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Goldstein

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[54] **ENGINE IGNITION TEST DEVICE**

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[52] **U.S. Cl.** **324/17,** 324/122
[51] **Int. Cl.** **G01r 13/42**
[58] **Field of Search** 324/15–19, 324/122

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[57] **ABSTRACT**

Engine ignition test device includes serially-connected adjustable spark gap and lamp for connection in parallel to a portion of an engine ignition circuit. The adjustable spark gap comprises a fixed electrode and a pivoted movable electrode that swings away from the fixed electrode for gap adjustment. The movable electrode can be repositioned to compensate for wear. Test probes include a test connector for serial connection in high voltage ignition lines and a test sensor for detecting the external electric field on the high voltage ignition leads.

8 Claims, 8 Drawing Figures

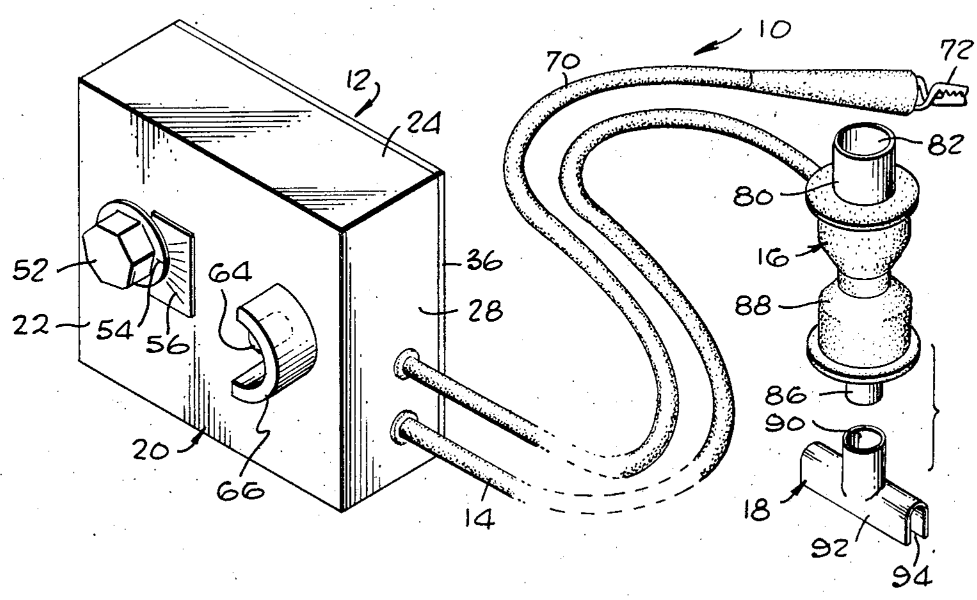


Fig. 1

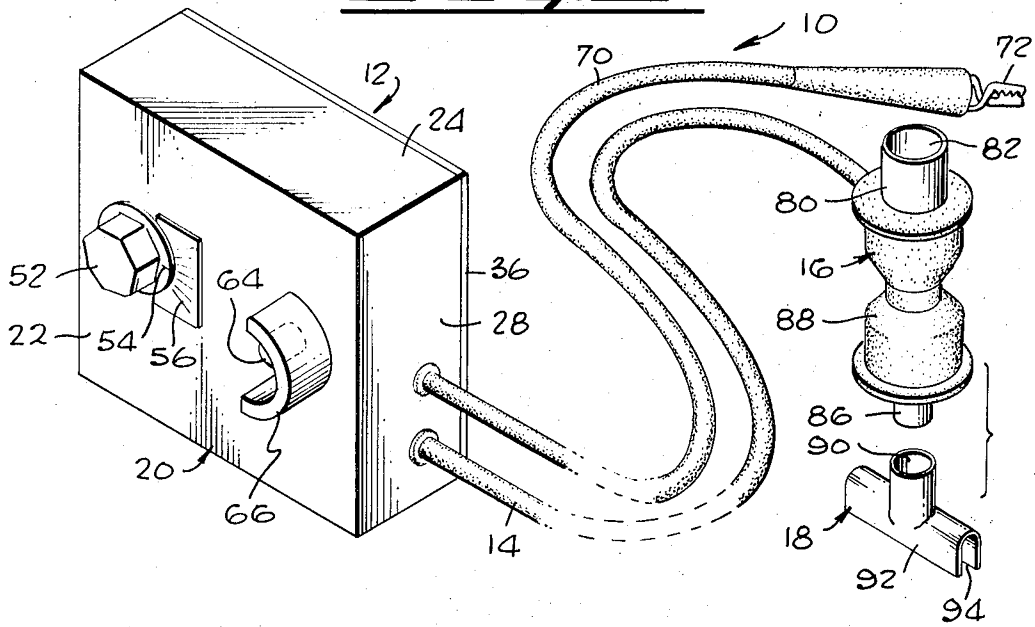
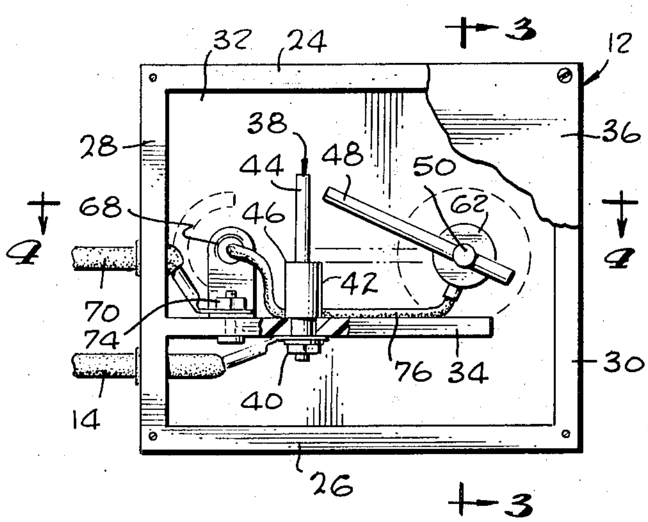


Fig. 2



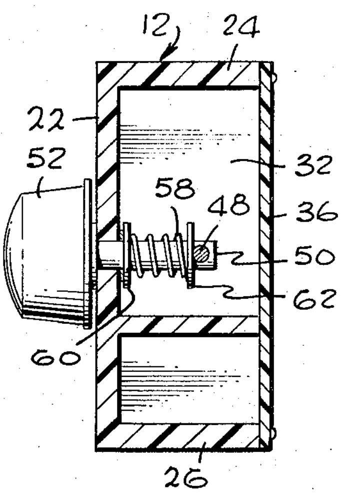


Fig. 3

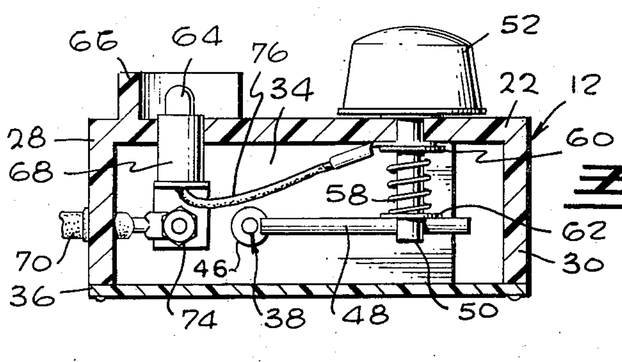


Fig. 4

Fig. 5

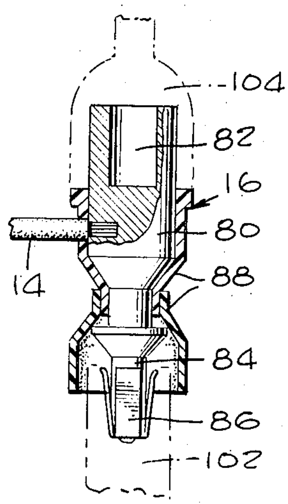


Fig. 6

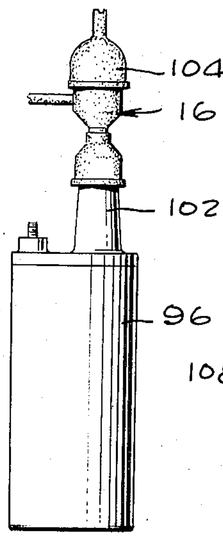
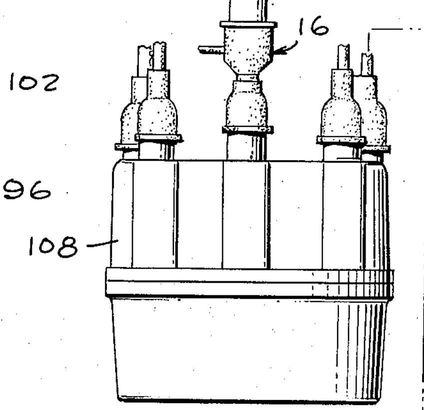
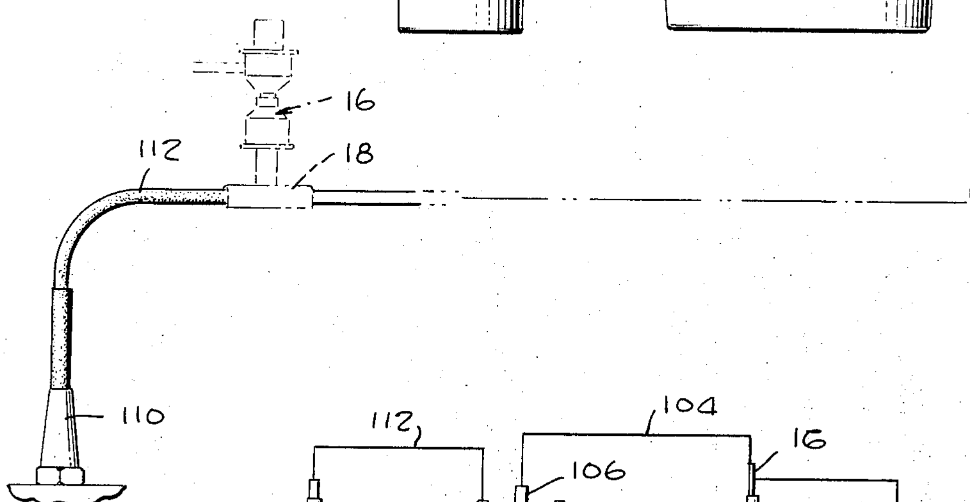


Fig. 7





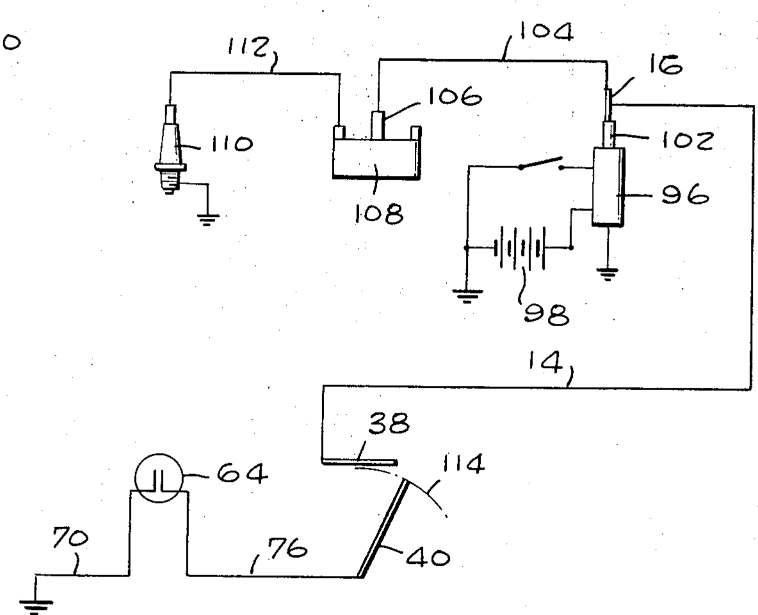


Fig. 8

ENGINE IGNITION TEST DEVICE

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention is directed to an engine ignition test device, particularly for testing the high voltage components thereof.

2. Description of the Prior Art

As spark ignition engines become more highly refined, and especially as it becomes desirable to reduce undesirable gaseous discharges from such engines, much new equipment has been developed for the diagnostic analysis of spark ignition engines. Perhaps the most highly refined and most universal piece of equipment for testing the electrical ignition components and system of a spark ignition engine is the oscilloscope, when properly equipped with suitable auxiliaries. Oscilloscopes specially fitted out for spark ignition diagnostics are presently known in the art. When equipped in this way, they can be connected to both the low and high voltage portions of the spark ignition system for analysis of point gap dwell and point resistance on the low voltage side, as well as coil voltage and spark condition in each of the spark plugs. These devices are complex and expensive. Certain high voltage diagnostics can be accomplished without resort to such expensive equipment.

High voltage spark gaps in parallel to the spark plugs in an internal combustion engine have been known. For example, Kovac U.S. Pat. No. 2,564,764 teaches the permanent installation of a fixed high voltage spark gap in parallel to the main high voltage coil lead to indicate to the driver existence of excessive voltage conditions, upon such a malfunction. Strauss U.S. Pat. No. 2,496,823 teaches an adjustable spark gap for use in ignition system testing on the high voltage side of the ignition coil. However, neither of these devices provides the information nor is sufficiently flexible or convenient to use as the engine ignition test device of this invention.

SUMMARY OF THE INVENTION

In order to aid in the understanding of this invention, it can be stated in essentially summary form that it is directed to an engine ignition test device which comprises a circuit including an adjustable high voltage spark gap serially connected to a lamp, the circuit being connectable in parallel to a portion of the high voltage section of a spark ignition engine ignition system.

It is an object of this invention to provide an engine ignition test device which is of economic construction and which is convenient and reliable to use in the testing of the high voltage portion of a spark ignition engine. It is a further object to provide a test device which includes an adjustable spark gap connectable in parallel to a portion of the high voltage system of a spark ignition engine. It is another object to provide a lamp in series with an adjustable spark gap so that, as the gap is adjusted, arcing thereacross can be observed in the series-connected lamp. It is a further object to provide an engine ignition test device which is convenient to use in a plurality of different tests in various portions of the high voltage system of an engine ignition. It is a further object to provide a test device which is easy to use in a plurality of different tests in determining the

voltage condition by means of the adjustable gap which is adjusted to permit an arc to ground.

The features of the present invention which are believed to be novel are set forth with particularity in the appended claims. The present invention, both as to its organization and manner of operation, together with further objects and advantages thereof, may be understood best by reference to the following description, taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an isometric view of the engine test device of this invention, with part of the electric leads thereof broken away to indicate longer length thereof.

FIG. **2** is a rear elevational view of the main housing thereof, with a portion of the back cover broken away to show internal construction.

FIG. **3** is a section taken generally along the line **3—3** of FIG. **2.**

FIG. **4** is a section taken generally along the line **4—4** of FIG. **2.**

FIG. **5** is a side view, with parts broken away and parts taken in section, of the test connector structure which forms a portion of the engine ignition test device of this invention.

FIG. **6** is a side elevational view of an ignition coil, with the test connector applied thereto.

FIG. **7** is a side elevational view of a portion of a conventional distributor, showing the employment of the test connector of the test device of this invention, and this figure further showing the conventional spark plug and spark plug lead, with parts thereof broken away.

FIG. **8** is a structural schematic view of an ignition circuit for a spark ignition engine, with the circuit of the test device of this invention connected thereto.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The preferred embodiment of the engine ignition test device of this invention is generally indicated at **10** in FIG. **1.** This comprises the test unit **12** which is connected by lead **14** to test connector **16.** Test sensor **18** is used with test connector **16** for certain of the tests which the engine ignition test device **10** is employed to perform.

The engine ignition test device operates on the principle of connecting a neon indicator light in series with an adjustable spark gap and connecting this series combination in parallel with various elements of the high voltage portion of the spark ignition circuit equipment of the internal combustion engine to be tested. The test unit **12** contains the neon light and the adjustable spark gap. Test unit **12** comprises a housing **20** which has the front wall **22** from which side walls **24** and **26** and end walls **28** and **30** depend to enclose interior space **32.** The interior space **32** is divided by interior wall **34** which extends at least partway across the space **32.** Back **36** covers the interior space **32** and may be removably secured if access to the equipment contained therein is required. Since the test device **10** is to be used at voltages corresponding to the high voltage side of spark ignition internal combustion engines and an equivalent spark is to be contained within housing **20,** housing **20** is preferably formed of high dielectric strength material, such as filled phenolic or many of the modern injection moldable thermoplastic synthetic polymer composition materials. Back **36** is preferably similarly formed of high dielectric strength material.

Electrode post **38** (seen in FIGS. **2** and **4**) is mounted through interior wall **34** and is secured thereby with a shoulder on one side of wall **34** (FIG. 2) and nut **40** on the other side of the wall. Thus, electrode post **38** is fixed in position. Electrode post **38** has a larger diameter portion **42** which has the shoulder which engages against interior wall **34**, and has a smaller diameter portion **44** extending therefrom into space **32**. These two portions are separated by stop shoulder **46**. Both portions are conveniently cylindrical for ease of manufacture, and stop shoulder **46** is conveniently planar, and positioned normal to the axis of electrode **38**. On the other hand, the smaller diameter portion **44** may not be of uniform diameter, but may be contoured for control of the spark gap, as is subsequently described; in any event, electrode portion **44** is preferably a surface of revolution about the central longitudinal axis of electrode **38** for purposes of ease of manufacture. Electrode **38** serves as one of the electrodes of the adjustable spark gap within test unit **12**.

The other electrode of the adjustable spark gap is formed by rod **48**. As seen in FIGS. **2**, **3**, and **4**, rod **48** passes through an opening near the end of adjustment post **50**. Adjustment post **50** passes through and is rotatable relative to the front wall **22** of test unit **12** and carries adjustment knob **52** on the front thereof. Adjustment knob **52** is secured to adjustment post **50** for rotation thereof so that the angular position of knob **52** corresponds to the angular position of post **50**. Adjustment knob **52** carries reference mark **54** which cooperates with indicia **56** secured to the front wall **22** to indicate the relative rotary position of adjustment post **50** and relative angular position of rod electrode **48**.

Compression spring **58** is engaged around adjustment post **50** and carries washers **60** and **62** on the inner and outer ends thereof. Washer **62** engages against rod electrode **48** to releasably restrain rod electrode **48** in its longitudinal direction. When adjustment of rod electrode **48** is desired, it is moved against shoulder **46**, washer **62** is depressed against spring **58**, and rod electrode **48** is pressed to the left (as seen in FIGS. **2** and **4**) so that its firmly engages smaller diameter portion **44**, and thereupon washer **62** is released to retain rod electrode **48** in its proper longitudinal position. In this position, adjustment knob **52** is secured to its post **50** in an appropriate angular position so that reference mark **54** indicates zero spark gap, and therefore zero voltage, on indicia **56**. From this construction, it is seen that, as the knob is moved, the outer end of rod electrode **48** swings away from shoulder **46** and increases the gap between the outer end of rod electrode **48** and the smaller diameter portion **44**. Thus, the adjustable spark gap is increased. From this geometry it is seen that the adjustable spark gap increases as the sine of the angle, because the outer end of the rod electrode **48** describes a circular path in cooperation with the cylindrical smaller diameter **44**. If a function other than the sine function is desired, the smaller diameter portion **44** can be appropriately shaped to produce the desired result. For practical purposes, the sine function is a desirable relationship, and indicia **56** indicate voltage values related to the spark gap.

Neon lamp **64** extends through an opening in the front wall opening **22** of test unit **12** so that it is visible from the front of the unit. It is protected by shield **66**, which protects it from mechanical damage and provides a shade to aid in its observation in brightly lighted environments. Socket **68** carries lamp **64** and is secured to the side of interior wall **34**. Neon lamp **64** is preferably the type where both electrodes are visible so that polarity can be observed.

Going to the wiring interconnection of the test unit **12**, ground wire **70** has a connector, such as alligator clip **72**, for connection to an electrical ground in the high voltage portion of the spark ignition circuit. Ground wire **70** enters test unit **12** through end wall **28**. Interiorly of end wall **28** it is connected under nut **74**, which secures socket **68**, and which serves as one of the socket terminals. From the other terminal side of socket **68**, electrically on the other side of neon lamp **64**, wire **76** connected neon lamp **64** to post **50**. The end of wire **76** carries a flat ring-type wire terminal which is positioned beneath washer **60** to maintain good electrical contact. Washers **60** and **62**, spring **58**, and post **50** are all metallic to provide electrical connection through to metallic rod electrode **48**. Test lead **14** is connected under nut **40** by a similar wire terminal and extends out of test unit **12** through end wall **28**.

Test lead **14** interconnects the test unit **12** with test connector **16**. As is seen in FIGS. **1** and **5**, the outer end of test lead **14** is directly connected, as by swagging or soldering, to the metallic body **80** of the test connector. Socket **82** is formed in the upper end of the body for connection of standard male connector high voltage ignition lines thereto. The lower end of body **80** has a nose **84** thereon and metallic leaf spring **86** is secured to the nose. These parts are dimensioned so that they can enter into the standard female socket in high voltage ignition equipment. Resilient sleeves **88** of high dielectric strength material are positioned around the major portion of body **80** to permit its handling and to prevent stray arcs.

Test sensor **18** comprises a U-shaped metallic sensor **92** which has an open sided longitudinal channel **94** extending the length thereof. The channel **94** is of sufficient width to be able to embrace the external insulation of a high volt ignition line. It has socket **90** attached thereto in which the male connector on test connector **16**, comprised of springs **86** on nose **84**, can be inserted. Test sensor **18** is of metallic material so that, when it is connected in that way, the sensor is electrically connected to test unit **12**.

FIG. **8** schematically indicates the arrangement of the conventional ignition circuit in a spark ignition internal combustion engine. It shows an ignition coil **96** having a battery **98** and breaker points **100** serially connected to the low voltage turns in the coil. Conveniently, one side of that system is grounded. When points **100** are closed, current builds up in the low voltage circuit. When they are opened, the magnetic field collapse causes a high voltage impulse in the high voltage coil of ignition coil **96**. This high voltage pulse appears between ground, to which one side of the high voltage coil is connected, and a female terminal in tower **102** of coil **96**. Coil wire **104** conventionally connects the coil tower **102** to tower **106** on distributor cap **108**. The distributor cap **108** internally contains a rotor which passes adjacent a plurality of contacts, each of which is connected to a different spark plug **110** through plug wire **112**. The spark plug **110** has a spark gap, the other side of which is connected to ground, to complete the high voltage circuit. While one spark plug is illustrated in each of FIGS. 7 and 8, it is understood that there are a plurality of such spark plugs and a plurality of such spark plug wires, in accordance with the plurality of connections on the top of the distributor cap 108. In the usual automotive and spark ignition internal combustion engines, there are four to eight spark plugs, one for each cylinder, and the same number of plug wires and sockets for connection of the plug wires into the distributor cap.

FIGS. 6 and 8 illustrate the method of connection of the engine ignition test device 10 into an ignition circuit for the initial and principal tests. In this position, the test connector 16 is plugged into the female terminal in the top of tower 102 on ignition coil 96, while the coil wire 104 is plugged therein. Knob 54 is adjusted so that the spark gap between electrodes 38 and 48 is fairly large. It is preferred that the indicia 56 indicate the voltage at which arcing will occur across the gap between the electrodes, to thus indicate the state of the equipment in parallel to it. On the first test, it is assumed that the spark plugs 110 have been determined to be in good adjustment and condition, and the points 100 similarly determined to be in good condition and adjustment. Preferably both the spark plugs and points have been replaced and set.

The adjustable spark gap 114 between electrodes 38 and 48 is adjusted so that it will not arc across until about 30 kv (kilovolts) are applied thereto. While particular values of voltage are given in this specification to represent corresponding gap dimension, it is understood that they are examples of what is expected in present-day automotive equipment. Different values with change in design and with different applications may suggest different numerical values than those set forth herein.

Thereupon, the engine is started and will run normally and properly if all the equipment is in good condition. Knob 54 is turned slowly to reduce the gap 114 between electrodes 38 and 48 and, if the gap between the rotor and the fixed terminals in distributor cap 108 are correct, and if all connection wires are in good condition, the light 64 will not flash until the gap 114 is closed to about 10 kv or slightly less. This is the normal arc voltage of the series connection of the rotor gap and spark plug gap when they are both in tolerance. When the battery 98 and spark coil 96 are correctly installed, the illumination of one side of the light 64 starts flashing due to a reduced gap 114, the engine stalls indicating that the parallel circuit through gap 114 is arcing so that the spark plugs 110 cannot spark. This is the usual condition indicating good condition of the equipment, when the lamp 64 starts flashing and the engine stalls at about 10 kv. When the coil and battery are correctly installed, provided the engines have the same ground polarity (negative in most American cars) the gap is then reduced the same electrode and the light will flash on. This electrode is arbitrarily called the negative ground electrode. If the coil or battery is installed with wrong polarity the other or positive electrode will flash on.

If the lamp 64 starts flashing at a higher arc voltage value than 10 kilovolts, as the gap 114 is reduced toward 10 kilovolts but the engine does not stall until about 10 kilovolts is reached, this indicates that one or more of the plug wires 112 is defective, because the higher voltage is applied across gap 114 at some distributor rotor positions.

To determine which of the wires 112 is bad due to high resistance of the conductor, test connector 16 is removed from the top of coil 96, and the coil wire 104 is plugged directly into the female terminal in tower 102. With the connections made in this way, the connections are in the usual, non-test arrangement. Nose 84 with its leaf spring connectors 86 are plugged into receptacle 90 in test sensor 18. The gap 114 is set to zero so that the electrodes 38 and 48 are in contact with each other. With the engine running, test sensor 18 is successively placed around each one of the spark plug wires 112. For those wires 112 which have the normal resistance value, the lamp 64 will glow only very faintly, or not at all. If the dial is turned to 1 or 2 kilovolts, the glow will disappear. If the wire is defective due to high resistance, the light will glow more brightly. If the dial is turned to 1 or 2 kilovolts, the light flash brightly at both electrodes. Modern cars use carbon core resistance spark plug wires. The carbon sometimes fails inside the wire by mechanical damage or burning, thus causing a break in the continuity of the wire, and therefore causing high resistance.

The engine ignition test device 10 can also be employed to determine the condition of ignition coil 96. In this test, test connector 16 is installed in the terminal on top of coil 96, as shown in FIG. 6, and the coil wire 104 is connected, also as shown in FIG. 6. One spark plug wire is removed and the gap 114 is adjusted so that it requires about 30 kv to arc across, and the engine is started. If the lamp 64 flashes, it indicates good condition of coil 96. If the lamp 64 does not flash, dial 52 is turned to reduce gap 114, and if the coil 96 does not produce sufficient voltage to arc across gap 114 by the time the gap is reduced to a dimension corresponding to about 20 kv, the coil 96 is below specification. The value of 25 kv is moderately good, and 20 kv is fair, but at this value the coil quality is marginal.

In the next test, the test connector 16 is plugged into the terminal on the top of coil 96, as shown in FIG. 6, and the coil wire 104 is inserted in the top of the test connector. With the gap 114 adjusted to about 25 kv, the engine is started. The gap is slowly reduced. If the light flashes on and the engine stalls above about 10 kv there is excessive resistance common to all spark plu connections. There are two things common to all of th spark plug circuits. The first is coil wire 104, and th second is the gap between the rotor and the fixed contacts within distributor cap 108. In determining th condition of wire 104, the test connector 16 is remov from the top of coil 96 and is placed in the center te minal of distributor 108, as shown in FIG. 7. Coil wi 104 is connected to the tower coil 96 and to test co nector 16. This takes wire 104 out of the test. The upon, the gap 114 is adjusted to about 30 kv, and engine is started. Knob 52 is slowly adjusted to red gap 114, and if lamp 64 does not flash and the eng does not stall until about 10 kv is reached, it is sh that the coil wire 104 is defective in having exces resistance. However, should that wire prove to b tolerance, test of the rotor gap is made. This is mad placing test connector 16 in the female socket w spark plug wire 112 is normally plugged into distri cap 108, and the wire 112 is plugged into the top c test connector 16. This removes the rotor gap fro test. Coil wire 104 is connected into its usual so With the gap 114 adjusted to 30 kv, the eng started. Thereupon, knob 54 is turned to reduc

114. If the light **64** flashes on above 10 kv, the problem is excessive rotor gap within the distributor cap. Replacement of either or both the rotor and cap will solve this gap problem.

In some circumstances, an individual spark plug wire may be shorted to ground. To determine this condition, the test connector **16** is preferably placed in the center connector of the distributor cap **108**, as shown in FIG. **7**, but it may be placed in the high voltage coil connection, as shown in FIG. **6**. The gap **114** is set for a value between the arc voltage value of the unconnected coil and the normal arc voltage of the system, e.g., a value of the gap **114** from 15 to 20 kv is useful. The engine is started and, if all of the tests described above have shown the equipment to be normal, the lamp **64** will not flash. As the engine is running, the spark plug wires **112** are successively removed and replaced from their corresponding spark plugs. When a wire is removed, if the wire is in good condition, lamp **64** will flash. Each wire is successively replaced and the next is removed. If any one of the spark plug wires is shorted out between its ends, the removal of the wire from the plug will not cause flashing in the lamp. Thus, grounding of that wire between the distributor cap and the spark plug is indicated.

By these tests, the engine ignition test device is employed to test a number of different characteristics of the high voltage portion of the ignition system in the spark ignition internal combustion engine.

While particular embodiments of the present inven-tion have been shown and described, it will be obvious o those skilled in the art that changes and modifica-ions may be made without departing from this inven-on in its broader aspects and, therefore, the aim in the ppended claims is to cover all such changes and modi-cations as fall within the true spirit and scope of this vention.

What is claimed is:

l. An engine ignition test device comprising a test t having a serially connected adjustable spark gap l a lamp, and a test connector serially connected to l adjustable spark gap, said lamp being visible exte-ly of said test unit, the improvement wherein said stable spark gap comprises:

ixed electrode having a stop shoulder thereon; and fixed axis and

novable electrode manually adjustably rotatable om the exterior of said test unit about an adjust-ent axis non-coaxial with said fixed axis from a sition where it is in engagement with said stop oulder to a position where it is out of engagement th said stop shoulder.

e engine ignition test device of claim 1 wherein:

ixed electrode has a smaller portion extending g said fixed axis away from said shoulder so that, as said movable electrode swings about said adjustment axis, the gap between said fixed electrode and said movable electrode is between said smaller portion and said movable electrode.

3. The engine ignition test device of claim **2** wherein:

said smaller portion is cylindrical about said fixed axis.

4. An engine ignition test device comprising:

a test unit, said test unit having an adjustable spark gap and having a lamp visible from exteriorly of said test unit serially connected to said spark gap and a test connector serially connected to said adjustable spark gap, said adjustable spark gap comprising:

a fixed electrode having a fixed axis;

a movable electrode rotatable on an adjustment axis non-coaxial with said fixed axis, an adjustment post positioned on said adjustment axis, said adjustment post being manually adjustable from the exterior of said test unit, said movable electrode being a rod extending through an opening in said adjustment post; and

a spring engaging said movable electrode in its opening in said adjustment post, so that said movable electrode is movable against said fixed electrode by motion through its opening in said adjustment post to compensate for arc wear on said movable electrode.

5. The engine ignition test device of claim **4** wherein:

said adjustment post carries a knob on the front of said test unit; and

said spring engages said adjustable electrode interiorly of said test unit.

6. The engine ignition test device of claim **4** wherein:

said fixed electrode has a stop shoulder thereon; and

said movable electrode is rotatable about said adjustment axis from a position where it is in engagement with said stop shoulder to a position where it is out of engagement with said stop shoulder.

7. The engine ignition test device of claim **6** wherein:

said fixed electrode has a smaller portion extending along said fixed axis away from said shoulder so that, as said movable electrode swings about said adjustment axis, the gap between said fixed electrode and said movable electrode is between said smaller portion and said movable electrode.

8. The engine ignition test device of claim **7** wherein:

said smaller portion is cylindrical about said fixed axis.

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