July 27, 1954 E. W. PIERCE ET AL 2,685,059

SPARK PLUG TESTER

Filed Feb. 11, 1949 4 Sheets-Sheet 1

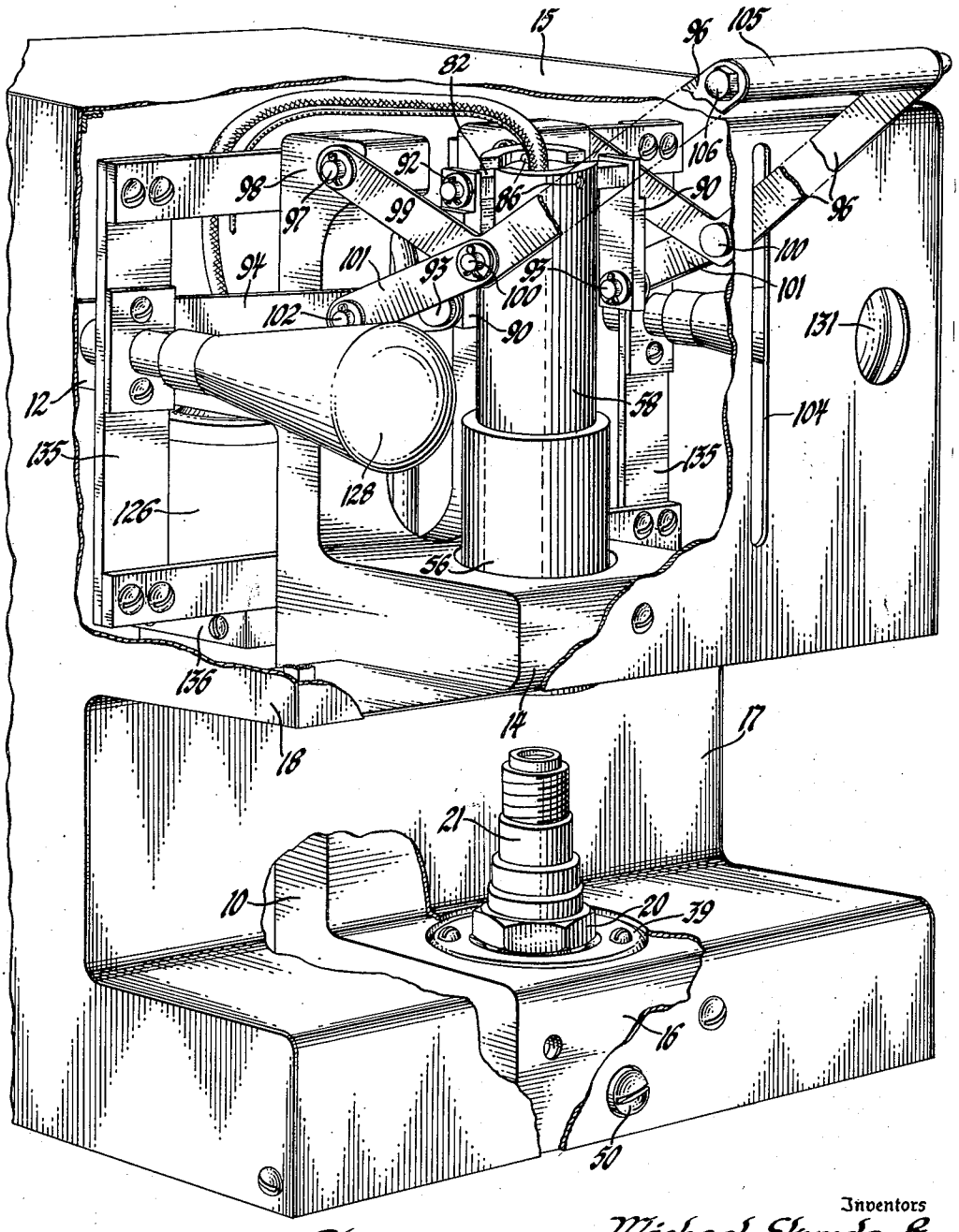


Fig. 1

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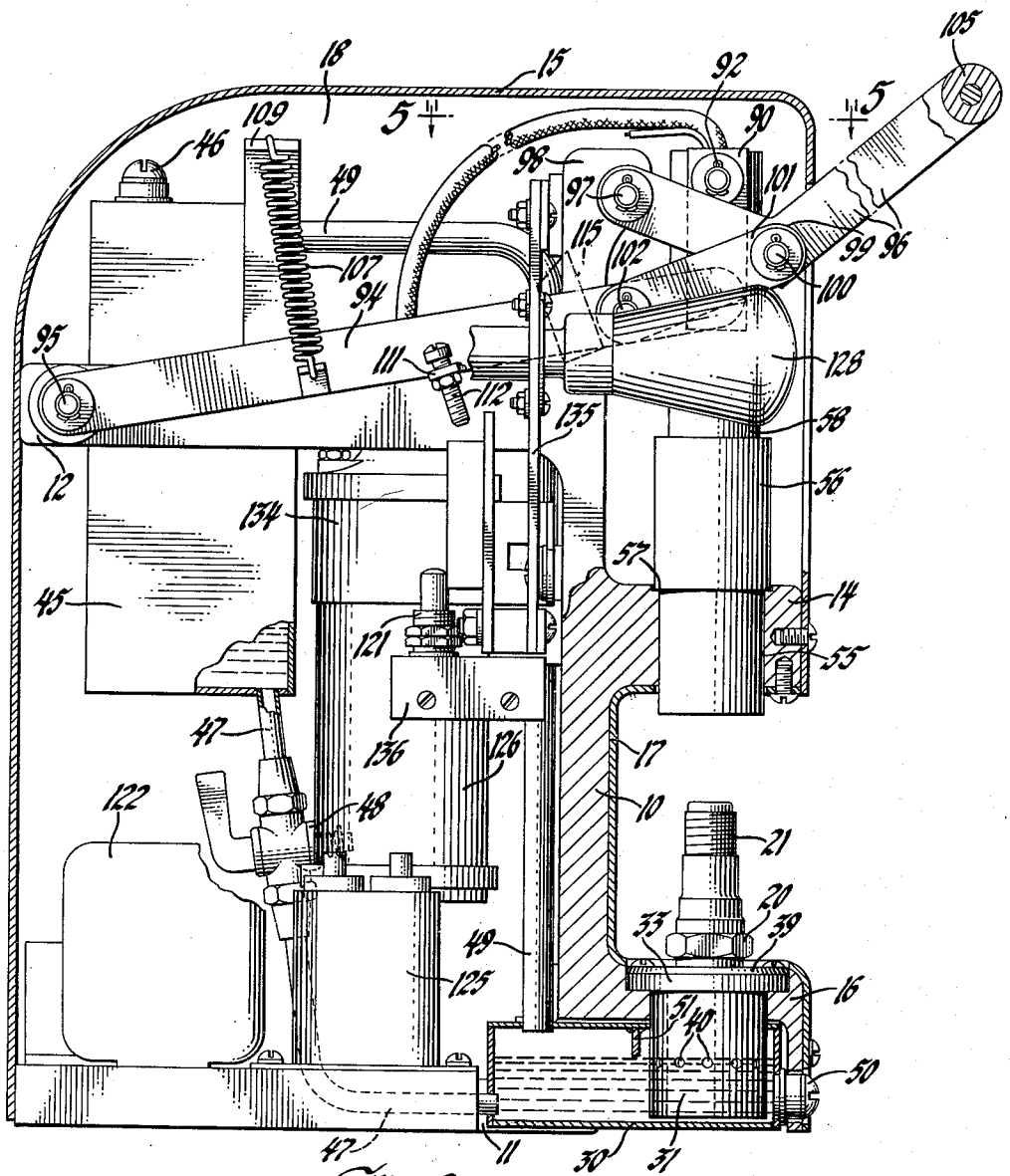


Fig. 2

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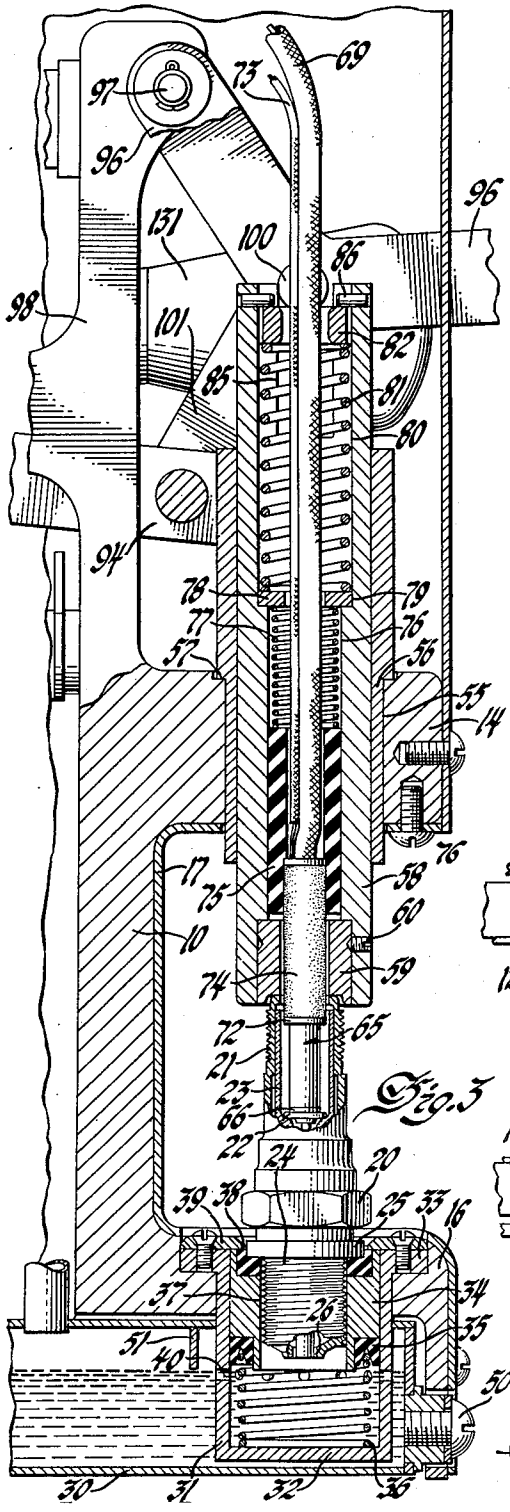


Fig. 3

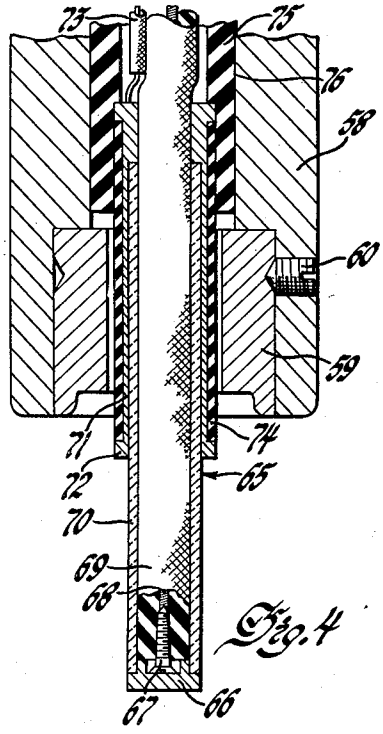


Fig. 4

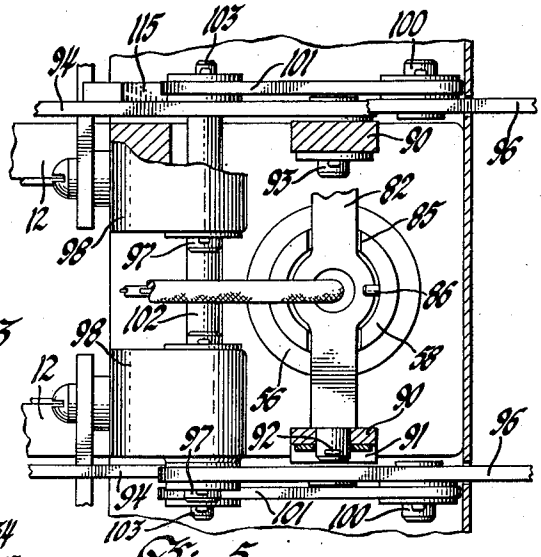


Fig. 5

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Filed Feb. 11, 1949 4 Sheets-Sheet 4

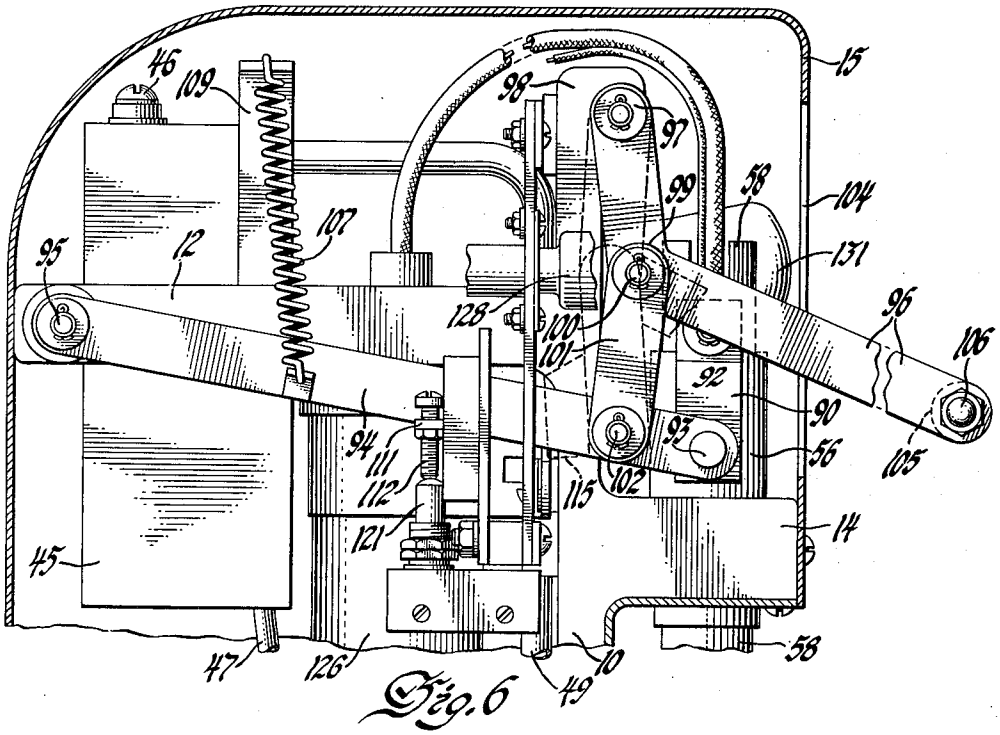


Fig. 6

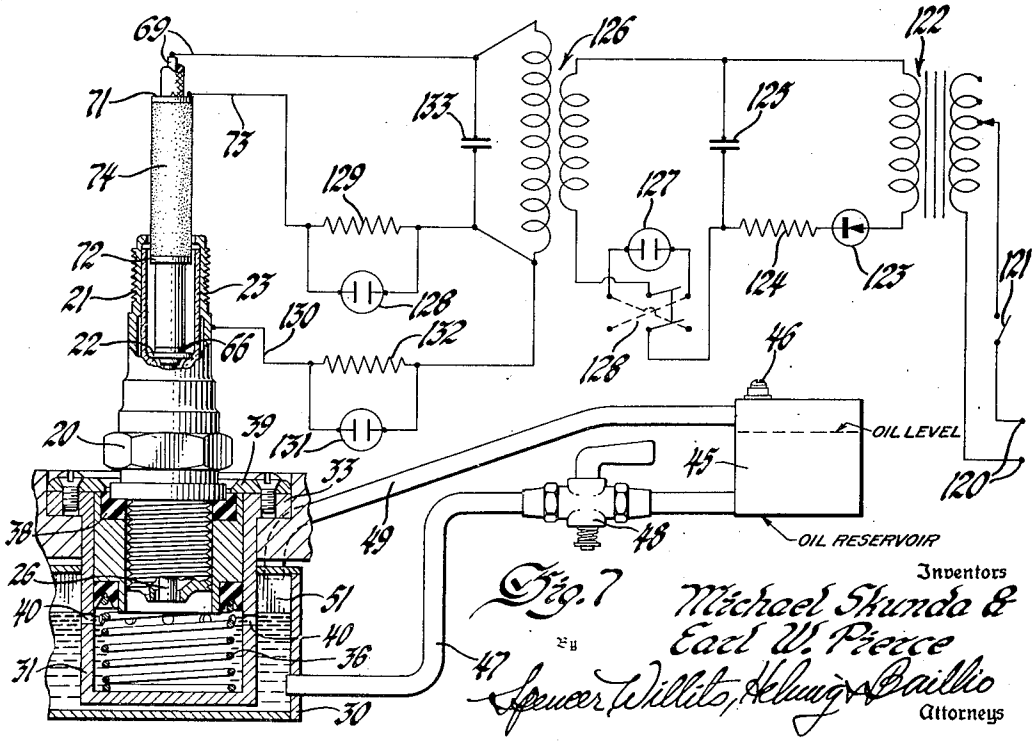


Fig. 7

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2,685,059

UNITED STATES PATENT OFFICE

2,685,059

SPARK PLUG TESTER

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Application February 11, 1949, Serial No. 75,882

17 Claims. (Cl. 324—15)

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This invention relates to an insulation tester, and more particularly to a manually operated automatic tester for spark plug insulators.

The object of this invention is to provide a spark plug insulation tester which automatically insulates the spark plug gap and applies a high voltage potential to the plug when the plug is clamped in position.

Another object of this invention is to provide a spark plug tester in which the spark plug electrodes are insulated from each other by a fluid under pressure created by movement of the spark plug.

Another object of the invention is to provide in a tester a uniform pressure applying plunger actuated by a toggle linkage through a pressure limiting spring.

Another object is to provide a seat for the element to be tested in a movable piston mounted in a cylinder having liquid level regulating means in order to apply fluid pressure to the element to be tested.

Though spark plug testers now used employ a single operating lever to move a conductor to engage the spark plug terminal and to hold the spark plug while the high potential test current is applied, they also require expensive motor-driven compressor or vacuum pump units to partially quench the spark gap with high pressure air to simulate engine operating conditions or to completely quench the spark gap with insulating fluid for a breakdown test of the insulation.

In accordance with this invention, the need for an auxiliary source of pressure or vacuum is eliminated. The spark plug is mounted in an aperture of a piston which is slidably mounted in a cylinder having a spring to hold the piston at one end to keep the fluid passage open to maintain a constant level of insulating fluid therein. An operating handle actuates a toggle linkage to move a combined element having a conductor and collector ring and a pressure applying ram head. As the ram head engages the spark plug, the plug and piston move and close the fluid passage in the cylinder. Further movement of the plug and cylinder increases the fluid pressure in the cylinder and forces insulating fluid around the electrodes of the spark plug to completely quench the spark gap. Then the high potential test current is applied by the conductor to the spark plug terminal. If the insulator is good the current will jump the air gap over the insulator to the collector ring and actuate one indicator. If the insulator is defective the current will pass through the insulator to the spark plug shell or shield and

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actuate the other indicator. Thus the condition of the spark plug insulator is positively and clearly indicated.

Other objects and advantages will be apparent from the following specification and drawings.

Figure 1 is a perspective view of the spark plug tester.

Figure 2 is a vertical sectional view of the spark plug tester.

Figure 3 is an enlarged partial vertical sectional view of the spark plug clamping elements.

Figure 4 is an enlarged detail view of the high voltage electrode.

Figure 5 is an enlarged partial sectional view on the line 5—5 of Figure 2.

Figure 6 is a partial vertical sectional view of the spark plug tester similar to Figure 2 but showing the linkage moved toward clamping position.

Figure 7 is a diagrammatic view of the electrical circuit and hydraulic circuit.

The spark plug tester is mounted on a frame 10 having a pair of rearwardly extending legs or base portions 11 and upper rearwardly extending lever supports 12 located adjacent each side of the tester. At about mid-height of the frame 10 a forward support 14 is located. A sheet metal housing 15 is secured to the support 14 and extends around to the base portions 11 of the frame. A hollow enlarged base portion 16 extends forwardly from the frame 10 and provides a support for the spark plug holder. To completely enclose the tester a sheet metal housing portion 17 is secured to the forward supports or extensions 14 and 16 and to the frame 10 therebetween. The housing portions 10 and 17 extend beyond the frame width to allow internal space for the tester mechanism. Side panels 18 attached to the housing portions 15 and 17 close the sides of the housing.

As best shown in Figure 3 the spark plug 20 to be tested is of the conventional shielded type. The plug has a shield 21 separated from the central electrical terminal 22 by the insulation 23 and a threaded portion 24 and shoulder 25 for securing the plug in an engine cylinder. At the end of the threaded portion 24 the electrodes 26 form the spark gap.

A tank 30 is positioned in the hollow base part 16. The rear portion of the tank extends between legs 11. A cylinder 31 closed by a base 32 and having an external shoulder 33 at the other end is positioned in a bore centrally located in the base portion 16. The bore has an annular recess or counterbore to provide a seat for the shoulder 33 of the cylinder 31 which ex-

tends through an aperture in the top wall of tank 30 and into the tank. The aperture is preferably larger than the cylinder to provide an air vent for the self-leveling oil system described below. If the cylinder is sealed to the tank a separate air vent hole may be made in the top wall of the tank on the same side of the baffle 51 as the cylinder. A piston 34 is slidably mounted in the cylinder and an annular seal 35 is located in a recess at the lower end to seal the space between the cylinder and piston. A compression spring 36 engages the cylinder base 32 and the seal 35 to hold the seal in place and to return the piston to its upper position. The piston has a bore 37 preferably smooth to receive the threaded portion 24 of the spark plug, while the spark plug shoulder 25 seats on gasket 38 positioned in a recess at the top of the piston. An annular stop 39 suitably secured to the cylinder shoulder stops upward movement of the piston in the cylinder. The piston is shown in Figure 3 in its upper position above oil entrance holes 40 in the cylinder 31.

The cylinder 31 is positioned in an aperture in the top wall of the tank 30. The fluid level is automatically maintained in this tank by the fluid reservoir 45 which has an air-tight filler plug 46 and a feed pipe 47 connecting the bottom of the reservoir 45 to the bottom of the tank 30. A suitable shut off valve 48 may be used in the feed pipe. A vent pipe 49 connects the top of the reservoir with the top of the tank. A drain plug and fitting 50 is positioned in the tank 30 near the bottom. The tank, the reservoir plugs, the fill and vent pipes are made and connected by air-tight joints such as silver solder. Inside the tank an air-tight baffle 51 is positioned at the top of tank 30 between the inlet and vent pipes and the cylinder aperture and extends down to a point just above the oil entrance holes 40 in the cylinder.

This arrangement will constantly maintain the level of the insulating fluid, such as oil or silicone, surrounding cylinder 31 just above the holes 40. The reservoir 45 is filled through plug 46, plug 46 is then replaced to provide an air-tight seal, and valve 48 opened to allow oil to flow to the tank 30. Since the air may enter tank 30 around cylinder 31 or other suitable vent and flow under baffle 51 to vent pipe 49, the oil will flow to fill tank 30 to the bottom edge of the baffle. When the oil in tank 30 reaches the bottom edge of baffle 51 the flow of air to the vent pipe 49 will be cut off, and thus the oil flow will be stopped at the level of the lower edge of the baffle.

The support 14, which is attached to the center of frame 10 and extends over the base 16, has a bore 55 coaxial with the cylinder 31. A bushing 56 with an external shoulder 57 engaging the upper surface of the support 14 extends through the support. A cylindrical ram 58 is slidably mounted in the bushing. The ram 58 has a recess in the head end to receive a cylindrical head 59, which is held in position by suitable means such as set-screw 60. This removable construction is employed so that the heads of different length may be interchanged to fit spark plugs of different length and to replace the heads when they are worn.

The electrical connections with the spark plug 20 are made by the electrode 65, and the ground connection by the ram 59 contacting the shield of the spark plug. The high voltage potential is applied to the spark plug terminal 22 by a brass contact 66. As best shown in Figure 4 the contact is secured by a screw 67 soldered thereto and embedded in the wire 68 of the insulated conductor 69, which is covered with the conventional flexible rubber insulation. In order to make the protruding portion of wire 68 rigid the insulation 69 is encased in a rigid insulating tube 70 preferably made of glass or plastic which is cemented to the contact 66.

A collector sleeve 71 surrounds the glass tube 70 and terminates in a collector ring 72 which will intercept any arc through the air gap from the contact 66 before it grounds on the spark plug shield 21 or the testing machine head 59. A suitable insulated wire 73 is connected to the collector sleeve 71 and extends alongside of the conductor 69. A sleeve 74 of insulation such as rubber surrounds the collector sleeve 71. The conductor 69 and collector sleeve 71 assembly are positioned and secured in a hollow sleeve 75 of hard insulating material which is slidably mounted in the bore 76 in the ram 58. A light spring is compressed between sleeve 75 and the annular abutment 78 in order to maintain a light pressure on the contact 66 to maintain it in engagement with the spark plug terminal 22. The abutment 78 has a suitable opening to allow the wires 69 and 73 to pass through, and is seated on a shoulder 79 connecting the small bore 76 with the large bore 80. A heavy compression spring 81 is seated on the abutment 78 and is engaged at the top by the round central portion of cross head 82. The arms of cross head 82 extend outward through slots 85 in the ram 58. Stop pins 86 hold the cross head in the ram 58 so that the cross head positively lifts the ram.

In order to actuate the ram 58 a toggle linkage is connected to the cross head 82. This toggle linkage is best shown in Figures 1, 4 and 5. A pair of connecting rod links 90 are pivotally connected at one end to the ends of the arms of the cross head 82. This end of the connecting rod links 90 has a recess 91 to provide space for the washer and cotter 92 or other suitable means which secures the link 90 on the cross head 82. The other ends of the connecting rod links 90 are pivotally connected by the pins 93 to the long levers 94 which extend to the rear of the testing machine where they are pivoted to the rearwardly extending frame arms 12 by pins 95. The handle levers 96 are pivoted by pins 97 which are mounted in pin supports 98 extending from the top of the frame 10. The handle levers 96 have a fixed bend or knee 99 spaced from the pivotal end and suitable apertures for the pins 100 which provide the pivotal connection between each hand lever and the adjacent toggle link 101. A transverse pin 102 is located between the long levers 94 and the reduced ends 103 projecting to provide a pivot for the other end of toggle link 101. Washers may be employed between the various links at their pivot points to space the links to reduce friction. The handle levers 96 extend through slots 104 in the housing portion 15. A handle 105 is mounted between the handle levers 96 and secured in place by a bolt 106 passing through apertures in the levers and handle.

The long lever is normally biased toward the upper or raised position by the spring 107 which is connected by a suitable fastener to the long lever and supported above frame arm 12 by bracket 109 secured to the frame arm. A nut 111 is welded to the long lever to hold an abutment

screw 112 and lock nut which engages and actuates the micro-switch when the lever is almost in the lower position as shown in Figure 6. A bumper 115 is also secured to a long lever 94, such as right-hand one shown in Figures 2 and 5, and bears against the edge of link 101 to stop the downward movement of the lever just after the toggle passes dead center. Figure 6 shows the toggle linkage just before dead center and the handle almost at the end of its path in full lines and the toggle linkage in dot-and-dash lines at the end of the movement just past dead center. Since the toggle is past dead center the linkage locks in the pressure applied position.

The electrical circuit used with this spark plug testing machine forms the subject matter of application Serial No. 29,773 of Wilfred A. Bychinsky, filed May 28, 1948, now Patent No. 2,603,685. In order to show how this electrical circuit is connected to this machine the circuit and a spark plug 20 is mounted in the machine as shown diagrammatically in Figure 7. The circuit is energized by a power source 120 which is preferably 110 volts, 60 cycle alternating current. The source is connected through a micro-switch 121 to the primary coil of transformer 122. The secondary coil of transformer 122 is connected in series with a rectifier 123, a resistance 124 and a condenser 125. Across the terminals of condenser 125 the primary coil of ignition coil 126 is connected in series with a break-down tube 127 which is connected into the circuit by a reversing switch 128. One terminal of the secondary coil of the ignition coil 126 is connected to the spark plug terminal 22 by a conductor 69. The other terminal of the secondary coil of ignition coil 126 is connected to the collector ring 72 and sleeve 71 by conductor 73 having an indicator preferably consisting of a glow tube 129 connected across a resistance 129. This other terminal of the secondary wire of ignition coil 126 is also connected to ground by a conductor 130 having an indicator preferably consisting of a glow tube 131 connected across a resistance 132. A condenser 133 may be connected across the terminals of the secondary coil of the ignition coil 126 in order to tune the coil for optimum output. The position of some of this electrical equipment may occupy in the housing is shown in Figure 2, together with a suitable support 136 for the micro-switch 121 and a clamp 134 for the ignition coil 126 and a bracket 135 for the glow or neon tubes 128 and 131.

Before testing a spark plug the machine is connected to a suitable current source and the reservoir 45 filled with insulating fluid such as oil. At stated above, the oil will flow through fill pipe 47 to fill the tank 30 to the lower edge of the baffle 51. When the oil touches the lower edge of the baffle 51 the flow of air to vent pipe 49 will be stopped, thus the oil flow will stop. The oil will flow through holes 40 to fill the cylinder 31 to this level. The handle 105 and ram 58 are held in the raised position as shown in Figure 2 by the spring 107 to provide room to place the spark plug 20 in position to be tested.

As best shown in Figure 3, the spark plug is heated on the gasket 38 to provide a fluid seal between the spark plug and the piston 34. As the ram 58 moves down the electrode tip 66 contacts the spark plug terminal 22. Further movement compresses spring 77 and then the ram head 59 engages the top of the spark plug shield 21 and moves the spark plug 20 and the piston 34 downward. As the piston starts to move the ports

40 are closed and the oil is trapped in the closed cylinder 31. Further movement of the piston compresses the air inside the tubular threaded portion 24 of the spark plug and forces oil up around the electrodes 26. A very small downward movement of the piston 34 is sufficient to raise the oil pressure to 17 pounds per square inch and this pressure will raise the oil about one-eighth of an inch above the bottom of the spark plug insulator. This oil pressure has been found sufficient to prevent arcing.

The ram 58 is moved down by pulling the handle 105 down. As the hand levers 96 are moved down about pivot 97, the pin 100 is moved downward inwardly. The toggle link 101 which connects pin 100 to link 94 moves from the near horizontal position shown in Figure 2 just beyond the vertical position shown in Figure 6 until the edge of link 101 engages bumper 115. The movement of the lever 94 is transferred to the cross head 82 by a connecting rod link 90. The cross head 82 acts on the ram 58 through a spring 81 which controls the amount of force applied to the spark plug at the normal height or position of the ram. It will be noted that the cross head 82 will move faster than the handle during the initial portion of the movement, but that the cross head will move slower during the final portion of the handle movement. Thus a high mechanical advantage is obtained with the final movement to create the desired high pressure of oil in cylinder 31. The ram spring 81 limits the pressure applied to the plug and insures that substantially the same pressure will be applied to all plugs regardless of small variations in length due to manufacturing tolerances.

The electrode 65 moves with the ram 58 and the contact 66 of the electrode engages the terminal 22 of the spark plug before the ram head 59 engages the spark plug. The electrode 65 is then resiliently held in engagement with the terminal by spring 77, while the ram moves on to engage the shield 21 and further compress spring 77. This is a light spring and merely maintains a light pressure between contact 66 and terminal 22 sufficient for an electrical connection. The collector ring 72 is fixed on the electrode and moves into position at the same time. The distance between contact 66 and collector ring 72 is a little less than the distance between the contact and the nearest ground which is usually the top edge of the shield 21. This arrangement prevents the test current from jumping the air gap to the shield.

The power is turned on by the micro-switch 121, which is actuated by the abutment 112 on lever 94 when the handle 105 approaches the end of stroke. The reversing switch which reverses the polarity of the break-down tube to increase its life may be similarly operated. The voltage is increased by the transformer 122. This current is rectified by rectifier 123 and charges the condenser 125 through resistance 124. The condenser 125 discharges through the break-down tube 127 to the primary coil of ignition coil 126.

The high voltage current from the secondary coil of ignition coil 126 is led by conductor 69 to the terminal 22 on the central electrode of the spark plug 20. Since the spark plug terminals 26 have been insulated at the gap by the oil, the current cannot take the normal path and arc across the spark plug gap. If the spark plug insulator 23 is defective the current will take the shortest path through the insulation 23 to shell

20 or shield 21. Since these parts of the spark plug 20 are grounded to the machine by ram head 59, the current will flow through glow tube 131 to indicate a defective spark plug insulator. If the insulator 23 is perfect and thus prevents the passage of current, the high voltage current will jump the air gap. In order to positively indicate this condition on another indicator a collector ring 72 is positioned adjacent the shield 21 between the shield 21 and the contact 66. Thus any arc through the air from contact 66 on the end of conductor 69 will be collected by the collector ring 72 before it reaches the shield 21, and flow through glow tube 128 to indicate a good insulator 23.

While in the above drawing and specification only a specific embodiment of the invention has been illustrated and described, it will be apparent to those skilled in the art that various modifications and improvements may be made within the terms of the claims.

We claim:

1. In a spark plug testing apparatus, support means for slidably mounting a spark plug having electrodes, and means actuated by the sliding movement of said support means for forcing insulating fluid under pressure around said electrodes of said spark plug for completely insulating the electrodes.

2. In a spark plug testing apparatus, a spark plug having spark electrodes, said spark plug being mounted on a movable member, means actuated by movement of said member for forcing oil under pressure around said eelctrodes, and means for moving said spark plug.

3. In a spark plug testing machine, a frame, a cross head, a hand lever actuated toggle linkage pivoted to said frame and to said cross head, a ram having a spring and a stop mounted thereon reciprocally mounted on said frame, said cross head engaging said spring to move said ram forwardly and engaging said stop to retract said ram, a spark plug engaging said ram, a piston having a bore therethrough engaging said spark plug, a cylinder around said piston having one end closed, means to supply fluid to the closed end of said cylinder, and said toggle linkage through said cross-head and spring moving said ram, said spark plug and piston to place the fluid under pressure.

4. In spark plug testing apparatus, a cylinder having a closed and an opened end, a piston having a bore in the opened end of said cylinder, means to maintain oil in said cylinder, a spark plug having a shell, a terminal and a spark gap positioned in the bore of said piston, a ram engaging said spark plug shell, means to resiliently urge said ram on said spark plug shell to force the spark plug and piston into said cylinder to force oil around said spark gap and a resiliently mounted electrode on said ram engaging said spark plug terminal.

5. In a testing machine for applying fluid pressure to a chambered member, a fluid tank, a cylinder having one end opened and the other end closed positioned in said tank, a piston in said cylinder resiliently held at the opened end of said cylinder, an aperture in the wall of said cylinder just below the inner end of said piston when said piston is resiliently held at the opened end of said cylinder to provide communication between said tank and cylinder, said chambered member being seated on the outer end of said piston, a passage through said piston communicating with the cylinder and the chamber in said member, and means to move said chambered member and said piston into said cylinder to force fluid under pressure into said chambered member.

6. In testing apparatus for applying fluid pressure to a hollow element, a support for the hollow element, a passage through said support adapted for communication with a hollow element, a cylinder closed at one end and slidably receiving said support, a spring to hold said support at the open end of said cylinder, a hole through said cylinder wall beyond the inner edge of said support when said support is at the open end of said cylinder, means to maintain insulating fluid in said cylinder to the level of said hole, and means to move the support into said cylinder.

7. In a testing machine for applying fluid pressure to a chambered member, a frame, a fluid tank, a cylinder having an open upper end supported on said frame and a closed lower end positioned in said tank, a piston in said cylinder resiliently held at the opened end of said cylinder, an aperture in the wall of said cylinder adjacent the inner end of said piston to provide communication between said tank and cylinder, said chambered member being seated on the outer end of said piston, a passage through said piston communicating with the cylinder and the chamber in the member, a ram movably mounted in said frame and engaging and moving said member and piston to force fluid into said member, a spring contacting said ram, a cross head engaging said spring, and a toggle linkage pivoted at one end to said cross head and at the other end to said frame.

8. In spark plug testing apparatus, a frame, a plug support movably mounted in said frame, means actuated by movement of said support for insulating the terminals of a spark plug, a ram for moving said support, a conductor resiliently mounted on said ram, and a toggle linkage for moving said ram.

9. In a spark plug testing apparatus, a frame, a plug support movably and slidably mounted on said frame, means responsive to movement of said support for insulating the electrodes of a spark plug, a ram movably mounted in said frame for moving said support, a conductor resiliently mounted in said ram to engage a spark plug terminal, and a toggle linkage having one end pivoted to said ram and the other end pivoted to said frame to move said plug support to insulate the electrodes of a spark plug.

10. In a spark plug testing machine, a frame, a cross head, a hand lever actuated toggle linkage pivoted to said frame and to said cross head, a ram reciprocally mounted on said frame, said cross head engaging a spring to move the ram forwardly and a stop to retract said ram, a spark plug engaging said ram, a piston having a bore therethrough engaging said spark plug, a cylinder receiving said piston having one end closed, and means to maintain a uniform level of insulating fluid in the closed end of said cylinder.

11. In spark plug testing apparatus, means for slidably mounting a spark plug having electrodes, means actuated by the sliding movement of said means for slidably mounting a spark plug placing the insulating fluid under pressure, and means for conducting insulating fluid to said electrodes to insulate the electrodes.

12. In a spark plug testing apparatus, a spark plug having spark electrodes, said spark plug being mounted on a movable member, said movable member being mounted in a chamber, means for maintaining a constant level of insulating fluid

in said chamber, means for moving said movable member, a passage from the interior of said chamber to said spark electrodes and means controlled by the movement of said movable member into said chamber to seal said chamber and to force insulating fluid through said passage and around said spark electrodes.

13. In a testing machine for applying fluid pressure to a chambered member, a fluid tank, a fluid reservoir located at a higher level, a fluid conduit from the bottom of the reservoir to the bottom of the tank, a baffle sealed in air-tight relation to the top and a portion of each side of the tank with the lower edge positioned at the desired liquid level, a vent conduit from the top of the reservoir to the top of the tank at one side of the baffle, and a vent in the top of the tank on the other side of the baffle whereby the fluid level in said tank is maintained constant.

14. In a testing machine, a frame, a lever pivoted to said frame at one end, a handle at the other end, a toggle link pivoted to the center of said lever, a ram slidably mounted in said frame, and means resiliently connecting in one direction and positively connecting in the other direction said toggle link to said ram.

15. In a testing machine, a frame having a vertical post and a rearward arm and a forward support, a long lever pivoted at one end to said arm, a bell crank lever pivoted at one end to said post, a handle at the other end, a toggle link connecting the center of the bell crank lever pivoted to the other end of said long lever, a cross head, a connecting link pivoted to said other end of the long lever and to said cross head, a ram slidably mounted in said frame support, said cross head being slidably mounted on said ram, a spring resiliently holding said cross head at the top of said ram whereby downward movement of the handle will move the long lever through the toggle and apply resilient pressure on the ram.

16. In testing apparatus for applying fluid pressure to a hollow element, a support for a hollow element, a passage through said support adapted for communication with a hollow element, a cylinder closed at one end for slidably receiving said support, means to move said element and said support into said cylinder to seal said cylinder and to apply fluid pressure to a hollow element, means to retract said support and means operatively associated with said support and cylinder and actuated in response to the retractive movement of said support to maintain a constant fluid level in said cylinder.

17. In a testing machine for applying fluid pressure to a chambered member, a fluid tank having liquid therein, means connected to said tank to maintain a constant fluid level in said tank, a cylinder having a side wall and an open upper end and a lower closed end position in said tank, a piston in said cylinder resiliently held in retracted position adjacent the opened end of said cylinder, said side wall of said cylinder having an aperture adjacent the inner end of said piston when the piston is in the retracted position and just below the liquid level of said tank to provide communication between said tank and cylinder, an annular seat on the outer end of said piston adapted to receive a chambered member, a passage through said piston communicating with the cylinder and the outer end of said piston within said seat to supply fluid to a chamber in a chambered member, and means to move a chambered member and said piston into said cylinder to force fluid under pressure into a chambered member.

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