Feb. 28, 1928. 1,660,964

W. L. HARTZELL

SPARK PLUG

Filed June 16, 1922

Fig. 1

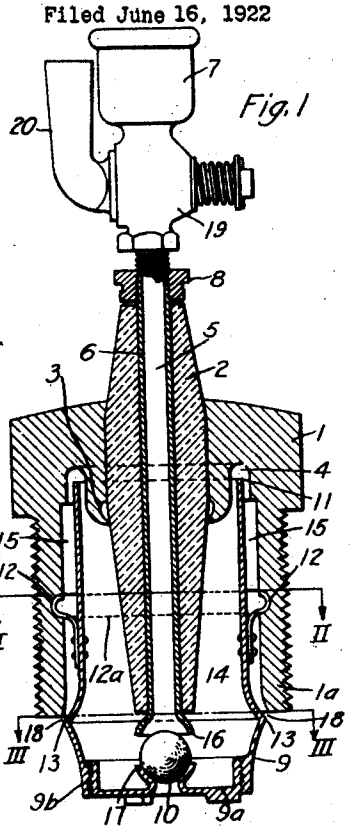



Fig. 2

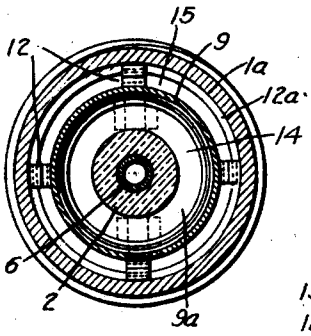



Fig. 3

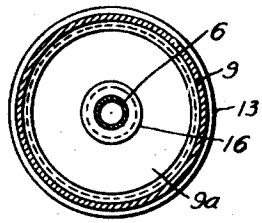



Fig. 4

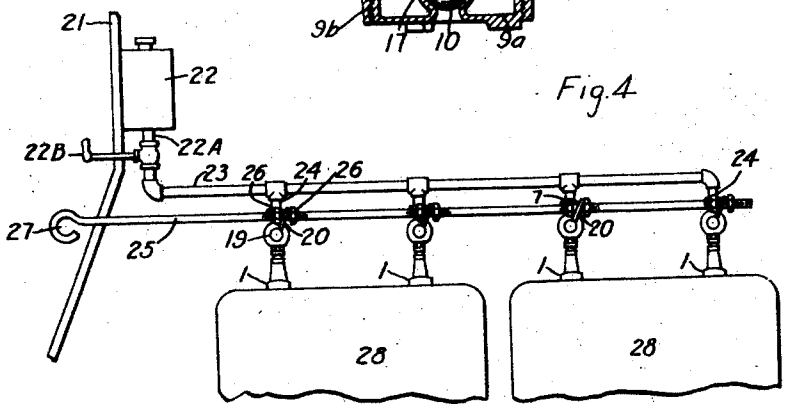
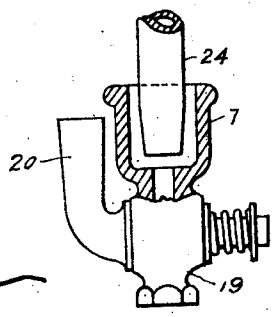



Fig. 5




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# UNITED STATES PATENT OFFICE.

WALTER L. HARTZELL, OF CHICAGO, ILLINOIS.

## SPARK PLUG.

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My invention relates to spark plugs or ignition devices for internal combustion engines and the like, and it has special relation to the combination of apparatus for ignition, priming and carburetion purposes.

One object of my invention is to provide a plurality of separated stationary conducting members or terminals, together with a movable conducting member, preferably a metallic ball for partially bridging a gap between the stationary members.

Another object of my invention is to provide a device of the above-indicated character for preventing fouling of the ignition terminals, which result is accomplished by reason of the chafing action of the metallic ball during the operation of the internal combustion engine.

A further object of my invention is to provide a spark plug or ignition device of such construction as to prevent the fouling or deposit of carbon upon the central insulator portion of the spark plug, such preventive action being effected by properly guiding an indrawn stream of air over the lower surface of the insulator in close contact therewith. In this way, the insulator is prevented from becoming coated with carbon or lubricating oil, which might cause the electrical charge to leak over the surface of the insulator instead of being concentrated at the firing point.

Still another object of my invention is to insure the ignition of the charge by removing all dead gas and the like from the vicinity of the ignition terminals and concurrently forcing the live gas to be ignited directly to the firing point.

A further object of my invention is to provide a spark plug wherein the explosive charge in the operating cylinder is prevented from burning inside of the cup or skirt of the spark plug, thereby reducing the heating of the plug as well as the liability of carbon deposit.

A further object of my invention is to provide means for inherently guiding a stream of air over or near the normally heated surfaces of the spark plug, particularly the seal between the insulator and the metallic body, thereby effectively cooling these parts and at the same time gradually increasing the temperature of the indrawn air. By the prevention of such heating of the seal, a tight joint is insured and the cracking of the insulator is prevented.

Still another object of my invention is to utilize the air heated in the manner just mentioned by spraying it into the interior of the cylinder and thus thoroughly mixing it with the explosive charge therein. For this purpose, an annular nozzle is provided between the outer cup-shaped member or skirt of the plug and an inner cup-shaped member that is relatively inverted and constitutes one of the terminals of the spark plug. A further object of my invention is to employ an apertured insulator, the aperture registering with the above-mentioned metallic ball, whereby the engine may be primed, the priming charge being supplied directly to the firing point, but the priming fluid being prevented from forming a drop across the firing point by reason of the action of the metallic ball.

Other objects of my invention will be understood from the following description and by reference to the accompanying drawing,

Fig. 1 of which is a view in longitudinal section of a spark plug or ignition device constructed in accordance with my invention;

Fig. 2 and Fig. 3 are transverse sections taken along the lines II—II and III—III of Fig. 1; Fig. 4 is a view in elevation of a control apparatus for governing the priming of the internal combustion engine from the driver's seat and also the amount of air being drawn into the cylinders through the spark plug; and Fig. 5 is an enlarged sectional view of a portion of the apparatus that is shown in Fig. 4.

Referring to the drawing, the illustrated apparatus comprises a metallic cup-shaped body or plug 1, which is externally threaded at its lower section or skirt $1^a$ in order to screw into the combustion chamber of the engine in the usual way, as shown. An insulator member 2, tapered at both ends, is inserted within the plug 1, the lower half of the insulator extending downwardly within the threaded portion or skirt of the plug, while the upper portion extends above the plug body, in accordance with a familiar construction.

A suitable seal 3 is provided at the lowermost contact area of the insulator 2 and the plug body 1, which seal may be of any suitable character. For the purpose of providing an effective cooling of the sealing area without impairing in any manner the effectiveness or mechanical strength of the seal,

an annular groove or upwardly extending recess 4 is provided in the lower side of the plug body 1, surrounding the seal 3.

The insulator 2 has a small aperture or passage 5 extending longitudinally therethrough and a perforated tube 6 extends through the aperture 5, the upper end of the tube being enlarged to form a priming cup 7 a suitable distance above the upper end of the insulator 2, while the lower end of the tube 6 is slightly enlarged into a hemi-spherical cup or seat 16, for a purpose to be set forth. The tube 6 is thus adapted to act as one electrical terminal of the spark plug, a suitable nut 8 being located near the upper end of the tube below the priming cup 7 for permitting the usual type of detachable electrical connection or wire.

A metallic cup-shaped member or shell 9, inverted with respect to the cup-shaped member or skirt $1^a$ of the spark plug, is inserted within the screw-threaded skirt $1^a$, being annularly spaced therefrom by a small distance for a purpose to be set forth. A central portion of the bottom member or cap $9^a$ of the cup 9 is turned upwardly and formed into a hemi-spherical shape or seat 17 just below the correspondingly shaped seat 16 of the conducting tube 6. The cap $9^a$ is adjustably threaded into the shell 9, as shown at $9^b$, for a purpose to be set forth.

A metallic ball 10 is lodged between the two hemi-spherical surfaces in question, the dimensions of the parts being such that, although the ball is freely movable in a vertical direction within predetermined limits, it cannot normally be dislodged or removed from the cage formed by the two hemi-spherical surfaces or seats 16 and 17. The adjustable distance between the nearest surface of the ball and the hemi-spherical surface that it is not in contact with, may correspond to the ordinary or any selected sparking distance for the ignition system employed, so that the spark, when desired, will jump across the gap between the ball and the spherical surface in question.

The upper edge 11 of the cup 9 is disposed within the annular recess 4 of the main body member 1, the cup being mechanically and detachably secured thereto in any suitable manner, as by a plurality of clips or bent springs 12, disposed around the cylindrical surface of the cup 9, and which yieldingly engage a groove $12^a$ in the inner wall of the screw-threaded portion $1^a$ of the body member 1.

A good electrical contact is also insured by the pressure between the clips 12 and the walls of the groove $12^a$. It will be understood that any other suitable method of mechanically and electrically connecting the cup 9 and the body member 1 may be employed, such as set screws, etc.

By reason of the construction just described, the vertical distance between the ball 10 and the seat 16 or 17—that is, the sparking distance of the plug—may be adjusted as desired, by manually raising or lowering the cap $9^a$. Also, the entire cup 9 may be readily removed and replaced as desired.

Furthermore, the outer surface of the cup member 9 in the vicinity of the lower edge of the screw-threaded portion $1^a$ of the body member 1 is expanded to form a sharp ridge or bead 13, whereby an annular nozzle 18 of suitably restricted dimensions is provided between the lower edge of the screw-threaded portion $1^a$ and the bead 13. The purpose of this nozzle arrangement will be hereinafter more fully explained.

It will be noted that, by reason of the construction just described, an air space 14 is provided around the lower portion of the insulator 2, between it and the walls of the cup member 9, while a smaller annular air space 15 is provided around the outside of the cup member 9, between it and the screw-threaded portion $1^a$ of the main body member 1. Communication between the two spaces or passages 14 and 15 is provided by means of the annular groove 4 in the underside of the body member 1, since the relative position of the cup members 1 and 9 is such as to leave the desired ventilating space between the two members in question at the upper edge 11 of the cup 9.

It will be noted that, by reason of the illustrated construction, the metallic ball 10 is adapted for ignition or sparking purposes by reason of its position with respect to the spherical surfaces or seats 16 and 17, respectively, of the tube 6 and the cup 9. Furthermore, by reason of the provision of the insertion of the tube 6 through the insulator 2, the metallic ball 10 may also be employed for priming purposes when the priming cup 7 is filled.

For the purpose of governing the flow of gasolene or air through the tube 6, a suitable valve or pet-cock 19, which may be actuated by a handle or lever 20, is provided below the priming cup 7.

The operation of the spark plug device may be described as follows: During the suction stroke of the engine, the ball 10 is drawn down to its lower seat 17 in the bottom of the cup 9, and, consequently, a charge of air is drawn through the tube 6. This charge of air first serves to cool the porcelain insulator 2 internally and, in so doing, absorbs a certain amount of heat itself. The air then strikes the ball 10, thereby blowing off soot or other deposit and is deflected outwardly into the annular space 14.

The air continues to flow upwardly past the outer surface of the lower portion of the insulator 2, serving the double function of cooling such outer surface and also blowing away any soot or other deposit. The air

then passes through the groove or channel 4 over the upper edge of the cup 9 into the small annular space 15. In passing into the groove 4, the seal 3 is effectively cooled by reason of the proximity thereof to the air stream.

The air stream finally is drawn out through the annular nozzle 18, which, as previously explained, is of such shape that the incoming air, which has been progressively heated by passing over the various elements named above during its tortuous course, will be sprayed into the gasolene mixture in a manner to promote efficient combustion. Furthermore, since the air itself will be somewhat heated, it will assist in vaporizing any particles of gasolene in the cylinder, thus further insuring complete combustion, at the proper time.

During the compression stroke of the engine, the pressure in the operating cylinder will raise the ball 10 against the upper seat 16 comprising the lower end of the tube 6 and thus will seal the air passage through the tube. However, a small amount of the gaseous mixture will be drawn directly up to the ball seat in question, thus insuring a good clean mixture at the firing point. The air spaces 14 and 15, however, will still contain substantially fresh air only and but little, if any, of the combustible mixture will, therefore, be found in these spaces. Consequently, when the combustion takes place in the cylinder, no burning mixture will surround the lower portion of the insulator 2 and, consequently, no soot will be formed or no heat will be generated adjacent to the spark plug inner portions.

When the charge is fired by the application of electromotive force to the terminals of the ignition circuit, the firing spark will pass from the ball 10, which is maintained in its upper position, as previously stated, to the seat 17 in the bottom of the cup member 9. As already mentioned, this distance is selectively adjusted to provide the proper jumping distance for the spark.

During the exhaust stroke, the ball 10 will remain in the upper seat 16 constituting the lower end of the tube 6 until the pressure in the engine cylinder drops sufficiently to allow gravity to return the ball to its lower seat 17. When the ball drops, any soot or oil which may have collected upon it during the firing will chafe or rub off, whereby the metallic ball will always be maintained bright and clean.

As regards the priming of the engine, the following method may be employed. The location of the priming cup 7 above the electric terminal member or nut 8 is very convenient in that it allows the necessary priming without in any way disturbing the electrical circuits. Upon pouring gasolene into the priming cup 7, in a manner subsequently described, a small stream flows through the tube 6 directly to the firing point, that is, directly to the seat 16 just above the ball 10. However, the stream of gasolene will not be concentrated in the form of a drop across the firing gap because of the inherent movement of the ball 10 which will break up or prevent any such formation of drops. In this way, a rich mixture is secured directly at the firing point, rendering the priming action very effective, without incurring the liability of directly bridging the firing gap with the priming liquid, which action would prevent firing.

Reference may now be had to Fig. 4, showing the application of my invention to an automobile in such manner as to permit ready control of the priming from the driver's seat.

The dashboard 21 of the automobile is provided with a suitable gasolene tank or receptacle 22 from which a feed pipe 23 runs past the various spark plug devices 1 that are associated with the respective engine cylinders 28. Opposite each priming cup 7 of the apparatus is an outlet pipe 24, of insulating material, which fits into the priming cup 7 to readily supply the necessary priming charge without permitting overflow of the gasolene, but not obstructing the passage of air.

To control the flow of gasolene for priming purposes, a suitable valve or pet-cock $22^A$ is supplied in the pipe line 23 which may be operated by a handle $22^B$ extending through the dashboard 21.

To control the flow of air to the cylinders either while priming or running, a rod 25 extends through the dashboard 21 and parallel to the feed pipe 23 past each valve handle 20. On opposite sides of the normal position of each valve handle 20, suitable nuts 26 are threaded upon the rod 25, being spaced at suitable distances to effect movement of each valve from its normal open to its closed position, or vice versa, by a corresponding longitudinal movement of the rod 25 by means of its handle 27, which may be located beyond the dashboard 21 in a convenient position.

It will be understood that any other suitable form of apparatus for readily effecting the priming action desired may be employed in lieu of the structure that is illustrated in Fig. 4.

The operation of the priming apparatus may be briefly described as follows: By moving the handle $22^B$, valve $22^A$ is opened, allowing a small amount of gasolene to pass through tube 23 and drop into each priming cup 7. The engine, when it begins to turn, will suck the gasolene into the cylinders through the hollow tube 6 in the spark plug, when the priming action will be as previously described.

By pulling the handle 27 of the rod 25, the various valve handles 20 upon the spark plug devices are actuated by the nuts 26 from their normal open towards their closed position, whereby the amount of air flowing through the spark plugs and thus the composition of the mixture in the cylinders may be regulated.

For starting, an exceedingly rich mixture is desirable. After the engine is primed, if it does not start readily, the amount of air being drawn in through the spark plugs may be suitably regulated, or on a steep hill, where a very rich mixture is desirable for a short heavy pull, the amount of air may be cut down.

I do not wish to be restricted to the specific structural details or arrangement of parts herein set forth, as various modifications thereof may be effected without departing from the spirit and scope of my invention. I desire, therefore, that only such limitations shall be imposed as are indicated in the appended claims.

I claim as my invention:

1. A spark plug device comprising a central member having an aperture therethrough, an outer cup-shaped member enclosing the lower portion of said central member, and a second cup-shaped member disposed in spaced relation within said outer member and forming an annular nozzle therewith.

2. A spark plug device comprising an apertured insulating member, a cup-shaped member enclosing the lower portion of said insulating member, and means for guiding air drawn through said insulating member around the lower outer surface thereof to prevent the formation of carbon.

3. A spark plug device comprising an apertured insulating member, an outer cup-shaped member enclosing one portion of said insulating member, and a second cup-shaped member inverted with respect to said outer member and disposed therewithin, whereby a charge of air may be drawn through said insulating member, around said one portion thereof within said second cup-shaped member, over the edge thereof and between the two cup-shaped members.

4. A spark plug device comprising an insulating member, an outer cup-shaped member enclosing one portion of said insulating member, and a seal between said two members, said cup-shaped member having an annular groove surrounding said seal.

5. A spark plug device comprising an apertured insulating member, an outer cup-shaped member enclosing one portion of said insulating member, a seal between said two members, said cup-shaped member having an annular groove surrounding said seal, and a second cup-shaped member inverted with respect to said outer member and having its free edge disposed within said groove, whereby a charge of air may be drawn through said insulating member, around said one portion thereof within said second cup-shaped member, over the edge thereof within said groove and between the two cup-shaped members.

6. A spark plug device for an internal combustion engine comprising an apertured insulating member, an outer cup-shaped member enclosing one portion of said insulating member, a conducting member extending through said apertured insulating member and constituting a cupped seat at one end, a second cup-shaped member inverted with respect to said outer member and disposed therewithin, said second member also having a cupped seat, and a metallic ball normally located within one of said seats and adapted to be actuated to the other seat during the compression stroke of the engine and to act as a sparking terminal, whereby a charge of live gas to be ignited may be drawn directly to the firing point and a charge of air may be drawn through and around said insulating member to prevent the formation of dead gas in the vicinity of the ignition terminals.

7. A spark plug device for an internal combustion engine comprising an apertured insulating member, an outer cup-shaped member enclosing one portion of said insulating member, and a second cup-shaped member inverted with respect to said outer member and disposed therewithin, whereby a charge of air may be drawn through said insulating member, around said one portion thereof within said second cup-shaped member, over the edge thereof and between the two cup-shaped members, the annular outlet therebetween constituting a nozzle for spraying the heated charge of air into the engine cylinder.

8. A spark plug device for an internal combustion engine comprising a central member having an aperture therethrough, an outer cup-shaped member enclosing the lower portion of said central member, and a second cup-shaped member disposed in spaced relation within said outer member and forming an annular nozzle therewith, whereby a charge of air may be drawn through said aperture and around said cup-shaped members to be heated and sprayed through said annular nozzle into the engine cylinder.

9. A spark plug device comprising an apertured insulating member, an outer cup-shaped member enclosing one portion of said insulating member, a seal between said two members, said cup-shaped member having an annular groove surrounding said seal, and a second cup-shaped member inverted with respect to said outer member and having its free edge disposed within said

groove, each cup-shaped member having a hemi-spherical seat and a metallic ball normally occupying the seat in said second cup-shaped member.

10. The combination with a plurality of engine cylinders, of a plurality of hollow spark plugs secured thereto, remotely-controlled means for simultaneously admitting priming charges to the firing-points of said spark plugs, and remotely-controlled means for simultaneously adjusting the amount of air drawn through said spark plugs.

In testimony whereof, I have hereunto subscribed my name this 21st day of August, 1922.

WALTER L. HARTZELL.