March 31, 1953 M. INGRAM 2,633,116

SHIELDED SPARK PLUG

Filed Nov. 2, 1949 2 SHEETS—SHEET 1

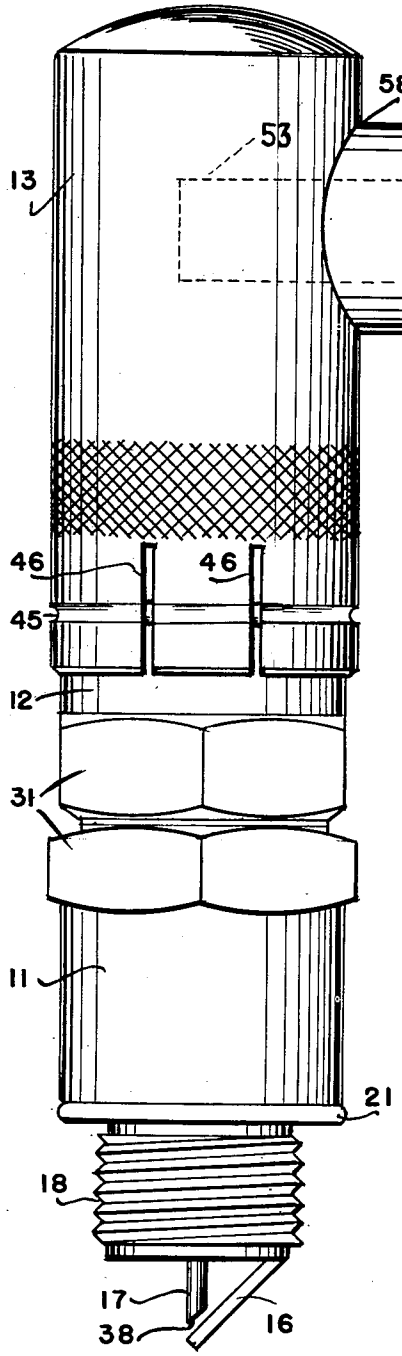


FIG. 1.

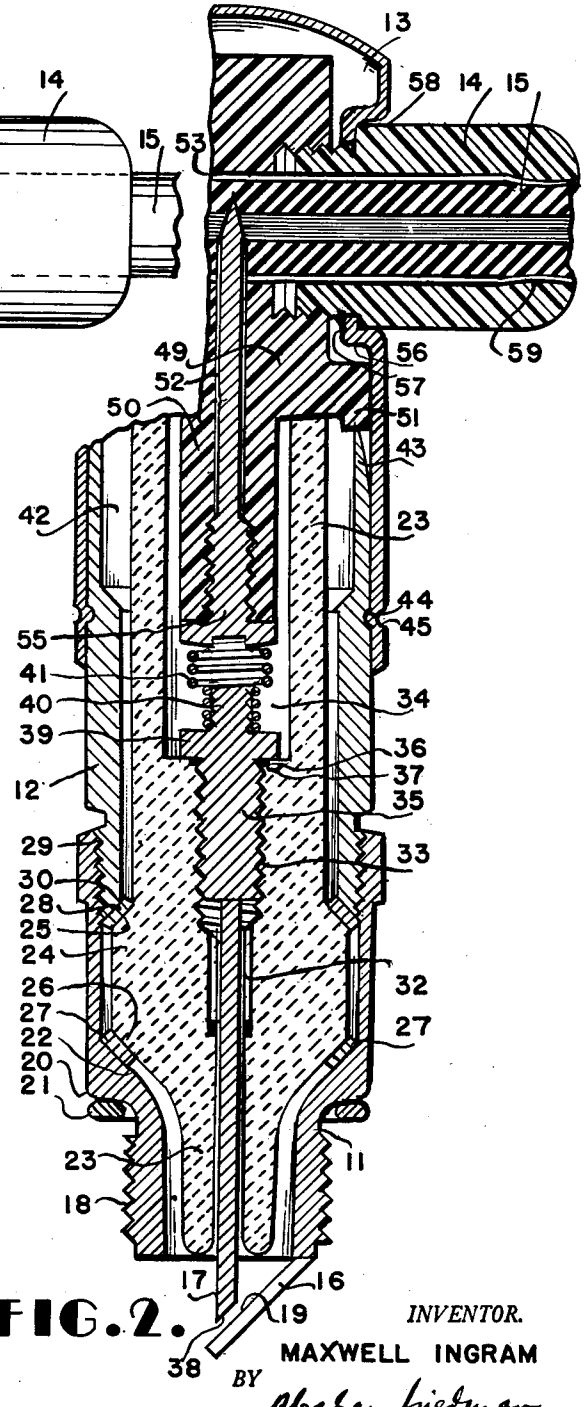


FIG. 2.

INVENTOR.
MAXWELL INGRAM
BY Abraham Friedman

March 31, 1953 M. INGRAM 2,633,116

SHIELDED SPARK PLUG

Filed Nov. 2, 1949 2 SHEETS—SHEET 2

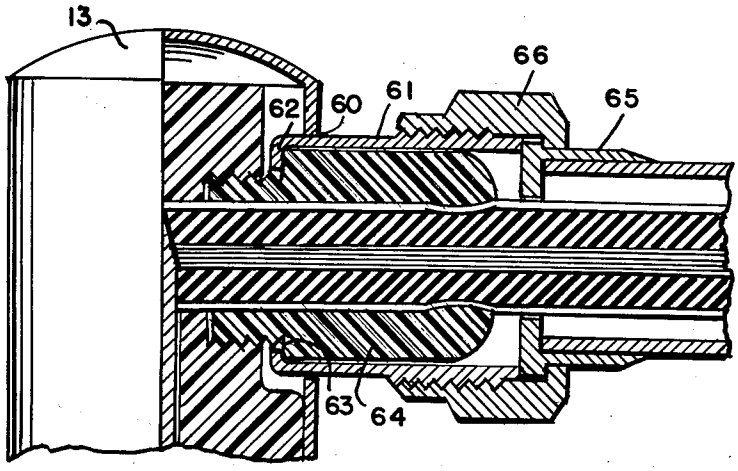


FIG. 3.

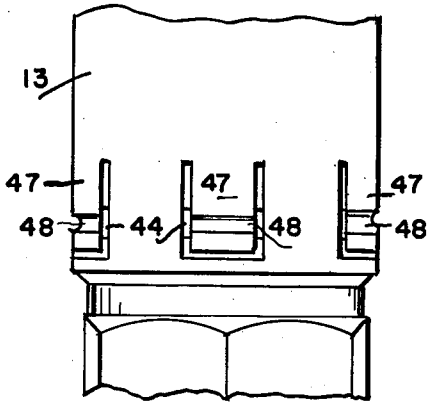


FIG. 4.

MAXWELL INGRAM

INVENTOR.

BY Abraham Friedman
Atty.

Patented Mar. 31, 1953

2,633,116

UNITED STATES PATENT OFFICE

2,633,116

SHIELDED SPARK PLUG

Maxwell Ingram, Dumont, N. J., assignor, by mesne assignments, to Leonard Spark Plug Co., Inc., a corporation of New Jersey

Application November 2, 1949, Serial No. 125,108

7 Claims. (Cl. 123—169)

1

This invention relates to new and useful improvements in a spark plug, and more particularly to a spark plug enclosed in a metallic shield.

It is an object of this invention to provide a spark plug with efficient shielding means for the purpose of preventing the radiation of electrical interferences from the spark formed therein in order to avoid interferences with the operation of radio and electronic equipment.

It is a further object of this invention to provide a spark plug having a shielding and cover assembly which may be readily and disengageably assembled and which is formed of parts capable of being efficiently and economically manufactured and assembled.

It is an additional object of this invention to provide a shielded spark plug arrangement wherein the high and low potential sections of said plug are adequately isolated and insulated from one another in such manner as to provide against the formation of leakage paths therein.

Another object of this invention is to provide a shielded spark plug arrangement wherein the entrance of moisture which might impair the operation of said plug is largely prevented and wherein means are provided for entrapping such moisture as may find its way into said plug.

It is a further object of this invention to provide a spark plug arrangement of the shielded variety wherein air spaces are so formed as to provide for a more even distribution of the heat engendered therein thereby preventing the impairment of the operation of said plug or the rupture of ceramic insulating means provided therein.

Another object of this invention is to provide said spark plug with efficient means for assuring electrical continuity between the sections of the high potential electrode positioned therein and the ignition cable connected thereto.

A still further object of this invention is to provide a shielding cap arrangement for said plug formed of two sections of insulating material surrounded by a one piece shell which may therefore be of sheet metal and which may be readily assembled and sealed and is adapted to retain a section of the high potential electrode as well as an ignition cable connected thereto in a convenient position.

A still further object of this invention is to

2

provide a shielding cover arrangement for said plug wherein an ignition cable may be readily connected to the high potential electrode thereof and provision is made for efficient insulation between the shielding portion of said cover and the high potential elements retained therein.

An additional object of this invention is to provide said plug with positive and negative cooperating electrode surfaces such that a highly efficient spark area is produced thereby.

Other and further objects of this invention will become apparent from the description thereof contained in the annexed specifications, or will otherwise become obvious. It will be understood that the invention here disclosed may be employed for other purposes to which the structure and arrangement are adapted.

Figure 1 is a side elevation of said shielded spark plug,

Figure 2 is a cross-section of the spark plug shown in Figure 1,

Figure 3 is a fragmentary view of a portion of the cover of the shielded spark plug, partly in cross-section showing a modified arrangement for securing an ignition cable therein, and

Figure 4 is a fragmentary view of the spark plug showing a modified form of means for disengageably securing the shielding cover in position.

The spark plug comprising the present invention is illustrated in Figure 1 of the drawings and comprises a body shell 11 which is secured to an intermediate body shield 12 and surmounted by a shielding cover 13 in engagement with said intermediate shield. A terminal tube 14 is provided on said cover to permit the entry of an ignition cable 15 therein. Ground and center electrodes are shown at 16 and 17 respectively.

As is more particularly shown in Figure 2, body shell 11 forms the main supporting body for said spark plug. Said shell is formed of metal and is provided with a lower portion of reduced diameter on which threads 18 are formed for the purpose of permitting the attachment of said plug to the body of an internal combustion engine and is well known in the art. Depending from said lower portion of the shell is ground electrode 16. Said electrode may be formed of an electrically conductive solid bar or wire of square or rectangular cross section, it having been found advantageous to form said electrode so as to pre-

sent a plane upper surface 19 to the face of the complementary center electrode 17 as will more clearly appear hereafter. Although the ground electrode may be formed integrally with the shell, it has been found advantageous to form these elements separately and then weld them to each other. It should also be noted that the ground electrode 16 is oriented at an angle with respect to the plane of the lower end surface of said shell. As a result of the reduction in diameter in the lower portion of the shell, a shoulder 20 is formed thereon which is adapted to be seated upon an engine block or cylinder head. Gasket 21 is interposed between said elements in order to provide for a gas tight seal between the engine and the spark plug as well as for the purpose of providing a desirable thermal and electrical conductive path therebetween. Shell 11 is further provided with an internal annular shoulder 22 whereon main body insulator 23 is adapted to be seated, as will more clearly appear hereafter.

Principal insulation between the grounded portions of said spark plug and the high voltage portions thereof is accomplished by means of main body insulator 23. Said insulator is formed of a ceramic or similar insulating material and is positioned within shell 11. The diameter of the insulator is enlarged at 24 as a result of which upper and lower annular shoulders 25 and 26 respectively are formed thereon. Gasket 27 is interposed between shoulder 22 on the shell and the lower shoulder 26 on the insulator; a similar gasket 28 being seated upon upper shoulder 25. Insulator 23 is firmly secured in position in shell 11 by the clamping action of intermediate shield 12. The shield is provided with a threaded lower portion which terminates in a beveled end 30 adapted to be seated upon gasket 28. Upon the threaded engagement of the internal threads on shell 11 with the external threads on the lower portion of the shield as shown at 29, the insulator is clamped tightly into position; the gaskets serving to provide gas tight seals as well as heat conducting paths from the insulator to the engine body and external atmosphere through the shell and shield. A hexagonal or similar surface may be provided upon a portion of the shell and shield as shown at 31 for the purpose of permitting said elements to be clamped tightly and to be mounted on an engine block by means of wrenches or similar tools.

Insulator 23 is provided with an axial bore 32 which is enlarged and threaded at 33 and further enlarged to form cavity 34. Positioned within axial bore 32 is center electrode 17 which is provided with a threaded upper portion 35 whereby it is secured in position in the insulator. A small gasket adapted to be firmly seated at the lower end of the enlargement in axial bore 32 snugly surrounds center electrode 17 thereby forming a seal therewith. The threaded portion of the insulator is counterbored at 36 for the purpose of receiving a sealing cement 37 to provide an appropriate gas pressure tight seal and to secure said parts to each other more firmly. The center electrode is solid throughout and of circular cross section; the lower edge thereof being beveled as shown at 38 thereby presenting an oval or elliptical solid surface area to the ground electrode of substantially greater area than the normal cross section thereof. As has heretofore been indicated ground electrode 16 presents a plane upper surface 19; said surface lies in a plane parallel to the plane of the elliptical surface of the center electrode. As a result of this arrangement the electrodes present substantial parallel solid surface areas to each other and produce a larger and more uniformly distributed spark area between the electrodes. The formation of both the ground and center electrodes from solid material provides good thermal conductivity to carry away and distribute the heat of the spark.

Center electrode 17 is further provided with a flange 39 which seats upon the lower rim of the wall of cavity 34 and determines the degree to which the electrode is extended through the bore of the insulator thereby determining the spacing between the electrodes. Said flange also acts to complete the seal between bore 32 in the insulator and the center electrode. Boss 40 is formed on the upper end of the center electrode and is adapted to be surrounded by helical spring 41 which is seated on flange 39. The lower convolutions of spring 41 are engaged in the threads formed on boss 40. The upper convolutions of said spring are formed with a larger diameter in order to permit the free action of said spring in spite of variations in the degree of compression of said spring. Binding between adjacent convolutions is also thus prevented. As a result of this arrangement an electrically conductive path is provided between the helical spring and the center electrode.

Intermediate shield 12 is formed of an electrically conductive metal and adapted to be threadedly engaged with shell 11 as has heretofore been indicated thereby forming a continuous conductive path with said shell and serving to clamp insulator 23 in position. The lumen of the interior of the shell and shield is greater than the outer diameter of the insulator thereby forming an air space between said elements. It should be noted that said space is enlarged at the upper portion of the shield, as shown at 42. It has been found that the upper portion of the ceramic insulator is frequently liable to rupture due to the inequality in temperature between the upper and lower portions thereof. As a result of the arrangement herein provided an air column exists along a substantial portion of the insulator thereby accomplishing a more equal distribution of heat along the length thereof as a result of the convection currents set up in said air column. Cracking of the insulator from this cause is therefore largely reduced.

The space between the meeting surfaces of the shield and cover may be such as to form a capillary path for moisture. In order to prevent the entrance of moisture into the interior of the plug by this means, the space between said meeting surfaces is enlarged at the upper edge of the shield. Thus the outer and end surfaces of the upper edge of the shield are beveled or tapered as shown at 43. As a result of this bevel the space between the cover and shield surfaces is enlarged and the formation of a capillary path beyond this point prevented.

The shielding of the spark plug is completed by means of cover 13 which surmounts intermediate shield 12. Said cover is formed of an electrically conductive metal and comprises a hollow housing which may be of sheet metal and is adapted to snugly fit around shield 12 and to be removeably secured thereto. An annular rib 45, adapted to be engaged with the complementary annular groove 44 on shield 12 is formed on the interior surface of said cover. The rib may advantageously be formed by indenting the ma-

terial of the cover. In order to impart a degree of resiliency to the material of the cover adjacent to said rib a series of circumferentially spaced slits 46 are formed in the material of the cover along the lower portion thereof; said slits terminating below the upper edge of shield 12. As a result of this arrangement the cover may be securely positioned on shield 12 and readily removed therefrom and replaced thereon; the resilient or yielding action of the lower portion of the cover permitting this to be accomplished.

A modified form of cover is shown in Figure 4 wherein a series of tongues 47 are formed in the material of the cover. Said tongues are provided with indentations 48 which form ribs on the internal surface of the cover adapted to be engaged in the complementary annular groove 44 formed in the shield. In order to permit the introduction of an ignition cable into the interior thereof, as will more clearly appear hereafter cover 13 is formed with a perforation 58 in its upper wall portion, said perforations being provided with indentation 56 and internally extending annular flange 57.

Positioned within cover 13 is cover insulator 49 which may be formed of a phenolic, ceramic or similar insulating material. Said cover insulator is formed with a depending post 50 which is adapted to be received in the interior of cavity 34 in insulator 23 and in spaced relation to the wall of said cavity. It should be noted that the upper end of the insulator 23 abuts upon the lower end surface of cover insulator 49 when said cover is in position, and that said cover insulator is provided with an annular depending flange 51 which rests immediately above the beveled end 43 of shield 12. The upper end of said shield lies below the level of the upper end of insulator 23. As a result of this arrangement any moisture or water which may enter the spark plug under pressure will collect in the space between insulator 23 and shield 12, and be trapped therein. In the event that such water reaches the level of flanges 51 it will flow out over the upper end 43 of the shield and out of the plug through the space provided between the cover and the bevel on the shield. The entry of any water into cavity 34 is thus prevented.

Cover insulator 49 is further provided with an axial bore 52 which extends through depending post 50 and communicates with transverse bore 53 formed in the upper portion of said insulator. Axial bore 52 is enlarged and threaded at its lower end to threadedly receive contact screw 55. The upper end of said contact screw is tapered to a point in order to permit the end thereof to pierce the insulation of an ignition cable as will more clearly appear hereafter. Transverse bore 53 extends part way only into said insulator and terminates somewhat beyond the point at which it is entered by contact screw 55 as shown by the broken line in Figure 1. The opening of said transverse bore is enlarged and threaded; registering with the perforation in the wall of cover 13.

The cover assembly is completed by means of terminal tube 14. Said tube is provided with a restricted inner end portion which is threaded and adapted to be threadedly engaged with the threads formed in transverse bore 53. By reason of the restriction of the forward portion of said tube a shoulder is formed which is adapted to abut upon internal flange 57 formed in perforation 58 of the cover. The terminal tube fits into the perforation and against flange 57 thereof

in a snug manner. Thus when the tube and cover insulator are threadedly engaged the cover insulator is drawn against the interior wall of the cover and the tube shoulder is drawn against flange 57. As a result of this arrangement the cover insulator is firmly secured in position and a water tight seal is provided between the cover and the tube. In order to provide an additional mechanical and electrical seal and to further secure the parts to each other an insulating varnish or cement is applied to the threads of the parts immediately prior to their threaded engagement with each other. A silicone resin may advantageously be utilized for this purpose. The bore of the terminal tube 14 is adapted to receive ignition cable 15. The outer end of the bore in said tube is restricted at 59 in order to firmly grip the cable which is inserted therein and to provide a tight seal therewith in addition to preventing its displacement therefrom. In the assembly of said cover terminal tube 14 is threadedly engaged with cover insulator 49 as heretofore indicated and ignition cable 15 is inserted into the tube the end of said cable passing into the transverse bore of said cover insulator. Contact screw 55 is then threaded into axial bore 52. As said contact screw is tightened the pointed end thereof pierces the insulation of the ignition cable and makes electrical contact therewith, in addition to preventing the withdrawal of the cable. Cover 13 may then be positioned upon shield 12 whereupon the upper end of the helical spring 41 makes contact with the head of the contact screw and completes the electrical circuit of the spark plug. When it is desired to remove or replace the ignition cable it is merely necessary to remove the cover and retract contact screw 55. The head of said screw is provided with a slot which is sufficiently large to receive a coin in addition to the blade of a screw driver thereby permitting the replacement of said cable without the use of special tools. Upon the retraction of the screw the cable is removed and a new cable may be inserted. The insulation on the cable need not be removed. The contact screw is then re-threaded into the bore and by piercing the cable insulation makes contact with the conductor therein. The cover may then be replaced.

A modified form of cover arrangement, particularly adapted for use with an ignition cable provided with a shielded braid or sheath, is shown in Figure 3. In this modified form, cover 13 is provided with a perforation 69 which is adapted to snugly receive a metallic sleeve 61. Said metallic sleeve is provided with flange 62 adapted to abut upon shoulder 63 of terminal tube 64. Said terminal tube is secured to the cover insulator in the manner heretofore indicated. The metallic sleeve 61 is soldered or brazed to the walls of the perforation in the cover. A metallic collar 65 is provided, to which the metallic braid covering the ignition cable, is secured as by soldering. Collar 65 and sleeve 61 are firmly secured to each other by means of collar nut 66. By reason of this arrangement continuous shielding is provided between the metallic sheath or braid of the ignition cable and the spark plug.

I have here shown and described preferred embodiments of my invention. It will be apparent, however, that this invention is not limited to these embodiments and that many changes, additions and modifications can be made in connection therewith without departing from the spirit and scope of the invention as herein disclosed and hereinafter claimed.

Having described my invention, what I claim as new and desire to secure by Letters Patent is:

1. In a spark plug having a shell adapted to be secured to the body of an internal combustion engine; an electrode carried by said shell, an insulator having a cavity therein carried by said shell, an electrode adapted to cooperate with said first electrode to form a spark gap, secured within said insulator, a helical spring located within said cavity in electrical contact with the upper end of said second electrode, an intermediate shield member secured to said shell and adapted to clamp said insulator in position, a cover adapted to detachably surmount said shield and provided with a perforation therein which is surrounded by an internally extending sleeve and flange; a complementary cover insulator positioned in said cover and provided with a depending post adapted to be received in the cavity of said first insulating member and a depending circumferential flange extending below the upper end thereof; a contact screw adapted to be threadedly received in an axial bore provided in said post and having a pointed end extending into a transverse bore provided in the upper portion of said cover insulator, the other end of said screw being adapted to make electrical contact with said helical spring; a terminal tube having an axial perforation adapted to receive an ignition cable and a reduced end portion adapted to be threadedly received in the opening of said transverse bore thereby introducing the end of said cable into the portion of said transverse bore entered by the contact screw and securing said cover insulator in position within said core.

2. In a spark plug having a shell adapted to be secured to the body of an internal combustion engine; an electrode carried by said shell, an insulator having a cavity therein carried by said shell, a center electrode adapted to cooperate with said first electrode to form a spark gap secured within said insulator; an intermediate shield member secured to said shell; a cover adapted to detachably surmount said shield and provided with a perforation in the wall thereof which is surrounded by an internally extending sleeve and flange; a complementary cover insulator positioned in said cover; a contact screw adapted to be threadedly received in an axial bore provided in said cover insulator and having an end extending into a transverse bore provided in the upper portion thereof, the other end of said screw being adapted to make electrical contact with said center electrode, a terminal tube having an axial perforation adapted to receive an ignition cable and a reduced end portion adapted to be threadedly received in the opening of said transverse bore thereby introducing the end of said cable into the portion of said transverse bore entered by the contact screw and securing said cover insulator in position within said core.

3. In a spark plug having a shell adapted to be secured to the body of an internal combustion engine; an electrode carried by said shell, an insulator having a cavity therein carried by said shell, an electrode adapted to cooperate with said first electrode to form a spark gap secured within said insulator, a helical spring located within said cavity in electrical contact with the upper end of said second electrode, an intermediate shield member secured to said shell and adapted to clamp said insulator in position, a cover adapted to detachably surmount said shield and provided with a perforation therein which is surrounded by an internally extending sleeve and flange; a complementary cover insulator positioned in said cover and provided with a depending post adapted to be received in the cavity of said first insulating member whereby the lower end surface of said cover insulator abuts with the upper end surface of said first insulator; a contact screw adapted to be threadedly received in an axial bore provided in said post and having a pointed end extending into a transverse bore provided in the upper portion of said cover insulator, the other end of said screw being adapted to make electrical contact with said helical spring; a terminal tube having an axial perforation adapted to receive an ignition cable and a reduced end portion adapted to be threadedly received in the opening of said transverse bore thereby introducing the end of said cable into the portion of said transverse bore entered by the contact screw and securing said cover insulator in position within said core.

4. The device according to claim 3 wherein a depending flange is provided on said cover insulator adapted to surround the upper end of said first insulator.

5. The device according to claim 3 wherein a depending flange is provided on said cover insulator adapted to surround the upper end of said first insulator, the end surface of said flange being adapted also to abut with the upper edge of said intermediate shield.

6. The device according to claim 3 wherein the upper end of the intermediate shield member is tapered so as to provide an enlarged space between said intermediate shield and the interior surface of said cover.

7. In a spark plug having a shell adapted to be secured to the body of an internal combustion engine; an electrode carried by said shell, an insulator having a cavity therein carried by said shell, an electrode adapted to cooperate with said first electrode to form a spark gap secured within said insulator, a helical spring located within said cavity in electrical contact with the upper end of said second electrode, an intermediate shield member secured to said shell and adapted to clamp said insulator in position, the upper portion of said intermediate shield being spaced from said insulator to provide an air space therebetween and the upper end of said intermediate shield being tapered, a cover adapted to detachably surmount said shield in telescopic relation therewith, the tapered upper end of said shield comprising an interruption of any capillary path for moisture between said cover and said shield, said cover being provided with a perforation therein which is surrounded by an internally extending sleeve and flange; a complementary cover insulator positioned in said cover and provided with a depending post adapted to be received in the cavity of said first insulating member and a depending circumferential flange extending below the upper end thereof; a contact screw adapted to be threadedly received in an axial bore provided in said post and having a pointed end extending into a transverse bore provided in the upper portion of said cover insulator, the other end of said screw being adapted to make electrical contact with said helical spring; a terminal tube having an axial perforation adapted to receive an ignition cable and a reduced end portion adapted to be threadedly received in the opening of said transverse bore thereby introducing the end of said cable into the portion of said transverse

bore entered by the contact screw and securing said cover insulator in position within said cover.

MAXWELL INGRAM.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,759,997	Pieper	May 27, 1930
1,782,745	Rohde	Nov. 25, 1930
1,927,267	James	Sept. 19, 1933
1,930,322	Paulson	Oct. 10, 1933
2,113,735	Mascuch	Apr. 12, 1938
2,309,236	Burrell et al.	Jan. 26, 1943
2,355,166	Johanson	Aug. 8, 1944
2,356,053	Hastings Jr. et al.	Aug. 15, 1944
2,368,889	Setterblade	Feb. 6, 1945
2,391,457	Carlson	Dec. 25, 1945
2,391,459	Hensel	Dec. 25, 1945
2,399,390	Robertson	Apr. 30, 1946
2,463,924	Van Orden	Mar. 8, 1949