June 25, 1935. H. C. HEATON 2,005,992

IGNITION SYSTEM

Original Filed Aug. 11, 1930 4 Sheets-Sheet 1

Fig. 1.

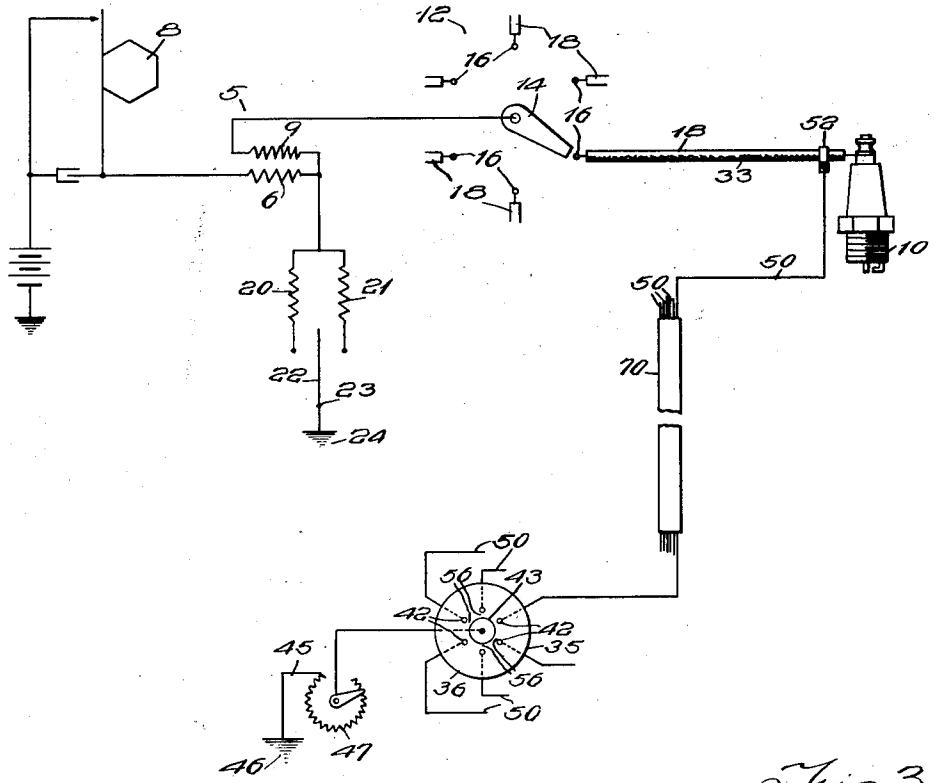


Fig. 2.

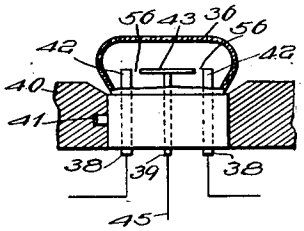
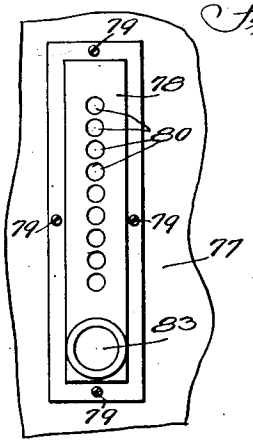


Fig. 3.



Witness:
William P. Kilroy

Inventor:
Herman C. Heaton

By Brown, Jackson, Boettcher & Dienner
Attys.

June 25, 1935. H. C. HEATON 2,005,992

IGNITION SYSTEM

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Fig. 4.

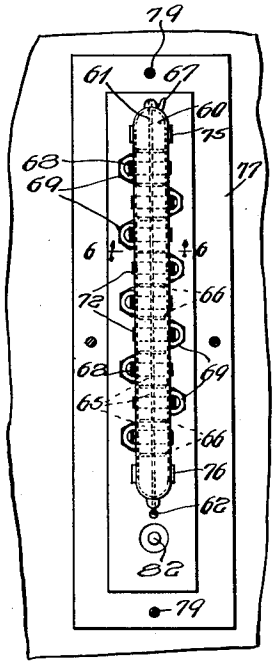


Fig. 5.

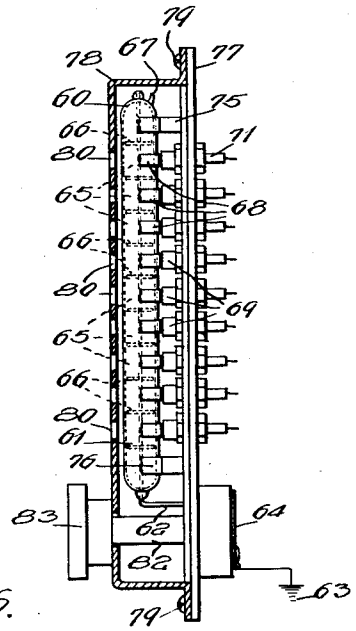


Fig. 6.

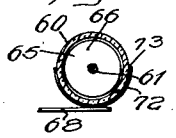


Fig. 7.

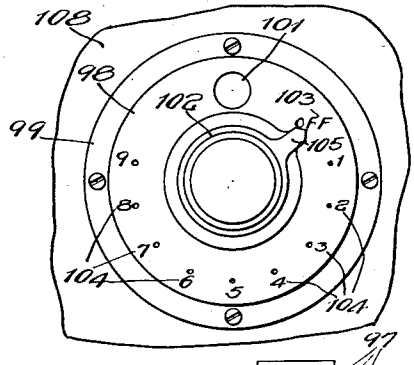


Fig. 8.

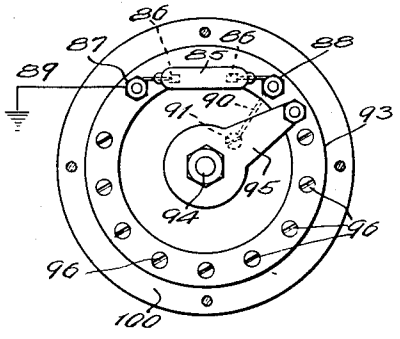
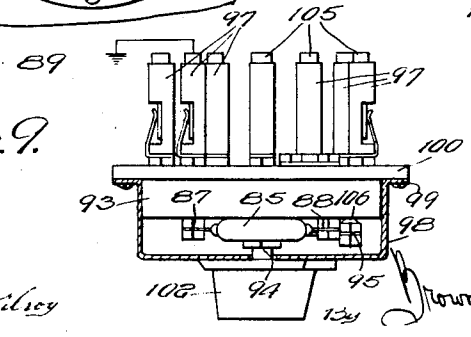


Fig. 9.



Witness:
William J. Kilsey

Inventor:
Herman C. Heaton
By Brown, Jackson, Boettcher & Dierker
Attys

June 25, 1935. H. C. HEATON 2,005,992

IGNITION SYSTEM

Original Filed Aug. 11, 1930 4 Sheets-Sheet 3

Fig. 10.

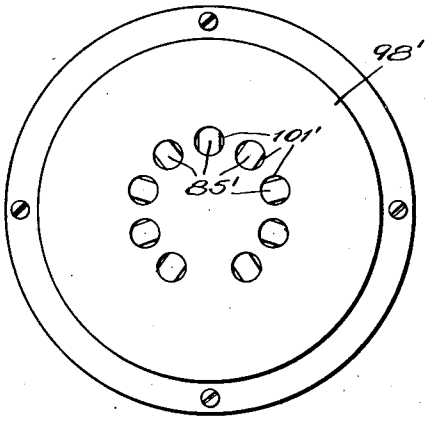


Fig. 11.

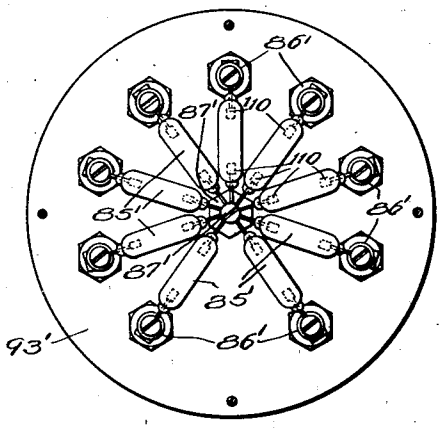


Fig. 12.

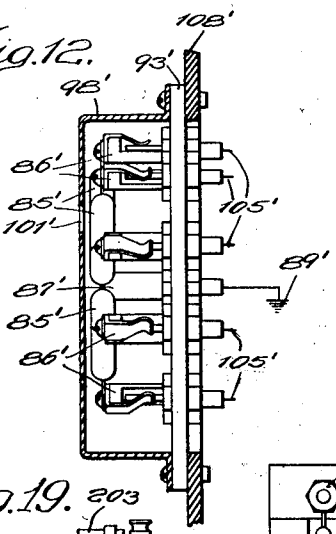


Fig. 13.

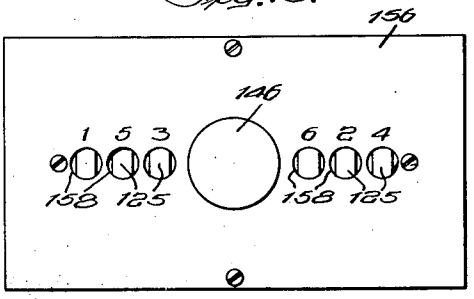


Fig. 19.

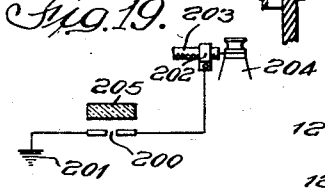
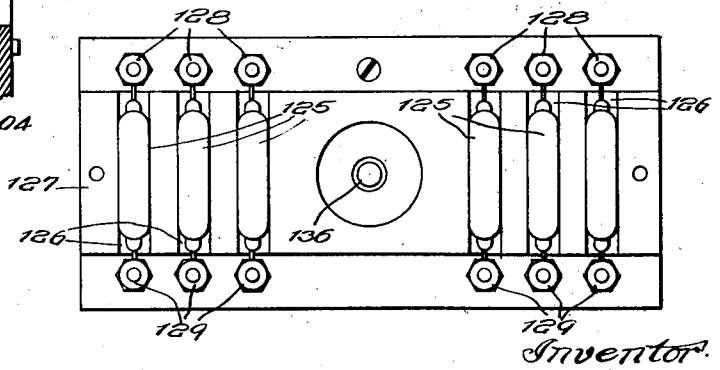


Fig. 14.



Witness:
William P. Wilson

Inventor.
Herman C. Heaton
By Brown, Jackson, Boettcher & Dienner
Attys.

June 25, 1935. H. C. HEATON 2,005,992

IGNITION SYSTEM

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Fig. 15.

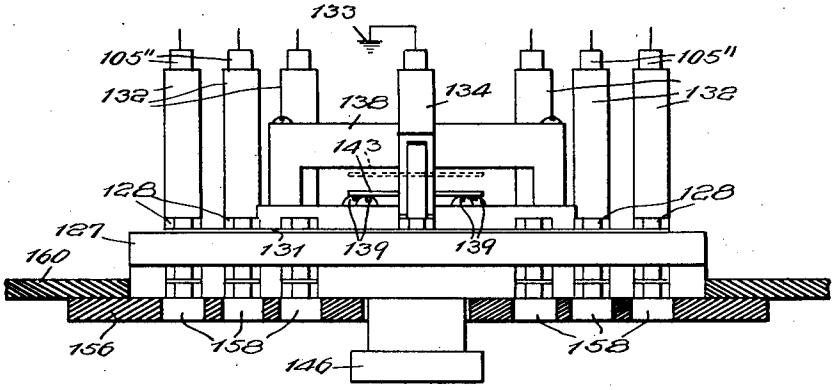


Fig. 16.

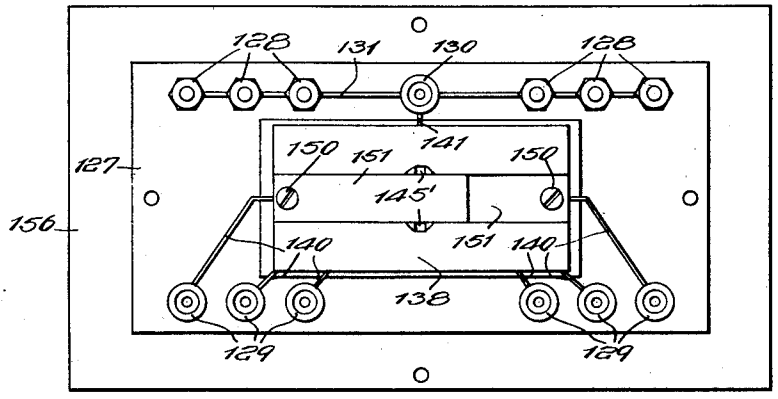


Fig. 17.

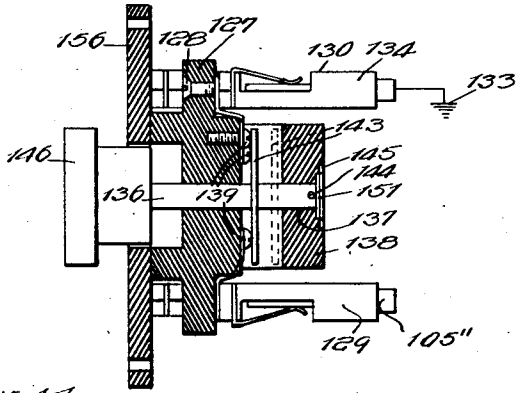
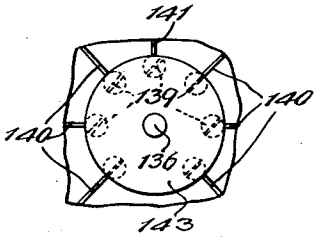


Fig. 18.



Witness:
William P. Kilroy

Inventor:
Herman C. Heaton
By Brown, Jackson, Boettcher + Dienner
Attys

Patented June 25, 1935 2,005,992

UNITED STATES PATENT OFFICE

2,005,992

IGNITION SYSTEM

Herman C. Heaton, Kenilworth, Ill.

Application August 11, 1930, Serial No. 474,341
Renewed November 24, 1934

6 Claims. (Cl. 175—183)

My invention relates to ignition systems, particularly ignition systems for internal combustion engines and contemplates improved means for indicating ignition characteristics.

The indications may be used for indicating the condition of the respective spark plugs and the condition of the respective high tension circuit connections thereto or they may be used for indicating the resistance to passage of the ignition spark across the spark gap or respective spark gaps as related to compression pressures in internal combustion engine cylinders or for indicating any other condition or conditions reflected in the ignition characteristics of the engine.

The present invention provides an improved multiple electrode gaseous tube and contemplates more particularly a multiple electrode tube having a centrally disposed ground electrode and a plurality of electrodes arranged in surrounding relation with respect thereto and adapted for connection with the respective circuits the ignition characteristics of which are to be indicated. It is to be understood that this is with reference to one embodiment of the invention and that numerous other embodiments are contemplated within the scope of the appended claims as will hereinafter appear.

A further provision of my present invention is to suppress within the tube interference from stray currents or the like.

A still further provision is for better defining and better restricting the electron discharges for the respective circuits.

Another provision is for shielding or partially shielding the gaseous tube means to promote better visibility of the indications by eliminating the effect of daylight shining on the face of the instrument.

The present invention still further provides a more compact type of indicator for use upon the instrument board of an automobile, airplane, motor boat or the like.

Other features of the invention will appear from the following detailed description taken in connection with the accompanying drawings, in which:

Figure 1 is a schematic circuit diagram showing an embodiment of the invention;

Figure 2 is a more or less diagrammatic side elevational view of the gas filled or gaseous tube shown in Figure 1;

Figure 3 is a front elevation of another form of instrument embodying my present invention;

Figure 4 is a view similar to Figure 3 with the cover removed;

Figure 5 is a side elevation of the device shown in Figure 4, and with the cover in vertical section;

Figure 6 is a cross section through the gaseous tube shown in Figures 4 and 5 and taken on the line 6—6 of Figure 4;

Figure 7 is a front elevation of another embodiment;

Figure 8 is a similar view of the embodiment shown in Figure 7 with the cover removed;

Figure 9 is a top plan view of the instrument shown in Figures 7 and 8 with the cover in section;

Figure 10 is a front elevation of another embodiment;

Figure 11 is a similar view of the embodiment shown in Figure 10 with the cover removed;

Figure 12 is a side elevation of the embodiment shown in Figures 10 and 11 with the cover in section;

Figure 13 is a front elevation of another embodiment;

Figure 14 is a front view of the embodiment shown in Figure 13 with the front plate removed;

Figure 15 is an enlarged top plan view of the instrument of Figures 13 and 14 and partially in section;

Figure 16 is a rear elevational view of the instrument shown in Figures 13, 14 and 15;

Figure 17 is a detail vertical section taken on the line 17—17 of Figure 16;

Figure 18 is a fragmentary detail elevation; and

Figure 19 is a fragmentary illustrative diagram of another embodiment.

The pilot circuit connection of my Patent No. 1,931,225, granted October 17, 1933 is preferably employed in connection with the indicating means of my present invention and I shall therefore describe the present invention in connection therewith but it is to be understood that this may vary and the appended claims are therefore drawn accordingly.

In the diagram of Figure 1 a spark coil designated at 5, has a primary winding 6 intermittently connected to a source of low potential current by means of an interrupter 8 and a secondary winding 9 which forms a source of high potential ignition current for the spark plugs 10.

The ignition current is distributed to the plugs or ignition devices 10 by means of a distributor 12. The distributor 12 has a distributing arm 14 which may be maintained in permanent connection with the secondary winding of the coil 5, as by means of a slip ring connection, and distributes the ignition current by rotation around

contacts 16 to which the spark plugs 10 are individually connected by the high tension leads 18.

The outer end of the arm 14 may contact directly with the contacts 16 successively in its rotation, or it may, in conjunction with these contacts 16, close the respective circuits 18 through relatively small gaps to avoid unsatisfactory contact through carbonization or otherwise, after use. The distributor 12 as well as the interrupter 8 may be operated from the timing gears of the engine in the usual or any preferred manner as well understood in the art.

The circuit, as thus far described, is illustrated for the purpose of acquainting those skilled in the art with one embodiment of my present invention. This circuit may be the circuit of any suitable or preferred ignition system and may vary. The impedances 20 and 21 correspond with the impedances 20 and 21 of Figure 1 of my copending application, Serial No. 365,934, filed May 25, 1929, and may be provided for plug and circuit testing purposes in accordance with the disclosure of that application. A suitable switch arm 22, pivoted at 23, is adapted for selectively completing either of the parallel or shunt paths through the impedances 20 or 21 to a ground connection 24.

High tension insulated cables are shown in or as the high tension leads 18 to the plugs 10. The particular cable shown is more fully disclosed in my Patent No. 1,931,225, of October 17, 1933. Suffice it to say that each of these cables comprises an inner conducting core with an electrostatic shield surrounding the conducting core with insulation between the inner conductor and the shield and insulation 33 covering the shield, the shield being in the form of a metal braided layer and the insulating covering 33 being preferably waterproof, as for example of shellaced fabric.

The indicating means shown in Figures 1 and 2 is in the form of a single gaseous or gas filled tube 35 common to all of the high tension leads 18.

The particular tube 35 shown comprises a suitable bulb 36 having a base 37. The base 37 may be formed of insulating material or is at least formed to insulate the terminals 38 from each other and from the central terminal 39. It is preferably adapted for mounting in support 40 and may have means such as slot and pin means 41 for retaining it in mounted position. The terminals 38 and 39 which extend through the base 37 are the terminals of electrodes 42 and 43 disposed within the bulb 36, the electrode 43 comprising a disc-like electrode centrally disposed and the electrodes 42, there being one of these electrodes 42 for each high tension lead 18, surround the electrode 43 and are spaced equidistant circumferentially from each other and radially from the electrode 43. The electrode 43 is connected through a lead 45 to ground at 46. A rheostat 47 may be provided in the ground lead 45. As illustrative of an actual embodiment of the invention a 200,000 ohm rheostat is contemplated at 47, the adjustable arm for adjusting the rheostat to ground being indicated at 48.

The terminals of the electrode 42 are connected to the respective high tension leads 18 by pilot wires 50, one of the pilot wires 50 being connected to each terminal 42 at one end and at the opposite end each wire 50 has capacity connection with the respective cables 18 through the insulation thereof. These capacity connections are, in the illustrated embodiment, obtained by terminal clips 52 one on each end of the wires 50 and one clip is connected to the electrostatic shield of each of the respective cable leads 18 as, for example, in the manner more fully disclosed in my patent above referred to. A containing cable sheath 70 may be provided for the wires 50, if desired.

In operation as the spark impulses occur successively at the respective plugs 10 discharges occur successively across the gaps 56 between the respective electrodes 42 and the ground electrode 43. The presence or absence of a discharge across any of the gaps 56 will indicate the presence or absence of a spark impulse at the associated plug 10. The pilot connection illustrated takes off and supplies but very slight electrical impulses to the gaseous tube 35 with the result that differences in current to the plugs or in the respective plug leads will be indicated or reflected by different degrees of illumination across the respective gaps 56, the different positions of the different gaps 56 annularly about the central disc electrode 43 indicating which plug or plugs it is the condition of which is to be indicated. The bulb 36 or the panel or support therefor may be marked with markings disposed adjacent the respective gaps 56 and corresponding with the firing order of the cylinders of the particular engine. These markings may, of course, be provided without arranging them upon either the bulb 36 or the panel or support therefor, as feasible or desired.

Accordingly, I obtain visual indications of the ignition characteristics through indications shown by the gas filled or gaseous tube 35 actuated by electrical impulses picked up from the high tension leads by the high tension cable shields and transmitted through the pilot wires 50 to the respective electrodes of the tube.

The indications may be used, as already pointed out, for indicating the condition of the respective spark plugs and the condition of the respective high tension circuit connections thereto or they may be used for indicating the resistance to passage of the ignition spark across the spark gap or respective spark gaps as related to compression pressures in automotive engine cylinders or for indicating any other condition or conditions reflected in the ignition characteristics of the engine.

The capacity connections between the pilot wires 50 and the high tension leads are preferably disposed in close proximity to the respective plugs 10. When these connections are placed at the lower end of the respective cables adjacent to the spark plugs the effect of leakage charges at or near the distributor head are avoided.

In actual practice I have utilized a variable resistance in the ground circuit at 47 having a maximum value of 200,000 ohms. I find that this serves as a means for adjusting the operation of the ground connection and that it tends to suppress stray currents which emanate from high potential leakage between the terminals of the distributor head which might otherwise be the source of interference. This interference is also increased by capacity effects between the individual conductors in the pilot wire cable and the use of shielded pilot wires to overcome this latter effect is contemplated.

I find that the central electrode 43 serves to define and restrict the electron discharge from each incoming electrode and that a clear demarcation of the indications for a multi-cylinder or a multi-spark system is obtained.

I have referred particularly herein to "neon" tube or "neon" tubes, but it is to be understood

that the particular gas or gases in the tube or tubes may vary. I intend to include any equivalent gaseous tube or tubes regardless of the particular gas employed. For example, "neon" is now commonly used where a red light is desired, argon and mercury vapor, or the like, for a green light, and argon and some other chemical in "neon" gas, for a blue light. I find that a gaseous tube of this sort is extremely sensitive and requires but a very slight actuating current. I also find that the slightest differences in current or irregularity of current passed through such tube will, with the pilot connections referred to, show up at once in the tube by differences in the illumination thereof and that there is a point where the tube lights or ceases to light. The lagging factor is negligible and these characteristics are all admirably adapted for the present purposes. There is no afterglow, as compared with that in an incandescent filament lamp and this is further important in providing sharp demarcations between indications where the tube is used for successively conveying different indications as successively the indications of the condition of the different spark plugs of a multiplug engine, or successively the condition of the circuit connections or other conditions reflected in the ignition characteristics to the different plugs.

The use of a partially evacuated vacuum tube or a plurality of partially evacuated vacuum tubes without such gas or gases as above described is also contemplated within the scope of my present invention.

Provision may be made for shielding or partially shielding the tube means **35** to promote visibility of the signals by eliminating the effect of the daylight shining on the face of the instrument. Such shielding means is shown in connection with the embodiments to be hereinafter described and while not shown in connection with this particular embodiment may be employed therewith.

In the embodiment of Figures 3, 4 and 5 the elongated gaseous tube **60** has a ground wire **61** extending substantially axially through the interior of the tube. One end of the wire **61** leads out from the end of the tube at **62** for connection to ground at **63**. A rheostat **64** may be provided in the ground connection as in the previous embodiment for varying the resistance to ground for the purposes previously explained.

Internally the tube **60** is divided into a plurality of compartments **65** by metal discs **66**. The ground wire **61** passes centrally through the discs or partitions **66** which may be supported and held in uniform spaced relation by soldering or fastening them to the wire **61**. The discs **66** preferably have free or loose fit within the tube **60** or equivalent provision is made for placing all of the compartments **65** in communication with each other and with the end compartments of the tube. This permits filling the entire tube with gas through one opening which may be at the end of the tube. As the gas enters it will pass around the discs **66** and distribute itself uniformly through the compartments **65**. After filling the tube the opening therefor may be sealed at **67** (Figure 5).

Each compartment **65** is provided externally of the glass wall of the tube **60** with an electrode **68**, one for each of the high tension leads or circuit connections from the distributor to the respective spark plugs. In Figures 4 and 5 these electrodes **68** are in the form of spring conducting fingers pressing yieldingly at or near their outer ends into contact with the outer surface of the tube **60**. Each of the electrodes **68** is carried by and electrically connected with a terminal connector **69** by means of which the electrodes **68** are connected to the pilot wires **71** leading to the respective leads from the distributor to the plugs **10**. A band of tin foil or equivalent material **72** is interposed between the tube **60** and each electrode finger **68** for the purpose of increasing the field of action of the electrodes **68**. The bands **72** may be secured directly to the outer surface of the tube **60** by suitable adhesive and each band while extending around the back and forwardly along the sides of the tube **60** is preferably open at the front as indicated at **73** so as to not interfere with clear vision of the interior of the compartments **65** from the front of the instrument. Pieces of mineral wool may be used between the electrodes **68** and the outer surface of the tube **60** in place of the tin foil pieces **72**.

In this embodiment the electron discharges occur successively from the respective electrodes **68** through the conducting pieces **72** as well as through the wall of the tube **60** and the gas content of the tube to the ground electrode or ground wire **61**. Obviously, as the spark impulses occur successively at the respective spark plugs discharges occur successively through the respective compartments **65** in the order of firing of the plugs. Suitable identifying means may be employed adjacent the respective compartments **65** for identifying each compartment with the plug or circuit with which it is connected.

I contemplate in this and the other embodiments placing suitable identifying markings directly upon the wall of the tube.

The gas filled tube **60** may be mounted near its opposite ends at **75** and **76** upon a panel or support **77**. A cover **78** encloses and shields or partially encloses or partially shields the tube **60** to promote better visibility of the indications by eliminating the effect of daylight shining on the face of the tube. This cover **78** may be secured to the support **77** at **79** and the front of the cover is provided with a vertically arranged series of openings **80** aligned with each of the compartments **65** to afford clear vision of the indications. The markings for identifying the compartments **65** with the plugs or circuits with which they are connected may be placed vertically along the outer surface of the front of the cover **78** adjacent the openings **80**.

The rheostat **64** may be mounted upon the support **77** with its shaft **82** extending through the front of the cover **78** and provided with a finger piece **83** for turning the shaft to vary the ground resistance.

With the discs **66** separating the interior of the tube **60** into a number of compartments one for each of the plugs or circuit connections the electron discharges for the respective high tension circuits are restricted and the indications are clear cut. The compartments may be relatively small enabling the use of shorter tubes and providing a more compact type of indicator for instrument board mounting. I find that with a space of only $\frac{3}{8}$ of an inch between adjacent discs **66** I am enabled to obtain clear cut indications.

In the embodiment shown in Figures 7, 8 and 9 the single relatively small gaseous tube **85** has electrodes **86** one of which is connected to a terminal **87** and the other to a terminal **88**. One of these terminals is grounded at **89**. The other

terminal 88 is connected by a wire 90 with a contact terminal 91. All of these terminals and the tube may be carried by an insulating supporting base 93 in which a shaft 94 is rotatably mounted. This shaft 94 carries a contact arm 95 the outer end of which is swingable successively into and out of contact with contacts 96, there being one contact 96 for each of the spark plugs or circuits the ignition characteristics of which are to be indicated. The contacts 96 may be mounted in the insulation block 93 and may be provided with connectors 97 to which the pilot wires may be connected. The inner end of the arm 95 has constant wiping contact with the contact 91 so that as the outer end of the arm is swung into contact with the respective contacts 96 the respective plugs or circuits will be connected to one side of the tube 85 through the arm 95, contact 91, wire 90 and terminal 88, and the other side of the tube being grounded at 89 the tube will indicate by the presence or absence of an electron discharge or by variations in the intensity of the discharge the ignition characteristics of the respective high tension circuits to the plugs.

A cover 98 fits telescopically over the block 93 and is flanged at 99 and secured to the flange 100 on the block 93. The outer face of the cover 98 has an opening 101 through which the indications conveyed by the tube 85 are visible and the shaft 94 extends out through the front of the cover and is provided with a finger piece 102 for turning the contact arm 95. An "off" position is indicated at 103 and markings are provided at 104 which in conjunction with the pointer 105 on the knob 102 indicates which plug or circuit it is that is connected to the tube 85.

The ground contact 87 is provided with a similar connector 97. It will be apparent that in this device the single tube 85 indicates the ignition characteristics of the different lines and that the connection of the tube to the respective pilot wires 105 for the respective lines is manually controlled. The outer end of the contact arm 95 has a ball-like contact indicated at 106 in Figure 9 for contact with the contacts 96. The contact 106 is shown out of contact with all the contacts 96 in Figure 8 and nine contacts 96 are shown, suitable for a nine-plug engine but the number will vary, of course, where the engine has more or less than nine plugs. The base 93 is shown as attached to a panel or other support 108 in Figure 7.

In the embodiment illustrated in Figures 10, 11 and 12 individual gaseous tubes 85' are provided, one for each of the pilot wires 105'. These tubes 85' have fixed position radially between a center ground terminal 87' and surrounding terminals 86' to which the pilot wires 105' are connected as indicated diagrammatically in Figure 12. The central ground terminal 87' is adapted to be grounded at 89' and the tubes 85' are shown as provided with electrodes 110.

The terminals 86' and 87' are all mounted upon an insulating base 93' and in this case the outer wall of the cover 98' is provided with a number of openings 101', one for each of the tubes 85'. The instrument is shown as attached to a panel or support 108', which may be the dash of an automobile, or the instrument board of an airplane or motor boat or any other suitable support as in the other embodiments.

In the embodiment of Figures 13 to 18, inclusive, the gaseous tubes 125 are arranged in generally parallel relation in pockets 126 in an insulating base 127 and are connected at their upper ends to terminals 128 and at their lower ends to terminals 129 mounted and insulated from each other on the base 127.

The terminals 128 are connected together and to a ground terminal 130 by a wire 131 (Figure 16). The terminals 129 are provided on the back side of the base with connectors 132 to which the pilot wires 105'' to the respective spark plug circuits are connected. The ground terminal 130 is adapted to be grounded at 133 (Figure 15). The ground terminal 130 is provided with a similar connector 134.

Rotatably journaled in the base 127 is a shaft 136 the inner end of which rotatably bears at 137 in an insulating bridge piece 138 mounted upon the back of the base 127. Mounted on the base 127 are a plurality of contacts 139 annularly disposed around the post 136. One of these contacts is connected by a wire 140 with each of the terminals 129 and the remaining contact 139 is connected by wire 141 (Figure 18) with the ground terminal 130.

Fixed upon the post 136 is a metallic or conducting disc 143 which when in the position shown in Figures 15 and 17 contacts all of the terminals 139, thereby connecting all of these terminals 139 to ground at 133. At its rear end (Figure 17) the post 136 is provided with a pin 144 which operates in a cam slot 145 in the bridge piece 138 so that by turning the handle 146 on the outer end of the post 136 this post or shaft 136 is shifted axially rearwardly by the travel of the pin 144 in the slot 145. This rearward travel of the shaft 136 moves the disc 143 out of contact with the terminals 139 and into the position shown in dotted lines in Figure 17, thus disconnecting the ground connection from all of the tubes 125.

In operation when the disc 143 is in the position shown in full lines in Figure 17, the circuits through the respective tubes 125 are completed successively with the completion of the respective ignition circuits to the various spark plugs. With the disc 143 in the position shown in dotted lines the ignition system may continue to operate without operating the indicating tubes. The knob 146 manually determines whether the indicating tubes are connected to operate with the operation of the ignition system or are disconnected therefrom. A pair of leaf springs secured at their outer ends at 150 to the bridge piece 138 overlap at their inner ends and the overlapping ends cooperate with the rear end of the shaft 136 to hold the pin 144 in the cam slot 145 and to yieldingly urge the disc 143 into contact with the terminals 139 when in its full line position. The engagement of the pin 144 in the slot 145 may be self-retaining or means such as the diametrical opposite depressions 145' (Fig. 16) may be provided for retaining the shaft 136 with the disc 143 in the position shown in dotted lines when said disc is moved to that position. The leaf springs are designated 151, and these springs also hold the pin 144 in the slot 145. A front plate 156 covers the outer surface of the base 127 and the tubes 125. This plate 156 is provided with openings 158, one for each of the tubes 125 and horizontally aligned for vision of the indications conveyed by the tubes. These openings 158 may be marked to correspond with the firing order of the particular engine as in Figure 13 and the entire instrument may be attached to a panel or other support 160 as in the other embodiments.

The pilot wires of the embodiments shown in Figures 3 to 18 may be connected to the high tension leads from the distributor to the spark plugs in the manner disclosed in Figure 1 and with the

description of these embodiments together with the description of Figure 1 it is believed that the operation of the various embodiments of the invention will be apparent without further explanation.

I have also provided for suppressing interference in the manner set out in connection with the rheostat but internally of the tube means instead of by means of an external ground resistance. I accomplish this by proportioning the gas content of the gaseous tube or gaseous tubes to secure the desired electrical resistance characteristics. I believe that this is broadly new and I find that in this manner interference from stray currents or the like may be suppressed.

One or more spark gap indicators may be employed in place of the indicating tube or indicating tubes within the scope of the present invention. This is shown diagrammatically in Figure 19 where a spark gap indicator shown at **200** is grounded on one side of the indicating spark gap at **201** and is connected on the other side at **202** with the high tension lead **203** to the spark plug **204** in the manner described in connection with Figure 1. It is to be understood that for a multi-cylinder engine or a multi-spark plug engine one of these indicating gaps **200** may be provided for each of the high tension leads to the respective spark plugs. Where such a spark gap indicator or a group of spark gap indicators are employed a suitable lens or a group of lenses may be provided for optically magnifying the spark gap indications. Such a lens is shown more or less diagrammatically at **205** in Figure 19.

I further contemplate providing a shielded cable in or as the high tension lead from the coil **5** to the distributor **12** (Fig. 1) and connecting a gaseous or other tube with the shield of such a cable in a manner similar to the connection of the wires **30** of Figure 1 to the shields of the cable leads **18**. A gaseous or other tube so connected could be used as an indicator, marker, signal or sign for any suitable or preferred purpose. A spark gap indicator so connected is also contemplated.

I find that with the indicating means connected to the high tension leads to the respective spark plugs in the manner herein disclosed where a spot light is mounted in the windshield of the automobile, for example, a condenser-like discharge occurs from this spot light to the windshield and that this discharge various with the action of the gaseous indicating tube or tubes.

I further contemplate controlling the sensitivity or the action of the tube or tubes by altering the design of the electrodes.

I further contemplate suitably arranging the electrodes which are connected with the respective high tension leads to the plugs and employing a ring-like or surrounding ground electrode about the electrodes which are connected with the high tension leads.

I further contemplate providing a shielded cable in or as the high tension lead from the coil **5** to the distributor **12** (Fig. 1) and then instead of grounding one side of the indicating tube or tubes I propose connecting that side of the tube or tubes with the shield of such cable.

I claim:

1. A system for indicating the operating characteristics of a plurality of high tension electrical circuits including means for successively energizing said circuits, shielded high tension conductors between said engaging means and said circuits, a tube filled with a gas providing for visible low tension discharges therein, a disc disposed centrally in said tube and connected to ground, a plurality of electrodes sealed in said tube in spaced relation about the periphery of said disc and electrostatically connected to said high tension conductors, and means for varying the resistance between said disc and ground.

2. A system comprising a plurality of high tension electrical circuits, means for successively energizing said circuits, electrostatic connections from said circuits to an indicating device, a common ground electrode disposed within said indicating device, a plurality of electrodes spaced from said ground electrode and connected to said electrostatic connections, a resistance between said common electrode and ground, and means for varying said resistance in accordance with the strength of stray currents incident to the energization of said circuits.

3. Means for indicating the operating characteristics of a plurality of successively energized high tension electrical circuits having shielded high tension conductors connected thereto, comprising a plurality of individual chambers formed in a single gaseous tube, means for defining each of said chambers and providing for gaseous communication therebetween, a common ground electrode extending through all of said chambers and securing said defining means in fixed position within said tube, and a plurality of electrodes having shielded low tension connection to each of said conductors, each of said electrodes engaging the periphery of one of said chambers.

4. Indicating means comprising an elongated tube filled with gas providing for visible low tension discharges, a plurality of spacing means defining individual discharge chambers within said tube, a common ground electrode extending axially through said tube centrally of said chamber, a plurality of electrodes electrostatically connected to the conductors of a plurality of high tension circuits and engaging said tube adjacent corresponding chambers whereby successive operation of said circuits causes successive discharges in the respective chambers.

5. A system comprising a plurality of high tension electrical circuits, means for successively energizing said circuits, electrostatic connections from said circuits to an indicating device having a plurality of spaced indicating chambers, a common ground electrode disposed within and extending through all of said indicating chambers, a plurality of electrodes connected between said electrostatic connections and said chambers, a resistance between said common electrode and ground, and means for varying said resistance.

6. An indicating device comprising a gaseous tube, means defining a plurality of individual indicating chambers in said tube, a common ground electrode extending through all of said chambers, a plurality of positive electrodes, each of said positive electrodes having peripheral engagement with one of said chambers, a resistance between said common electrode and ground, and means for varying said resistance.

HERMAN C. HEATON.