June 17, 1924. 1,497,750

M. S. HOPKINS

SPARK PLUG TESTING APPARATUS

Filed Sept. 10, 1921 2 Sheets-Sheet 1

Fig. 1.

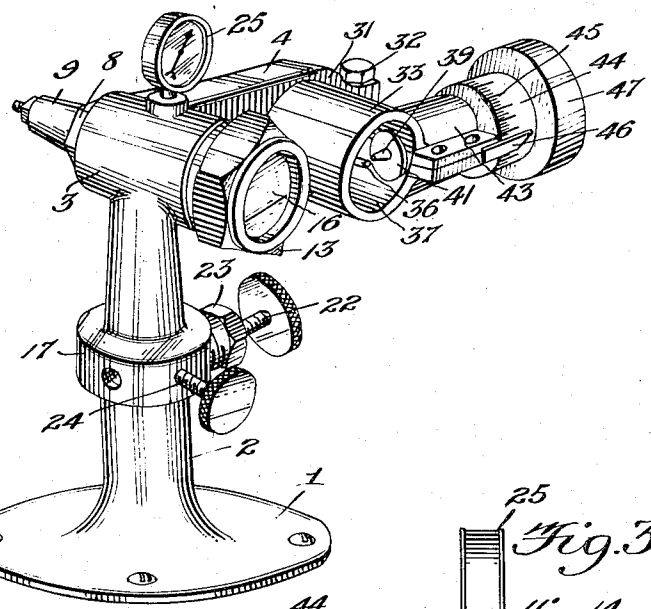


Fig. 2.

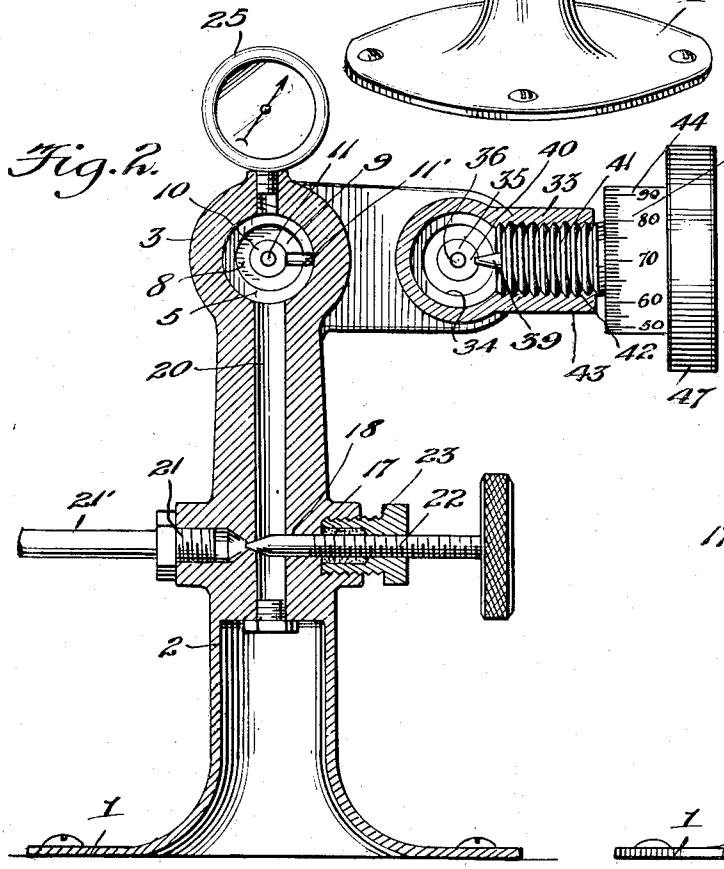
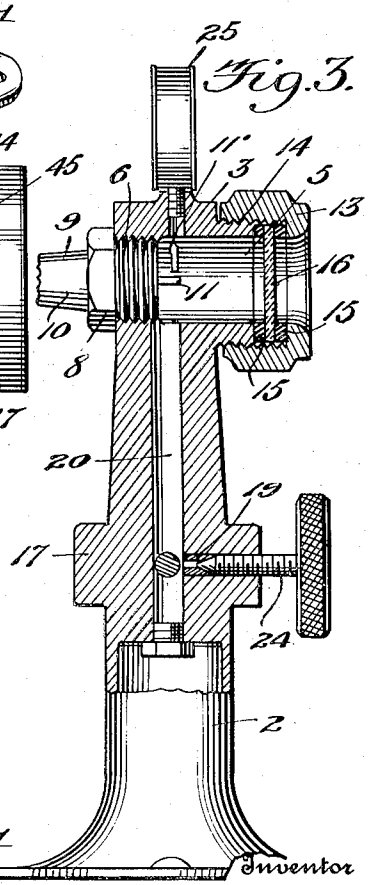


Fig. 3.



Inventor

M.S. Hopkins

By C. C. Shepherd

Attorney

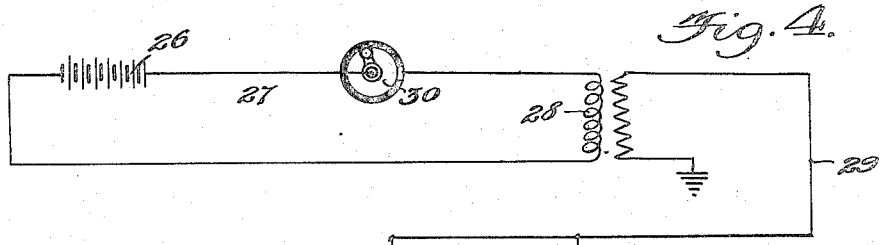
June 17, 1924. 1,497,750

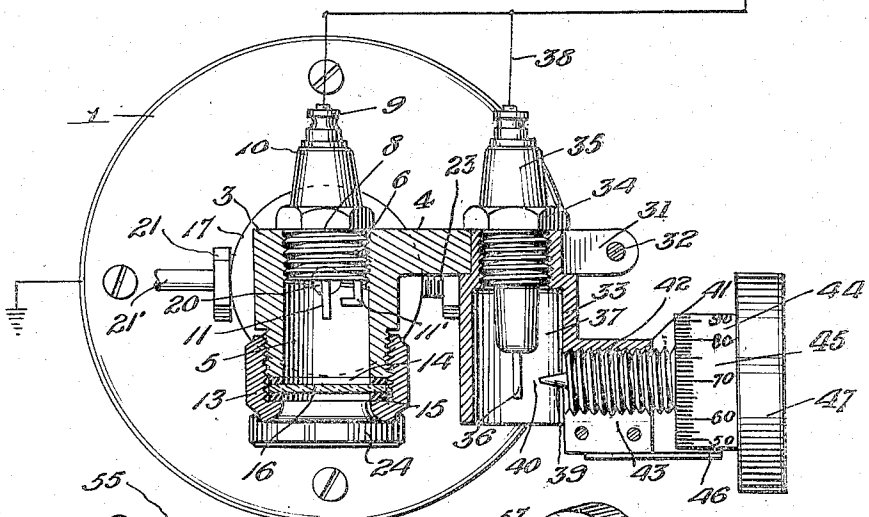
M. S. HOPKINS

SPARK PLUG TESTING APPARATUS

Filed Sept. 10, 1921 2 Sheets-Sheet 2

Fig. 4.





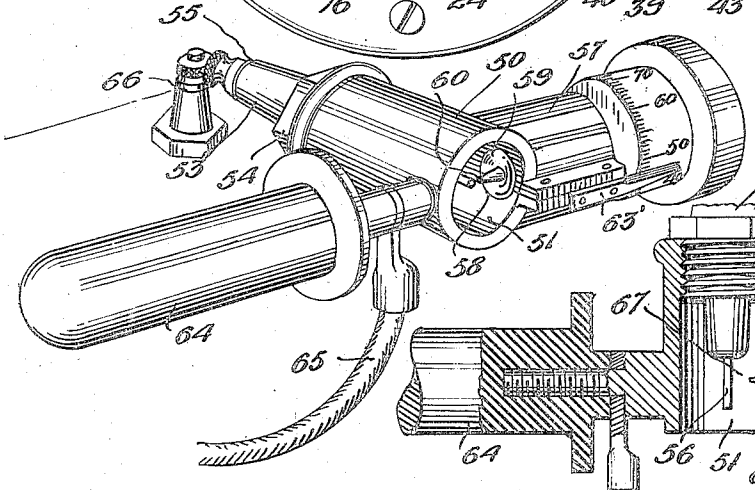


Fig. 5.

Fig. 6.

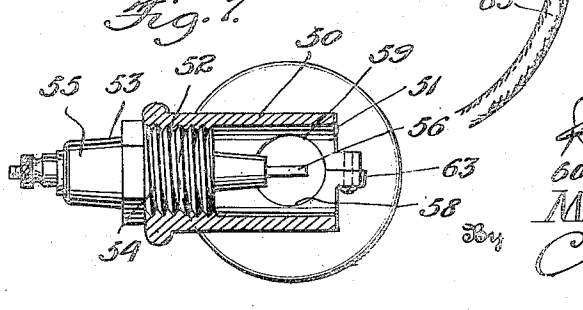


Fig. 7.

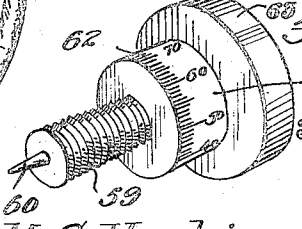


Fig. 8.

Inventor

M. S. Hopkins

By C. C. Shepherd

Attorney

Patented June 17, 1924. 1,497,750

UNITED STATES PATENT OFFICE.

MICHAEL S. HOPKINS, OF COLUMBUS, OHIO.

SPARK-PLUG-TESTING APPARATUS.

Application filed September 10, 1921. Serial No. 499,785.

To all whom it may concern:

Be it known that MICHAEL S. HOPKINS, a citizen of the United States, residing at Columbus, in the county of Franklin and State of Ohio, has invented certain new and useful Improvements in Spark-Plug-Testing Apparatus, of which the following is a specification.

This invention relates to apparatus designed for ascertaining by measurement the capacity of certain electric apparatus, to-wit, the high tension discharge for induction coils, magnetos and other similar apparatus. An object of the invention resides in the provision of means whereby an ignition system of an internal combustion engine can be readily tested to ascertain operating conditions thereof, with the further view of determining whether or not under working conditions the spark produced by each of the sparking devices of the system is sufficient to propagate the flame for insuring proper combustion of the fuel within the cylinders of an engine; to determine the resistance that the spark gap or gaps of such devices under actual working conditions, and to provide means whereby such spark gaps may be properly and uniformly adjusted to secure the most efficient results obtainable in proportion to the current capacity of the system.

In accordance with the invention, apparatus is utilized by means of which an ordinary spark plug employed in an ignition system of the type specified is capable of being connected by a parallel circuit with a set of electrodes of a sparking device situated in communication with the atmosphere, the said sparking device including relatively adjustable electrodes, which upon mutual manipulation, are capable of varying the resistance in the parallel circuit at will, with the view of controlling such resistance so that the same may be made to approximate the resistance offered to the passage of an electric current through the spark plug in the system proper, whereby when the resistance in the said spark plug and sparking device are substantially equalized, the distance between the relatively movable electrodes in the said device may be ascertained by micrometer readings, in order that adjustments may be made, if necessary, in the electrodes of the engine spark plug to enable the latter to operate to the best advantage and to render the same similar and uniform in resistance with the other plugs employed in conjunction with the system.

Another object of the invention resides in the provision of a testing apparatus of this character wherein a metallic body is provided having a pair of chambers formed therein, one of said chambers being in open communication with the atmosphere and the other thereof being closed and yet visible by a transparent lens or panel, the closed chamber of the apparatus being adapted to receive an ordinary engine spark plug and resistance conditions similar to those obtaining in the cylinder of an engine are produced in the closed chamber by providing means admitting of the entrance of air or gas under pressure therein, the open chamber being provided with a spark point construction wherein relatively movable electrodes are provided which are electrically connected in parallel with the ignition circuit employed for the plug in the closed chamber, the arrangement being such that in testing a spark plug the movable electrodes are positioned so that the resistance therebetween will be greater than that obtaining between the electrodes of the spark plug in the closed chamber, thus permitting the latter to be energized and the sparks produced therefrom observed through the transparent lens, and whereby upon the adjustment of the movable electrodes to diminish the resistance therebetween the current may be transferred from one of said spark points to another in order that by noting the distance between the movable electrodes the resistance offered to the passage of an electrical current in jumping the electrodes situated in the closed chamber may be determined, this apparatus being particularly designed for laboratory experimentation.

A further object of the invention resides in the provision of an apparatus designed for use in testing spark plugs while situated within the cylinders of an internal combustion engine and under actual operative conditions, and wherein the same structure and principles of operation as aforesaid are present with the exception that the closed chamber is eliminated, the cylinders of the engine proper serving in lieu thereof.

For a further understanding of the invention reference is to be had to the following description and to the accompanying drawings, in which:

Figure 1 is a perspective view of the form of my improved testing apparatus designed for securing data and other definite determinations,

Figure 2 is a vertical sectional view taken through the apparatus,

Figure 3 is a similar view taken on a plane at right angles to Figure 2.

Figure 4 is a horizontal sectional view through the body,

Figure 5 is a perspective view of the form of my invention utilized for testing spark plugs situated within an engine,

Figure 6 is a vertical sectional view taken on the line 6—6 of Figure 5,

Figure 7 is a similar view taken at right angles to Figure 6, and

Figure 8 is a detail perspective view of the movable electrode and micrometer structure.

Referring more particularly to the form of my apparatus disclosed in Figures 1 to 4 inclusive there is provided a structure wherein is included a flat circular base 1, which terminates in a vertical upstanding stem 2 which has its upper end formed to include a metallic body 3, horizontally offset as at 4. The body 3 includes a horizontally extending closed chamber 5, which is threaded as indicated by the numeral 6 at one end thereof for the reception of the metallic shell 8 of a spark plug 9, adapted to be tested by means of the apparatus. The spark plug 9 may be of any standard design, and includes the usual insulation core 10, though which a main electrode 11 extends and terminates in spaced relationship from a ground electrode 11′ carried by the shell 8.

The opposite end of the chamber 5 is closed by means of a nut 13, which is threaded upon the body 3 as at 14, and gaskets 15 are situated between the abutting end portions of the body 3 and the nut 13, in order that the joints therebetween may be sealed. A lens or other transparent panel 16 is clamped between the gaskets 15 and the nut 13, the said lens serving to enable the chamber 5 and more particularly the electrodes 11 and 12 to be exteriorly viewed, and yet to retain the said chamber in a closed condition.

Mid-way of the height of the stem 2 there is provided an annular enlargement 17 which is provided with communicating bores 18 and 19 disposed for communication with a vertically extending passageway 20, leading upwardly through the stem into the chamber 5. One end of the bore 18 is connected as indicated by the numeral 21 with an air line 21′, capable of delivering air or any other suitable gas under compression into the chamber 5, and the inflow of this fluid is adapted to be governed by means of a needle valve 22, which is threaded in connection with a packing gland 23 formed in the opposite end of the bore 18 with respect to the air line connection 21. By manipulating the valve 22 it will be apparent that the internal pressures within the chamber 5 may be governed. The bore 19, which is located angularly with respect to the bore 18, is provided with a valve 24, which upon being opened will permit of the escape of air from the chamber 5, and to thus effect the release of the internal pressures within said chamber. A gage 25 is situated upon the body 3 and communicates with the chamber 5 in order that the gas pressures therein may be readily determined by the reading of the gage. By this construction it will be apparent that the spark plug 9 positioned within the apparatus may be subjected to conditions which will approximate those that obtain in the cylinders of an internal combustion engine, the purpose of the closed chamber and the means for controlling the admission of compressed air or any other gas suitable to produce a varying resistance between the electrodes of the plug under test, thus making it possible to produce the same resistance or other conditions similar to those which obtain when a spark plug is used to explode combustible gases within an engine cylinder. By means of the lens it is possible to observe the spark produced by the plug 9 under such conditions, thus permitting of the observation of the spark at the electrodes of the plug and the measuring of the energy dissipated at the electrodes of the plug, thus permitting of adjustment and the gathering of data to produce an efficient unit.

It will be understood that the plug 9 is adapted to be positioned within an ignition system of any suitable type and to this end a magneto or battery 26 may be utilized connected by the lead 27 with transformer coils 28 and then by means of a lead 29 with the exterior end of the electrode 11, current passing through said electrode and across the spark gap therein to the electrode 11′, where the current may be ground and returned to the source of energy 26, an interrupter 30 being disposed as usual in the circuit to make and break the latter in the ordinary manner.

In combination with this structure the body 3 of the apparatus has its horizontally offset portion 4 provided with a pair of clamping jaws 31, united by means of a screw 32, and capable thereby of rigidly supporting a metallic shell 33, preferably formed from iron. Arranged to be positioned within one end of the shell 33 is a spark plug structure which consists of the usual threaded casing 34, an insulating core 35 and a main longitudinally extending electrode 36, confined within the core 35 and

spaced from the casing 34, the inner end of the electrode terminating within an open chamber 37 formed within the shell proper, while the outer end of the electrode is adapted to be connected by means of a lead 38 with the lead 29, in order that the electrode supported within the shell 33 will be wired in multiple to the spark plug 9. Preferably, the electrode 36 is stationarily supported, and its inner end is designed for cooperation with a relatively movable electrode 39. This electrode is usually provided with a needle point, and is capable of being moved toward and away from the contiguous end of the electrode 36 for the purpose of varying the length of the spark gap 40 provided between said relatively movable electrodes.

The mounting for the electrode 39 in this instance consists of a screw 41 of predetermined threaded pitch, which is adapted to be received within a longitudinally extending threaded bore 42 provided in the offset end 43 of the shell 33, and the rotation of the screw 41 for one complete turn is adapted to effect a measurable relative movement between the electrodes 36 and 39. To this end, the screw 41 is provided with an enlarged collar 44, upon which micrometer graduations 45 are provided, and a stationary index finger 46 is carried by the offset end 43 and is arranged for cooperation with the graduations 45, whereby the extent of rotation of the screw 41 may be ascertained and regulated. Preferably, this construction will result in providing a direct reading micrometer attachment for the movable electrode 39, which tends to permit of a simplified reading of the micrometer and to readily ascertain the exact length of the gap 40. Ordinarily, the graduations 45 indicate one thousandths of an inch in multiples thereof. A disk 47 of insulation is mounted in connection with the collar 44 to permit of unhampered rotation of the screw 41 upon actual conditions of operation.

By virtue of this apparatus it will be seen that the testing of a spark plug for ascertaining its electrical efficiency may be readily carried out. A spark plug, such as indicated by the numeral 9 is threaded carefully into the closed chamber 5 and suitably connected with an ignition circuit, such as indicated by the numerals 26 to 30 inclusive. Air under pressure is then admitted into the chamber 5 by way of the needle valve 22 and the air line 21, permitting resistance conditions to be set up within the chamber 5 approximating those which actually exist in an engine cylinder, the pressures being governable by operating the valves 22 and 24 in accordance with readings obtainable from the gage 25. While this has been done the relatively movable electrode 39 is operated so that the spark gap 40 will offer greater resistance to the passage of an electric current than the spark gap between the electrodes 11 and 12. Then, when the circuit is energized sparks will be produced at the electrodes 11 and 12 in the ordinary manner, and the character, quality, size and other properties of the sparks emitted by the plug 9 may be visually ascertained by gazing into the chamber 5 through the lens 16. It is by use of this construction that an operator may determine the proper spacing of the electrodes 11 and 12 for the purpose of producing a spark possessing maximum heat value, or if the spark plug is found to be perfect and yet a weak spark is present, the disorder can be traced to the circuit in which the plug is situated, and the efficiency in current carrying capacity of the apparatus located within said circuit may then be noted. Finally, to determine the resistance which is offered to the current in jumping the gap between the electrodes 11 and 12, the direct reading micrometer may be operated so as to effect relative approach between the electrodes 36 and 39, minimizing the spark gap 40 between such electrodes until the resistance therein is slightly lower than that which exists between the electrodes 11 and 12. This condition may be readily ascertained by noting through which plug the current is traveling, a fact which is made manifest by the spark produced at the spark gaps. When it is found that the current tends to pass through the electrodes 36 and 39 instead of the electrodes 11 and 12 the operator by observing the positions of the micrometer graduations 45 with respect to the index finger 46 may ascertain the exact distance between the electrodes 36 and 39, a feature which enables the actual resistance in the spark plug 9 to be readily determined, and by means of this data the efficiency of the system generally may be readily ascertained. This apparatus is particularly useful for laboratory or other testing purposes wherein a spark plug is removed from the cylinders of an internal combustion engine.

However, in Figures 5 to 8, inclusive, I have shown a form of my invention wherein the resistance in a spark plug may be determined when the engine, with which a spark plug is connected, is in active operation. This apparatus in principle is substantially the same as the apparatus heretofore described, with the exception, however, that the closed testing chamber is omitted, the said chamber being rendered unnecessary in that the apparatus is designed to test a plug while the latter is fitted within an engine.

To this end, the modified form of the invention shown in Figures 5 to 8 consists of a metallic body member 50, preferably formed from iron and embodying a chamber

51 open at one end to the atmosphere. The chamber 51 is provided with a threaded end 52 in which is removably positioned a spark plug structure 53, consisting of a metallic shell 54, an insulation core 55 and a main stationary electrode 56, which is terminated within the confines of the chamber 51 in order that the same will be independent of extraneous magentic influence.

The member 50 is provided with an offset extension 57, wherein is provided a threaded longitudinally extending threaded bore 58, capable of receiving the micrometer screw 59 having a pointed ground electrode 60 fixed upon the inner end thereof and adapted to be positioned for cooperation with the inner end of the electrode 56. The screw 59 is provided at its outer end with a collar 61 suitably graduated as at 62 to denote a one thousandths part of an inch and multiples thereof and a disk 63 of insulation is carried by said collar and of greater diameter than the latter to permit of the rotion of the screw 59, the extent of rotation of such screw being determinable by observing the positions of the graduations 62 with respect to a fixed stationary index finger 63′, carried by the offset extension 57 of the member 50. A spool shaped handle 64 of insulation is provided in longitudinal alignment with the screw 59, said handle permitting the apparatus to be handled safely and easily. The ground connection 65 is connected with the body member 50 and may lead to any suitable metallic ground.

In use, the electrodes 56 and 60 are separated and the outer end of the electrode 56 is placed, as shown, upon the wiring terminal of a spark plug 66 to be tested. Then, by shortening the spark gap between the electrodes 56 and 60 current supplied to the plug 66 may be led through the electrode 56 and ground upon the electrode 60. Relative adjustment between the electrodes 56 and 60 is continued until the current will just pass through the electrode 56 instead of passing through the plug 66, or in other words until a balance has been obtained and this balance may be very accurately reached by means of the micrometer adjustment. Then, by noting the length of the spark gap 67 between the electrodes 56 and 60 the internal resistance offered to the passage of current to the plug 66 may be ascertained. If the resistance is found to be exeessive in proportion to the capacity of the electric apparatus employed to energize the plug, adjustment in the electrodes of the plug 66 should be made to secure the best results, and conversely if the resistance in the plug 66 is insufficient to insure a proper dissipation of energy in the form of heat the electrodes should be otherwise adjusted to secure the proper resistance. Both forms of my apparatus may be usefully employed in testing spark plugs and ignition systems generally and by proper use thereof spark plug electrodes may be properly adjusted to produce efficient surface to an extent commensurate with their structural peculiarities.

What is claimed is:

1. In apparatus for testing spark plugs, a body member including an open chamber and a closed chamber, said chambers being adapted to receive sparking devices arranged in parallelism in a common circuit, and means serving to admit of relative adjustment between the electrodes of the sparking device situated in the open chamber whereby the passage of current through one or the other of said sparking devices may be regulated.

2. In apparatus for testing spark plugs, a body member including a pair of chambers, one of said chambers being open to the atmosphere the other of said chambers being substantially closed, sparking devices arranged to be received within said chambers and arranged in a common circuit, and relatively movable electrodes provided in the sparking device situated in the open chamber and operating upon adjustment to control the passage of current through one of said devices or the other.

3. In apparatus for testing spark plugs, a body member formed to include a pair of chambers, one of said chambers being open to the atmosphere and the other of said chambers being substantially closed, a removable spark plug adapted to be fitted into the closed chamber, a permanent sparking device situated in the open chamber, and said device including relatively adjustable electrodes capable of regulating the resistance of the circuit in which said spark plug and device are situated and to thereby govern the passage of current selectively through said plug and spark producing device.

4. In apparatus for testing the efficiency of spark plugs, including a body member having a pair of chambers formed therein, one of said chambers being open to the atmosphere the other of said chambers being substantially closed, the said closed chamber being adapted to receive a removable spark plug, a sparking device situated in the said open chamber and including a fixed main electrode and a relatively movable ground electrode and a micrometer structure connected with said ground electrode and operating to permit of adjustment of the latter to govern the length of the spark gap formed between the electrodes of said device.

5. In apparatus for testing spark plugs, a body member formed to include a pair of chambers, one of said chambers being open

to the atmosphere and the other substantially closed, the said closed chamber being provided for the reception of a removable spark plug, a relatively permanent sparking device situated in the open chamber, said sparking device including a main electrode and a relatively movable ground electrode, a micrometer structure operated to control the relative positions of said main and ground electrodes, and means for admitting a fluid under pressure into the closed chamber.

In testimony whereof I affix my signature.

MICHAEL S. HOPKINS.