SPARK PLUG TESTING UNIT

Filed Nov. 22, 1950 2 SHEETS—SHEET 1

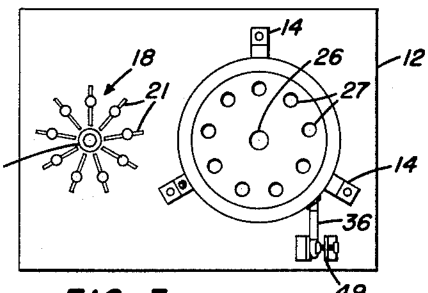

FIG. 3

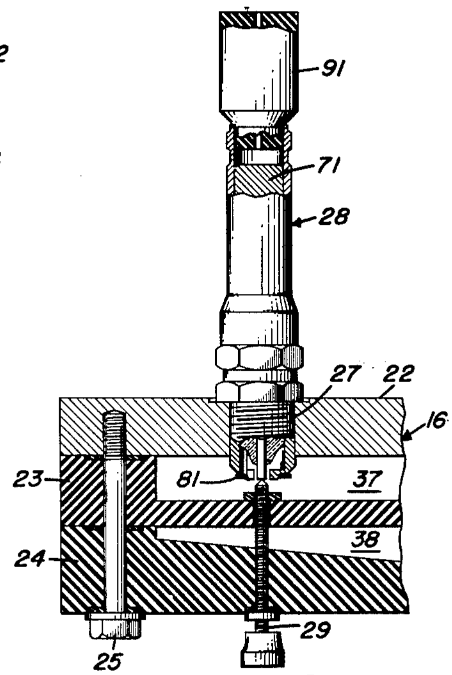

FIG. 2

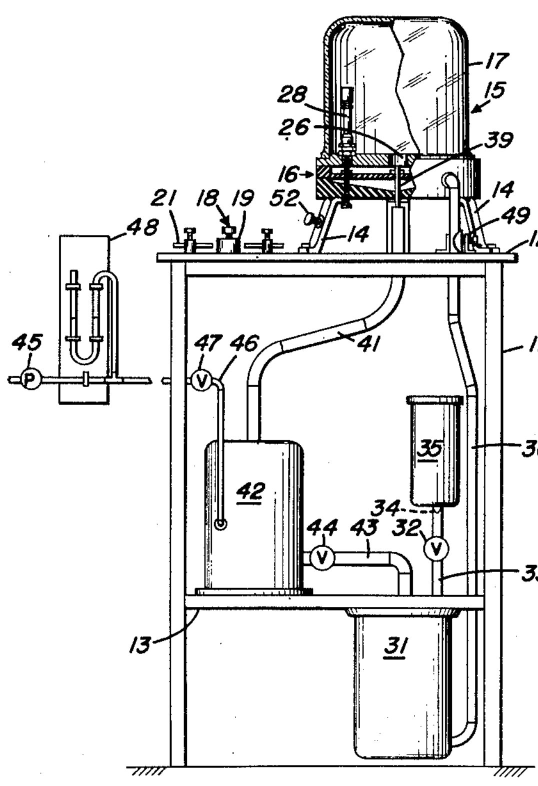

FIG. 1

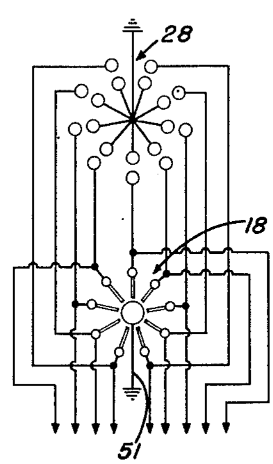

FIG. 4

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SPARK PLUG TESTING UNIT

Filed Nov. 22, 1950 2 SHEETS—SHEET 2

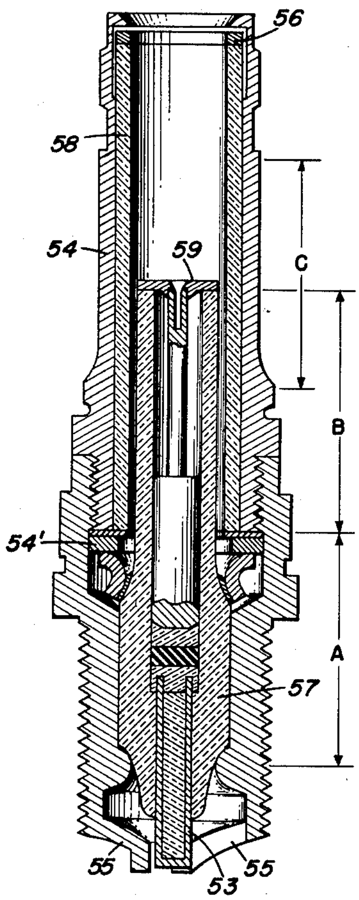

FIG. 5

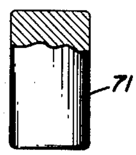

FIG. 7

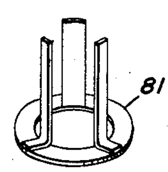

FIG. 8

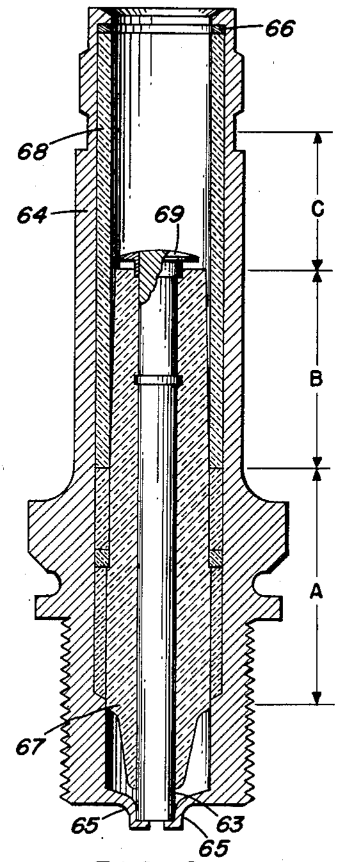

FIG. 6

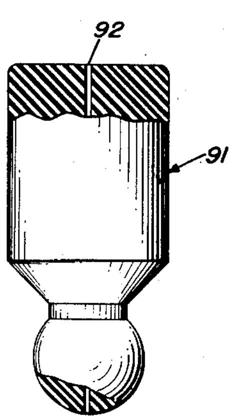

FIG. 9

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SPARK PLUG TESTING UNIT

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4 Claims. (Cl. 175—183)

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The present invention relates to a method and apparatus for testing spark plugs and more particularly to a method and apparatus for testing the insulating properties of the ceramic portions of assembled spark plugs.

In the manufacture of spark plugs, the ceramic portions thereof are frequently cracked or otherwise damaged so that their insulating properties are impaired. The extent to which this impairment of the insulation adversely affects the operation of the plug is dependent upon the region in which the crack or other damage occurs and the extent of the crack. Thus, a plug may fail to ignite the fuel mixture in an engine if the insulating bushing or the insulating sleeve is defective. On the other hand, a plug with a cracked or broken nose may continue to ignite the fuel mixture if the plug remains gas tight. It is therefore of importance in testing spark plugs to determine both the region and the extent of damage to the ceramic portions of the plug in order to determine adequately the effect of this damage on the operation of the plug.

The present invention proposes to test the insulating properties of a spark plug by immersing the lower end of the plug in a liquid insulating medium, such as oil, to insulate the electrodes from each other. The upper insulating portion of the plug is maintained at a low pressure in order to permit a spark to jump easily across any possible crack in the ceramic portions of the plug. A source of high potential is then applied across the electrodes of the plug and across an auxiliary air gap, and arcing across the auxiliary gap is indicative of proper plug insulation.

An object of the present invention is the provision of a method and apparatus for determining the insulating properties of spark plugs.

Another object is to provide a method and apparatus for determining the location and the extent of damage of the insulating portions of a spark plug.

A further object of the invention is to provide a method and apparatus for testing a spark plug in which proper operation of the plug is indicated by arcing across an auxiliary air gap.

Still another object is to provide a method and apparatus for testing spark plug insulation in which the upper portion of the plug is maintained at a low pressure.

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A still further object is to provide a method and apparatus for testing spark plug insulation in which the adjacent portions of the electrodes are immersed in an insulating medium to prevent sparking thereacross.

The exact nature of the present invention as well as other objects and advantages thereof will be readily apparent from consideration of the following detailed description relating to the annexed drawing in which:

Fig. 1 is a front elevational view, partly in section, of one form of apparatus for carrying out the present invention;

Fig. 2 is a partial sectional view of the base of the chamber of Fig. 1, illustrating the position of a spark plug to be tested;

Fig. 3 is a top plan view of the apparatus of Fig. 1 with the jar or cover removed;

Fig. 4 is a wiring diagram of the electrical apparatus of Fig. 1;

Figs. 5 and 6 are front sectional views of two forms of spark plugs that may be tested according to this invention;

Fig. 7 is a front elevational view, partly in section, of one form of insert according to this invention;

Fig. 8 is a perspective view of a pronged insert according to this invention; and

Fig. 9 is a front elevational view, partly in section, of a plug for use with the spark plug of Fig. 6.

Referring now to the drawings, wherein like reference characters designate like or corresponding parts throughout the several views, there is shown in Fig. 1, which illustrates a preferred embodiment, a frame 11 which supports a top plate 12 and an intermediate plate or shelf 13, plates 12 and 13 preferably being constructed of insulating material, such as laminated phenolic.

Secured to plate 12 in any suitable manner are a plurality of legs 14 which support the spark plug testing chamber, generally designated as 15, chamber 15 comprising a base 16 and a cover 17, such as a conventional bell jar, detachably secured thereover. The auxiliary spark gap system, generally designated as 18, is also mounted on plate 12, system 18 comprising a central grounded electrode 19 and a plurality of adjustable electrodes 21 distributed thereabout, as shown in Fig. 3.

Base 16 of chamber 15, as shown in Fig. 2, comprises a conducting disc 22, preferably made of stainless steel, and a pair of insulating discs 23 and 24, preferably made of laminated phenolic. Discs 22, 23 and 24 are assembled together in the manner shown in Fig. 2, preferably by cementing with neoprene and clamping with stainless steel bolts 25. Disc 22 has a central aperture 26, for a purpose to be described later, and a plurality of apertures 27 circumferentially spaced about disc 22 adjacent the periphery thereof, each of apertures 27 being arranged to receive a spark plug 28 to be tested.

Lower insulating disc 24 is tapered downwardly from opposite ends toward the center, while upper insulating disc 23 is machined so as to be thicker at the outer portion, as indicated in Fig. 2, the thickness of disc 23 being preferably 1 inch on the outer portion and one-quarter inch on the inner portion. Discs 23 and 24 are provided with a plurality of circumferentially spaced apertures, not designated, the apertures in one disc being aligned with the corresponding apertures of the other. Into each pair of aligned apertures is inserted a contact element 29, preferably a threaded stainless steel bolt, for contact with the central electrode of one of the spark plugs 28 to be tested.

Mounted downwardly on shelf 13 is a drum 31 which is partially filled with the liquid insulating medium, such as transformer oil. The liquid medium is forced up into chamber 15 by the opening of valve 32, one side of which is connected to the upper end of drum 31 by means of line 33 and the other side of which is connected to the atmosphere by means of orifice 34 and air dryer 35, such as a silica jel dryer. The lower end of drum 31 is connected to chamber 15 by means of line 36 which extends through disc 23 into the passage 37 formed between discs 22 and 23. Passage 38 between discs 23 and 24 serves as a reservoir for any fluid which may leak past disc 23.

An overflow vent 39 extends centrally through discs 23 and 24 in alignment with aperture 26 and has its upper end aligned with the lower surface of disc 22. Vent 39 communicates by means of line 41 to the upper end of a drum 42 mounted upwardly on shelf 13, drum 42 communicating at its lower end with the upper end of drum 31 by means of line 43 and control valve 44 therein. Drum 42 also communicates with a vacuum pump 45 by means of line 46 and valve 47 therein, there being a pressure gage 48 in line 46.

In operation, the plugs to be tested are inserted in apertures 27 and positioned so that the central electrode of the plug contacts contact element 29. Cover 17 is then placed over base 16, the joint between cover 17 and base 16 being made air tight, preferably by cementing a thin sheet of neoprene to the base of cover 17. Valve 32 is then closed, and valves 44 and 47 are opened. An adjustable valve 49 in line 36, shown in the form of an adjustable clamp, is also opened.

Pump 45 is then operated to evacuate chamber 15 to a predetermined pressure, as indicated by gage 48. When this pressure has been attained, valves 44 and 47 are closed, valve 32 opened, and valve 49 partially closed in order to regulate the flow of fluid into passage 37. Fluid is permitted to enter passage 37 slowly until the fluid level is visible through aperture 26 in disc 22. When the fluid level is visible, valve 49 is closed and the height of the fluid is controlled by overflow vent 39.

The electrical connections from the magneto distributor block, not shown, are made as indicated in Fig. 4. To prevent sparking across the auxiliary gaps, regardless of the condition of the plug, it is necessary to connect the shell of the plug to the grounded side of the auxiliary gap with a flow impedance conductor. This is done by means of a copper strip 51 from central electrode 19 to leg 14, leg 14 making electrical contact with the shell of the plug through bolt 25 and disc 22. A terminal 52 on leg 14 is connected to the base of the magneto, so that the potential difference between the testing unit and the magneto is relatively small.

If the auxiliary gap fires when the magneto is started, the plug in parallel with this gap is satisfactory. If the auxiliary gap fails to fire, it indicates that the plug in parallel therewith is defective. By making electrode 19 of stainless steel 1 inch in diameter and one-eighth inch thick, and by making electrodes 21 of stainless steel having a one-sixteenth inch radius at the sparking ends, an auxiliary gap setting of 0.025 inch would require a breakdown voltage equivalent to that required for a three-eighths inch gap under a pressure of one atmosphere using pointed electrodes. This breakdown voltage is less than that of the spark plug electrodes when submerged in oil, if the gap thereof is not less than 0.014 inch.

In order to determine accurately the region and extent of damage to the ceramic portions of the plug, reference is now had to Figs. 5 and 6, which illustrate two forms of conventional spark plugs that may be tested by the method and apparatus of the present invention. In Fig. 5, the spark plug is shown as comprising a central electrode 53, an outer shell 54 having ground electrodes 55 affixed thereto, a conducting ring 56, an insulating bushing 57, and an insulating sleeve 58. Similarly, the spark plug of Fig. 6 comprises like elements, designated 63 to 68 inclusive.

If a crack occurs in insulating bushing 57 or 67 in the region designated A, the spark plug will fail to ignite the fuel mixture if the sparking voltage between center electrode 53 or 63 and shell 54 or 64 through the crack is less than the sparking voltage across the plug gap. The plug may fail if this crack becomes filled with conducting products, regardless of the sparking voltage through the crack. If a crack occurs in bushing 57 or 67 in region B, the probability of misfiring decreases as the location of the crack approaches top terminal 59 or 69 of electrode 53 or 63. For cracks in this region, the probability of gap firing failure is much greater for the type of plug of Fig. 5, since the space between bushing 67 and sleeve 68 in this region is sealed.

For cracks in insulating sleeve 58 or 68 in the region B, the probability of misfiring increases as the crack approaches top terminal 59 or 69. The greatest probability of plug failure arises for cracks occurring in sleeve 58 or 68 in the region designated C.

In testing spark plugs of the type shown in Fig. 5, the pressure should be reduced as much as possible without causing sparking from the top terminal 59 to ring 56, or from terminal 59 to portion 54′ of shell 54. In actual tests, a pressure range of 4 to 16 inches of mercury was utilized, and it was found that this type of plug may be tested satisfactorily over a pressure range of 8 to 16 inches of mercury. At a pressure of 8 inches of mercury, a discharge should take place between electrode **53** and shell **54** if bushing **57** is cracked in the region designated A, B and the portion of C near terminal **59**.

If this procedure indicates that the plug is satisfactory, additional tests are made to determine the condition of sleeve **58**. To perform this operation satisfactorily, it is necessary to increase the potential gradient in sleeve **58**. This is done, according to the present invention, by the insertion of a metal cylinder or insert **71**, as shown in Fig. 7, into the plug between terminal **59** and ring **56**. The position of insert **71** in the plug is indicated at **71** in Fig. 2. Tests have shown that this procedure greatly increases the average gradient in sleeve **58**, the average gradient in the air space between insert **71** and sleeve **58** being 160 kv. per inch when 10 kv. are applied across terminal **59** and shell **54**.

With insert **71**, all cracks in sleeve **58** except those very close to the top or bottom thereof may be detected readily. If the test still does not indicate failure, it is then necessary to determine the condition of the nose of the plug. As pointed out above, a plug may continue to ignite the fuel mixture, even though the nose thereof is cracked or broken. Therefore, in order to increase the gradients in the nose region and consequently decrease the sparking distance necessary for a discharge through a crack in the nose, a pronged insert **81**, shown in Fig. 8, is inserted in the lower chamber of the plug. This insert **81** is indicated at **81** in Fig. 2.

Actual tests have shown that this procedure will indicate failure of the plug over the entire pressure range, even though this failure was not indicated in the earlier tests without insert **81**. In using insert **81**, it is necessary to keep the oil off the prongs thereof, or the oil will serve as an insulator and will lower the probability of a discharge through the cracked nose. When the temperature of the oil is low, the thickness of the film collecting on the prongs of insert **81** may be great enough to give complete protection against discharge. It was found that the best results were obtained when the oil was at a temperature of 70° to 85° F.

In testing plugs of the type shown in Fig. 6, a pressure range of 6 to 16 inches of mercury may be utilized, the lower limit being preferred. An insert similar to insert **71** is used to detect sleeve damage, except that this insert may have a portion thereof extend into the region between sleeve **68** and bushing **67**. This is not possible for plugs of the type shown in Fig. 5, since portion **54'** of shell **54** is not insulated. A pronged insert similar to insert **81** is used in detecting cracks in the nose of plugs of the type shown in Fig. 6.

For plugs of the type disclosed in Fig. 6, an insulating plug **91**, preferably of rubber, may be inserted in the upper portion of the spark plug. The configuration of plug **91** is shown in Fig. 9, there being a central aperture **92** therethrough to permit passage of air, and its position in the spark plug is shown in Fig. 2. When plug **91** is used, the pressure in chamber **15** may be reduced to 1 or 2 inches of mercury without any discharge occurring between terminal **69** and ring **66**, thereby making possible ready detection of cracks in the nose. Plug **91** will not be effective when used with spark plugs of the type shown in Fig. 5, because there still remains a discharge path from terminal **59** to portion **54'** of shell **54**.

After the tests are completed, valves **47** and **49** remain closed and valves **32** and **44** are opened thereby opening chamber **15** to the atmosphere. When the pressures inside and outside of chamber **15** have equalized, jar **17** is removed. In this manner, the air entering chamber **15** is dried by means of dryer **35**, thereby preventing any corrosion of base **16** or the sealing means employed.

Although the means for maintaining the spark plug electrodes insulated and for maintaining the upper end of the plug at a lower pressure have been described with particularity, it is clear that well-known means other than that disclosed may be utilized without departing from the spirit and scope of the present invention. Thus, chamber **15** may be completely isolated from the insulating fluid reservoir, and the means for reducing the pressure made completely independent from the means for supplying fluid. Similarly, the means for obtaining the auxiliary spark gap may be different from that described.

It is therefore to be understood that, within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. In apparatus for testing the insulation of a spark plug having electrodes adjacent the lower end thereof, the combination comprising a sealed chamber, container means positioned adjacent said chamber and having a liquid insulating medium therein, means for mounting the plug in said chamber with its lower end immersed in the insulating medium whereby normal current flow between the electrodes is prevented, means for at least partially evacuating said chamber, and means extending through said liquid insulating medium for applying a high electromotive force between the electrodes whereby current is permitted to flow across damaged plug insulation between the electrodes, and means preventing discharge of said electromotive force across the upper ends of said electrodes in the sealed chamber.

2. The combination according to claim 1, and an auxiliary electrical path spaced from said sealed chamber, and means for simultaneously applying said electromotive force across said auxiliary path whereby current flow through said auxiliary path is indicative of the sound condition of the insulation of the plug under test.

3. Apparatus for testing the insulation of a spark plug having electrodes at the lower end thereof, said insulation extending the length of the plug between the electrodes from a point adjacent the lower ends thereof, the combination comprising a sealed chamber, container means positioned adjacent said chamber and having a liquid insulating medium therein, said sealed chamber and said container means being separated by a base plate which is adapted to receive said plug so that the upper end is positioned in said sealed chamber and the lower end is positioned in the liquid insulating medium, whereby normal current flow between the lower ends of the electrodes is prevented, means extending through said insulating medium for controlling the level thereof and permitting at least partial evacuation of said chamber by pump means associated therewith, means extending through said insulating medium and connected to one of said electrodes for supplying a high electromotive

force between the electrodes whereby current is permitted to flow between the electrodes across damaged portions of the insulation therebetween, and means preventing discharge of said electromotive force across the upper ends of said electrodes in the sealed chamber.

4. The combination according to claim 3, and an auxiliary electrical path spaced from said sealed chamber, and current means for simultaneously applying said electromotive force across said auxiliary path whereby current flow through said auxiliary path is indicative of the sound condition of the insulation of the spark plug under test.

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