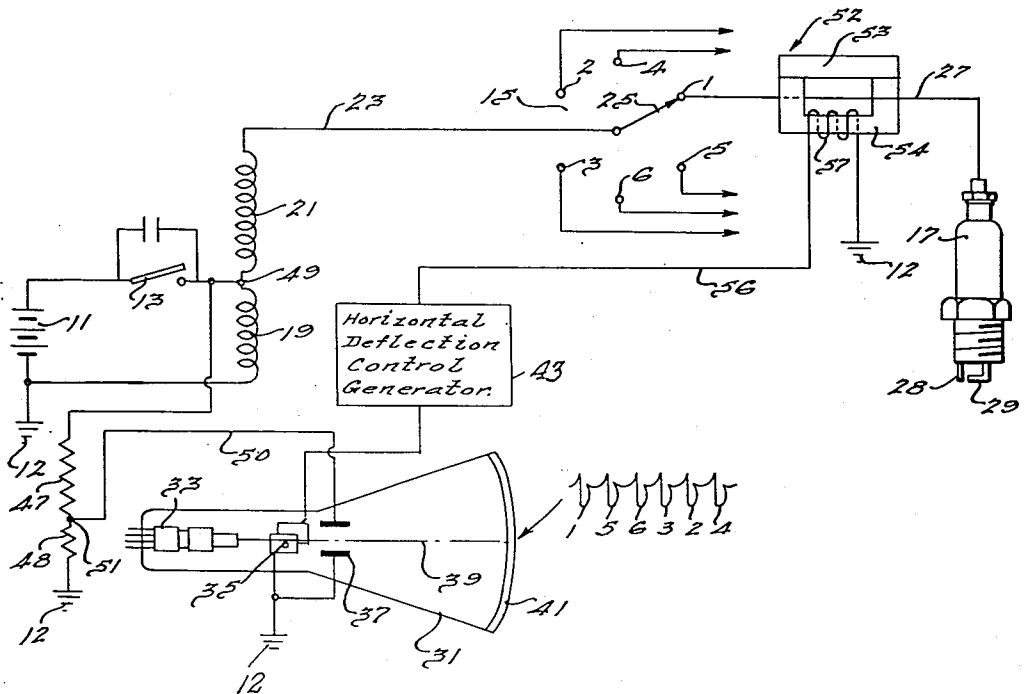
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J. D. McCULLOUGH

2,471,968

INDICATING DEVICE

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INVENTOR.

Jack D. McCullough
BY

BY

Harness and Harrie

ATTORNEYS.

UNITED STATES PATENT OFFICE

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INDICATING DEVICE

Jack D. McCullough, Detroit, Mich., assignor to
Chrysler Corporation, Highland Park, Mich., a
corporation of Delaware

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6 Claims. (Cl. 175—183)

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This invention is related to electrical apparatus, and particularly to devices used for measurement and observation of certain phenomena. In its specific embodiment, the invention is used jointly with a cathode ray oscillograph which, in turn, is used for indicating visually transients or other forms of response. Where desired, photographic records of the phenomena may be made by photographing the oscillograph pattern in known manner.

Particularly, the apparatus herein to be described is concerned with providing a visible means for determining and indicating the performance of spark plugs in gasoline engines of all types.

The present invention is concerned particularly with the development of a device which provides a relatively cheap and portable means which is well adapted to be used for servicing aircraft engines and, in fact, all forms of automotive gasoline engines. Accordingly, the apparatus is particularly useful at airports, garages and manufacturing plants for the purpose of indicating the exact performance of the sparking system, and making it a relatively simple matter not only to detect and determine imperfect performance, but actually to observe the exact functioning of the particular spark plugs so that any such plugs not functioning correctly may be removed and replaced. In this way it is possible promptly to note and observe the exact seat and cause of imperfect engine operation.

An object of the present invention is the application of an oscillograph to an ignition system for noting the performance of spark plugs in the ignition system. By my invention I am enabled to observe the performance of all the spark plugs. I may apply the oscillograph to the primary side of the ignition system.

A further object of the invention is to provide improvements in control effected by the vertical and horizontal deflecting means serving to operate upon the cathode ray beam in a cathode ray oscilloscope. More particularly, the control is applied to an oscilloscope indicating simultaneously the performance of various spark plugs in an ignition system and is effective to provide synchronism between the deflection of the cathode ray and discharge of the spark plug and to enable an observer readily to determine which of the spark plugs in the ignition system produces each and every pattern to be seen in the oscilloscope. This will involve not a connection from the ignition system to one of the deflecting means but the setting up of impulses in the deflecting

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means through inductive action of the ignition system.

Other objects will appear from the disclosure.

In the drawing there has been schematically illustrated a conventional ignition system, which may comprise the energy source, such as the battery 11 having one terminal thereof grounded at 12, and the conventionally represented breaker points, shown for illustrative purposes as the switch 13 and their conventional capacitors, the transformer comprising the primary winding 19 and the secondary winding 21, of which one terminal of the primary is also grounded at 12, and of which the outer terminal of the secondary 21 connects by way of the conductor 23 to the rotating armature 25 of a distributor 15. Various contacts, shown by the numerals 1 through 6, inclusive, of the distributor 15 are intended to connect to different cylinders of the complete motor, with the numerals adjacent each terminal point being indicated in a conventional manner relative to the rotation of the distributor arm 25. The illustration is intended to show one suitable form of firing order, which it may be assumed follows the designations 1, 5, 6, 3, 2, and 4, although it is to be understood that this is merely given for the purpose of illustration, as is likewise the illustration of the assumed six cylinders, for it is obvious that in automotive engines, the number may vary within wide limits, and particularly for aircraft engines the numbers of cylinders and resultant distributor points are very substantially increased.

There has been shown only a single spark plug element 17 to which energy is supplied by way of the conductor 27 connecting to the upper terminal thereof in known manner. It will be appreciated, however, that other spark plugs (not shown) connect to each of the other points 5, 6, 3, 2, and 4 in substantially like manner. The energy supplied by way of the breaker points, the transformer and the distributor to the spark plugs is discharged across the gap provided between the points 28 and 29, which are also shown in purely conventional manner.

In order that the spark discharge may be measured and observed, control is exerted over the deflection of the cathode ray beam 39 within a cathode ray oscilloscope 31 in a manner later to be explained. The oscilloscope tube 31 comprises the usual electron gun 33, represented in purely schematic form, which is adapted when suitably energized by appropriate operating voltages from sources not shown, to produce an electron beam 39 which is directed longitudinally of

the tube to strike against a luminescent end wall target or screen, conventionally represented at 41, where it produces a luminous trace due to impact.

In the path of the beam 39 as it moves from the electron gun 33 to the target or screen 41, suitable deflecting means are provided. These deflecting means may be either electrostatic or electromagnetic, or a combination of these two forms, but for illustrative purposes, the drawing shows the horizontal deflection as provided by electrostatic means consisting of two deflecting plate electrode members 35, and the vertical deflection likewise is assumed to be controlled by the electrostatic deflecting plate pair 37. For the purpose of providing horizontal deflection of the electron beam 39 within the tube 31, a horizontal deflection control generator 43 has been provided. This generator preferably consists merely of the usual form of relaxation oscillation generator in which a charge is built up across a condenser element charged through an appropriate form of constant current charging instrumentality, which is dischargeable at times when an associated discharge tube is suitably energized or triggered under the control of a phenomenon associated with the ignition circuit.

The discharge tube may be of either of the high vacuum or the gaseous type, which is well known in the art. When the deflecting plate electrode pair 35 is connected so that one electrode element is connected to be energized in accordance with the charge upon the storage condenser of the horizontal deflection control generator 43, and the other plate is connected to ground at 12, for instance, the potential across the condenser of the relaxation oscillator combination will be a measure of the deflection. If now a deflection of the beam 39 in the tube 31 can be initiated by suitably energizing or triggering the element 43 under the influence of the transient to be observed, it is apparent that synchronism may be established between deflection of the cathode ray and discharge of the spark plugs.

A high impedance voltage divider comprising resistance elements 47 and 48 is connected between the ground 12 and a junction point 49 between the primary winding 19 and the secondary winding 21. A conductor 50 leads from a junction point 51 between resistance elements 47 and 48 to one side of the vertical deflecting means 37. The other side of the vertical deflecting means is connected to the ground 12. In this way control of the vertical deflecting means is effected from the primary winding 19 of the transformer. The voltage across the primary winding 19 appears each time a spark occurs in any of the plugs of the ignition system, and thus a vertical deflection of the cathode ray beam will be produced on the luminescent target or screen 41.

In order that the complete system may be properly synchronized and locked in step with the operation of the system, the horizontal deflection control generator is now synchronized through induction produced by current flowing in the line 27 leading to any of the spark plugs 17. An electromagnetic pick-up or current transformer 52 has a removable cross arm 53, and a permanent end cross arm 54. The conductor 27 extends through the space between the arms 53 and 54. A conductor 56 is coiled around the arm 54 as indicated at 57 and leads from ground to the horizontal deflection control generator. A conductor leads from the generator to one side of the horizontal deflecting means 35, the other side being connected to the ground 12. The use of

the magnetic pick-up 52 not only effects synchronization of the system but also enables an observer to determine which pattern in the screen 41 is associated with a particular plug. The pattern of the plug having the conductor 27 with which the magnetic pick-up is associated is at one end of the screen, conventionally, the left end, and the other patterns will follow in order to designate the plugs following in the firing order after the particular plug. For instance, the magnetic pick-up is associated with the conductor for plug No. 1, and the order of plugs following thereafter is 5-6-3-2-4. Thus, as indicated, the pattern at the left end of the screen is for plug No. 1, and the other patterns are in order from left to right for plugs Nos. 5-6-3-2-4.

I claim:

1. In combination, a multi-cylinder internal combustion engine including an ignition system comprising a primary and secondary transformer winding, a contact making and breaking element, a distributor, spark plugs of a number corresponding to the number of cylinders in the engine, and conductors leading from the distributor to the spark plugs, a cathode ray oscilloscope including means for developing a cathode ray scanning beam and a pair of deflecting means for deflecting said scanning beam in each of two mutually perpendicular directions relative to an observation target, a connection from one winding of said transformer to one of said deflecting means for deflecting said cathode ray beam in one of its directions of deflection, and means for generating repetitive deflections of the developed cathode ray beam in the other of said directions at a frequency equal to the frequency of operation of the contact making and breaking element divided by the number of engine cylinders, said last mentioned means including a current transformer associated with a conductor leading to one spark plug and means operatively connecting the current transformer and the said other of said deflecting means.

2. In combination, a multi-cylinder internal combustion engine including an ignition system comprising a primary and secondary transformer winding, a contact making and breaking element, spark plugs of a number corresponding to the number of cylinders in the engine, and conductors leading from the distributors to the spark plugs, a cathode ray oscilloscope including means for developing a cathode ray scanning beam and a pair of deflecting means for deflecting said scanning beam in each of two mutually perpendicular directions relative to an observation target, a connection from one winding of said transformer to one of said deflecting means for deflecting said cathode ray beam in one of its directions of deflection, and means for generating repetitive deflections of the developed cathode ray beam in the other of said directions at a frequency equal to the frequency of operation of the contact making and breaking element divided by the number of engine cylinders, said last mentioned means including an electromagnetic pick-up associated with a conductor leading to a spark plug for causing electrical impulses in the conductor to induce impulses in the said other deflecting means.

3. In an assembly comprising an ignition system for an internal combustion engine comprising primary and secondary transformer windings, a contact making and breaking element, a distributor, spark plugs, and conductors leading from the distributor to the spark plugs, a cathode ray oscilloscope including means for developing a

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cathode ray scanning beam and means for deflecting said scanning beam in each of two mutually perpendicular directions relative to an observation target, the combination with the oscilloscope, of means for effecting control of the deflection of the cathode ray beam in one of the mutually perpendicular directions from the primary side of the ignition system, means for controlling deflection of the cathode ray beam in the other of the mutually perpendicular directions, and circuit forming means including terminal portions and an inductive device connectingly therebetween for triggering the last mentioned means by induction from the conductor leading from the distributor to a spark plug, said terminal portions and inductive device being adapted for operation in physically and/or insulatedly spaced relation to all parts of the aforesaid conductor.

4. An analyser adapted for use with an ignition system including a distributor, a plurality of engine spark plugs, and conductors leading from the distributor to the spark plugs, said analyser comprising a cathode ray oscilloscope including means for developing a cathode ray scanning beam and a pair of deflecting means for deflecting said scanning beam in each of two mutually perpendicular directions relative to an observation target, means for associating one deflecting means with the ignition system on the side of the distributor away from the spark plugs to effect the deflection of the scanning beam in one of the two mutually perpendicular directions and to make all spark plugs participate equally therein, and a current transformer associated with the other deflecting means and coupled with the conductor connecting the distributor and a certain spark plug so as to respond by induction to current impulses in the conductor and thereby to initiate the deflection of the scanning beam in the other of the two mutually perpendicular directions for cooperating with the first mentioned associating means in simultaneously presenting indications of performance by all spark plugs and for enabling the identification of the various indications of performance with the various spark plugs.

5. An analyser adapted for use with an ignition system comprising primary and secondary transformer windings, a distributor, a plurality of engine spark plugs, and conductors leading from the distributor to the engine spark plugs, said analyser comprising a cathode ray oscilloscope including means for developing a cathode ray scanning beam and a pair of deflecting means for deflecting said scanning beam in each of two mutually perpendicular directions relative to an observation target, means for associating the deflecting means with one transformer winding to effect the deflection of the scanning beam in one

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of the two mutually perpendicular directions and to make all spark plugs participate equally therein, and a current transformer associated with the other deflecting means and coupled with the conductor connecting the distributor and a certain spark plug so as to respond by induction to current impulses in the conductor and thereby to initiate the deflection of the scanning beam in the other of the two mutually perpendicular directions for cooperating with the first mentioned associating means in simultaneously presenting indications of performance by all spark plugs and for enabling the identification of the various indications of performance with the various spark plugs.

6. An analyser adapted for use with an ignition system comprising primary and secondary transformer windings, a distributor, and conductors leading from the distributor to a primary of engine spark plugs, said analyser comprising a cathode ray oscilloscope including means for developing a cathode ray scanning beam and a pair of deflecting means for deflecting said scanning beam in each of two mutually perpendicular directions relative to an observation target, means for associating the deflecting means with the primary transformer winding to effect the deflection of the scanning beam in one of the two mutually perpendicular directions and to make all spark plugs participate equally therein, and a current transformer associated with the other deflecting means and coupled with the conductor connecting the distributor and a certain spark plug so as to respond by induction to current impulses in the conductor and thereby to initiate the deflection of the scanning beam in the other of the two mutually perpendicular directions for cooperating with the first mentioned associating means in simultaneously presenting indications of performance by all spark plugs and for enabling the identification of the various indications of performance with the various spark plugs.

JACK D. McCULLOUGH.

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Certificate of Correction

Patent No. 2,471,968.

May 31, 1949.

JACK D. McCULLOUGH

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows:

Column 6, line 19, claim 6, for the word "primary" read *plurality*;
and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 8th day of November, A. D. 1949.

[SEAL]

THOMAS F. MURPHY,

Assistant Commissioner of Patents.