Jan. 16, 1940. A. A. KASARJIAN 2,187,472

MULTIPLE SEAL SPARK PLUG

Filed Aug. 4, 1937 2 Sheets-Sheet 1

Fig. 1

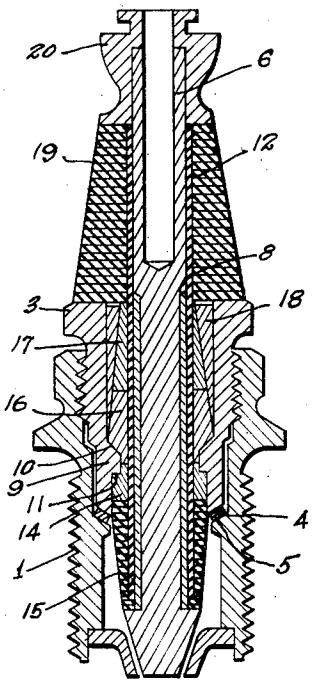
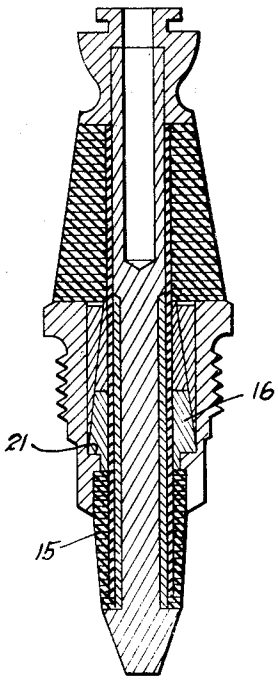


Fig. 2



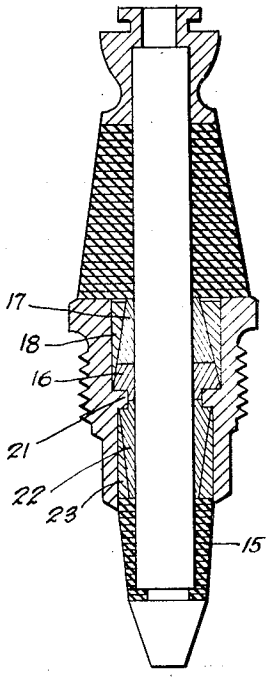


Fig. 3

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Filed Aug. 4, 1937 2 Sheets-Sheet 2

Fig. 4

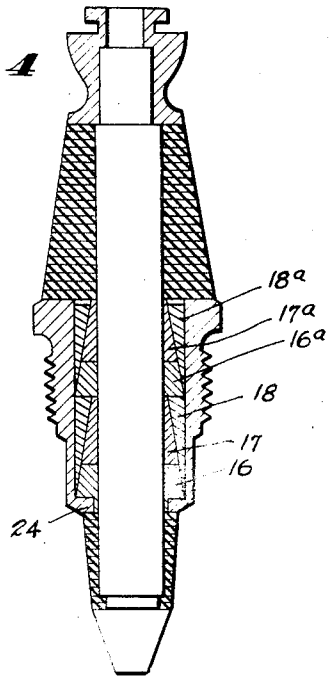


Fig. 5

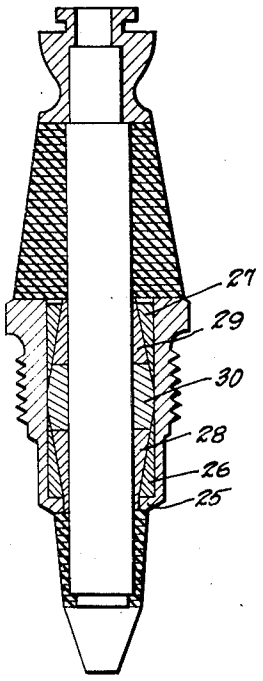
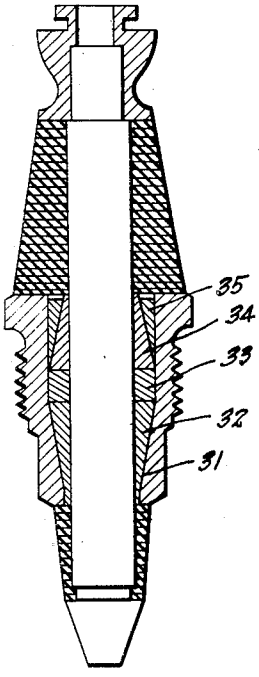


Fig. 6



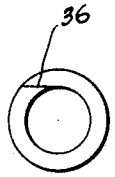


Fig. 7

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UNITED STATES PATENT OFFICE

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MULTIPLE SEAL SPARK PLUG

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Application August 4, 1937, Serial No. 157,267

23 Claims. (Cl. 123—169)

This invention relates to spark plugs and is directed more particularly to that general type of spark plug disclosed in Mosler Patent No. 1,588,489, issued June 15, 1926. According to said patent, a circular sleeve-like compression member is forced into close fitting relation with respect to the center electrode by an annular wedge, forced, under considerable pressure, between the exterior of said sleeve and the shell or bushing of the plug, the purpose being to produce a sufficiently tight relation between the center electrode and the shell or bushing as will insure against leakage of compression between these parts.

Plugs of the character shown in the Mosler patent have proven of great value in the automotive arts and through the years have been produced in great numbers. There is, however, an ever increasing tendency to higher engine compressions. As the engine compressions increase new problems are introduced and it becomes increasingly difficult to hold this compression against leakage and to properly maintain the plug temperatures within efficient operating limits.

The problem of dissipation of heat from the center electrode is a difficult one and is of great importance. The amount of heat that can pass off through the terminal nut of the plug is limited to the temperature which the insulation of the ignition cable can stand without deterioration. The amount of the heat which may accumulate in the center electrode of a spark plug operating in a high compression engine, is sufficient to destroy such insulation if attempt is made to dissipate it wholly through the terminal nut. Therefore, it has been found necessary for the protection of such insulation and for the proper operation of the plug, to take off the heat through the sealing devices of the plug in order that most of the heat absorbed by the central electrode may be dissipated through the bushing and shell to the cylinder block and the water jackets or air cooling fins of the latter. This requires an appropriate path for such heat, but it should be borne in mind also that there is an optimum range of temperature at which the center electrode should be maintained for its highest efficiency. If the center electrode temperature falls materially below this optimum range of temperature, it will tend to accumulate carbon, oil or other extraneous deposits which will, in due course, bring about short circuiting of the plug. If the temperature rises appreciably above this optimum range, there will be a tendency to deteriorate the ignition lead to the plug and the interior parts of the plug will come to a point of incandescence and produce pre-ignition. Consequently in order to produce a satisfactory plug, particularly for use in high compression engines, it is necessary that the construction be such as to maintain the temperature of the center electrode within the optimum range of temperature during operation and at the same time to afford a proper seal against the leakage of gas through the plug under pressures prevailing in modern engines of such compression.

The optimum range of temperature referred to is limited by the evaporation temperature of oil on one side and the ignition temperature of the fuel on the other side. The degree of tightness necessary is dependent upon the indicated mean effective pressure and the speed of the engine, and these are constantly increasing so that means of tightening, as taught by the prior art, are inadequate to cope with the situation. One object of the present invention is to produce a plug which will accomplish these results.

I have found it possible to carry out this object by utilizing within the plug structure a multiple seal, as hereinafter more fully described, so constituted that it will not only hold tight under very high compressions, but that it will also effectually maintain the center electrode of the plug at proper operating temperatures and will permit of the construction of a plug of unusually wide heat range and one which is operative in practically any internal combustion engine without fouling or causing pre-ignition.

Furthermore as a result of numerous tests I have noted instances in spark plug operation wherein it was found that the mica washers, used as insulating spacer elements in the plug, showed unmistakable signs of failure. This convinced me that the mica had accumulated heat beyond its point of dehydration and that this was the cause of the failure. The failure due to dehydration of a spacer mica often occurred adjacent to the bushing. The cause of this failure is due to the fact that mica washers adjacent to the bushing, being way up in the combustion chamber of the plug, are very little if at all subjected to the cooling effect of the incoming charge of the engine. Consequently the mean effective temperature is higher at this point. The gradual accumulating heat rises beyond dehydration temperature of mica and failure at this point results. I have found it possible to eliminate this

difficulty by putting a body of high heat conductive material adjacent to and in contact with the uppermost washers where the failure has occurred and which serves to rapidly dissipate the heat from this point.

Another object of the invention is to so construct the shell or bushing of the plug that the multiple seal may be effected at pressures above which the insulating element of the plug can properly sustain. I have been able to accomplish this result through the use, in the plug shell or bushing in which the center electrode is mounted, of a rigid fixed abutment against which such pressures are exerted and which is of sufficient strength to withstand the stresses incident thereto.

Difficulty may be experienced in some cases in the formation of a multiple seal through the employment of wedging means, due to the varying resistance to radial compression of a tapered sleeve or compression member which I may use in this connection, but I have found that it is possible to entirely overcome this difficulty by making the taper of the wedge slightly different from the taper of the compression elements to equalize the unit compressing stress along the inside surface of the compressed member or members, as hereinafter more fully explained.

Features of the invention, other than those adverted to, will be apparent from the hereinafter detailed description and claims, when read in conjunction with the accompanying drawings.

The accompanying drawings illustrate different practical embodiments of the invention, but the constructions therein shown, are to be understood as illustrative, only, and not as defining the limits of the invention.

Figure 1 is a central vertical section through a plug embodying the present invention.

Figures 2–6 are similar views showing modified forms of construction.

Figure 7 is an end view of one of the compression members showing the same split.

The plug of the present invention may be designed for use in internal combustion engines of any kind and for any purpose and may embody insulating elements of porcelain, mica or any other material appropriate for the particular use to which they are to be put. However, for the purpose of illustration, I have shown in the drawings plug constructions particularly adapted for employment in high compression engines and useful in connection with aviation.

Referring first to Figure 1, the plug therein shown comprises a shell 1 having ground electrodes 2 of any appropriate kind. The upper end of the shell is internally threaded to receive a bushing 3 adapted to be screwed into the shell to bring its lower tapered end 4 to a seat on a gasket 5 in the usual manner. The center electrode comprises a spindle 6 having a spindle head 7 at its lower end and so positioned as to cooperate with the ground electrodes 2 of the plug.

The spindle head may be made integral with or secured to the spindle 6 without departing from this invention and while Figure 1 shows the lower portion of the spindle encased within a conductive envelope 8 of copper or other high conductive metal, the shank may be hollow and filled or lined with heat conductive metal, or both of these conductive devices may be employed. These heat conducting devices may, however, be dispensed with without departing from the invention.

Within the bushing 3 and intermediate its upper and lower ends is an internal annular flange 9, the upper face of which is in the form of a sloping shoulder or abutment 10, while its lower face is in the form of an annular flat shoulder or abutment 11. The spindle 6 extends through the shell and enveloping said spindle is a wrapping of cigarette mica 12 extending from adjacent the spindle head to adjacent the upper end of the spindle.

Encircling the cigarette mica 12 directly adjacent the flange 9 is a metallic ring 14 of copper or other relatively soft high conductive metal and between this ring 14 and the spindle head are interposed laminated disks of mica 15. Directly adjacent and above the flange 9 is an annular compression member 16, preferably of copper or other high conductive metal, and directly above this member is a second annular compression member 17, preferably of brass, although both compression members 16 and 17 may be of copper or both of brass. I may also use some other good conductive metal, such as beryllium alloys in the fabrication of either or both of these parts. The compression members 16 and 17 are provided with cylindrical bores adapted to closely embrace the cigarette mica wrapping 12 of the spindle, while the external surfaces of said compression members 16 and 17 are of tapered or frusto conical form, the exterior surface of the compression member 16 forming a continuation of the like surface of the compression member 17.

The internal bore of the bushing, in the proximity of these compression members, is cylindrical and there is adapted to be received, between the compression members and the bore of the bushing, an annular wedge 18, the external surface of which is cylindrical, while its internal surface may be complementary conical with respect to the compression members. The wedge 18 is preferably of solid steel or some other sufficiently hard metal to hold its shape when subjected to high pressures. Surmounting the bushing are the usual mica insulated washers 19 and the terminal 20.

In fabricating the plug thus described, there is first applied to the spindle the mica wrapping 12, thereafter the mica washers 15 are applied and then the ring 14. This assembly is then brought into cooperative relation with the bushing 3 while held in suitable jigs sufficient pressure is exerted upon the spindle head in the direction of the bushing to tightly compress the mica disks 15 and the ring 14 against the flange 9 of the bushing. Considerable pressure is thus applied but it should be kept below the point which would detrimentally affect or disrupt the mica washer 15. If the ring is of copper or other relatively soft material, this pressure may be sufficiently great to cause the metal of such ring to flow in such manner that it will tightly engage with the interior bore of the bushing and with the flange 9 and force the cigarette mica 12 into close gripping contact with the spindle of the center electrode whereby there is such intimate contact produced between these parts as to foster and permit a good heat exchanging relation between them.

After the parts described have been compressed as stated, this compression is held while the compression members 16 and 17 are introduced over the upper end of the spindle and moved downwardly into the bore of the bushing above the flange 9, and the wedge 18 immediately follows these parts. After the wedge has been brought

loosely into position, great power is thereupon applied to said wedge, by an appropriate hydraulic or pneumatic press or other means capable of impressing thereon great power, and the wedge is forced downwardly into the bore of the bushing and acts upon the compression members 16 and 17 to force them into tight gripping relation with the cigarette mica 12 to force said cigarette mica into tight gripping relation with the spindle, the wedge serving through reaction, to come into close conformity and engagement with the bore of the bushing. During this operation, the pressure exerted may be great enough to actually flow the metal from which one or both of the compression members 16 and 17 is formed to bring about the tightest and most intimate contact between the associated parts. The application of this great pressure is made possible because it is caused to act against the flange 9 which protects the mica washers 15 from the brunt of such pressure.

As a matter of fact I have found that if I make one or both of these compression members 16 and 17 of copper or other relatively soft metal, it may be caused to flow and entirely fill the space allotted to it to form an indestructible tight seal. In any event, the wedge acts upon both compression members to form seals at two distinct elevations in the plug, i. e., a multiple seal.

I have made the important observation in connection with my studies and tests on the operation and action of the wedge that if a single compression member is employed, the wedge acts upon this member to cause tightening only over a relatively small area where the wedge is thick and the compression member is thin, but that, when I employ a plurality of compression members with a common wedge, I get a distinct wedging action on each compression member by successive portions of the wedge and I am thus able to get not only a multiple seal at distinctly different elevations, but I am also better able to flow the metal even though such metal is of brass or similar material. In any event, experience has demonstrated that, when a plurality of compression members are employed as stated, operated upon by a single wedge, there is obtained a multiple seal of greatly increased effectiveness.

Furthermore when the compression member 16 is subjected to the enormous pressure of the wedge, as stated, it is possible to actually flow said member beyond the upper face or abutment 10 of the flange 9 and into contact with the ring 14 to form a close and intimate engagement therewith well adapted to heat exchange between these elements.

I have made highly satisfactory and efficient plugs, according to Figure 1, by making the parts 14 and 16 of copper and by assembling them in the manner described under sufficient pressure to cause flowing of the copper. In use these plugs have been found to have a very wide heat range and to be perfectly tight under high compressions. They do not tend to overheat or cause pre-ignition and their temperature may nevertheless be kept sufficiently high to preclude fouling. The fact of the matter is that the highly conductive copper with its relatively high specific heat seems to act as a heat reservoir to take up undesirable heat from the spindle and away from the adjacent washers 15 and to conduct it away to the bushing and from thence to the shell, but these copper parts nevertheless retain sufficient heat, so that, if the center electrode tends to cool down below the optimum temperature, these copper parts will feed back sufficient heat, so that the electrode does not become so cool as to cause fouling. I therefore obtain a very nicely balanced condition of heat in the center electrode which safeguards the plug from overheating or remaining too cool in operation. By virtue of this fact, moreover, I properly protect the mica washers 15 from dehydration and safeguard the plug from failure from this cause.

After the wedge has been forced into its final position, as described, the mica insulation 19 is applied to the spindle and is followed by the terminal 20 which may be secured in place on the spindle in any appropriate way as by threading or otherwise.

The construction of Figure 2 is, in many respects, similar to the structure of Figure 1, but differs therefrom in that the ring 14 of Figure 1 is omitted in Figure 2 and in Figure 2, the abutment 21 which corresponds to the abutment 10 is made flat in Figure 2 instead of conical as in Figure 1. The top mica washer of the washers 15 of Figure 2 are in engagement directly with the lower edge of the compression member 16 and these washers are protected to some extent by these contacts, although not as thoroughly as in the preceding figure.

In the construction of Figure 3, the flange 21, which corresponds to the flange 9 of Figure 1, is positioned about midway of the height of the bushing. Above this flange is incorporated compression members 16 and 17 and a wedge 18 as in Figure 1, while below the flange there is provided one or more compression members 22 and a cooperating wedge 23. In this arrangement the compression member 22 is preferably of copper or other relatively soft, high conductive metal, while the wedge 23 is of a harder material, such as brass, beryllium alloy or steel. The structure shown in Figure 3 is assembled by first assembling that portion of the structure below the flange 21, i. e., by applying pressure to the end of the spindle head in the direction of the bushing, while the wedge 23 and compression member 22 are in place. This procedure will cause a tightening of the wedge and compression member under pressures which the washers 15 can properly withstand and, after these parts are tightly assembled as stated, the compression members 16 and 17 and the wedge 18 are introduced and pressure applied thereto as hereinbefore described with reference to Figure 1. Here again we get the multiple seal with proper protection to the mica washers 15 and also the ability to apply great pressure through the wedge 18 because of the presence of the interposed flange 21 which protects the mica washers 15 from being destroyed by such pressure.

In Figure 4 there is illustrated another modified form of the invention which is highly efficient. In this showing there are two pairs of compression members, that is to say, the lower compression members 16 and 17 acted upon by a wedge 18 and upper compression members 16*a* and 17*a* acted upon by an additional wedge 18*a*.

In assembling a plug of this kind, the wedge 18 is first acted upon by a press or other appropriate means under great force to act upon the compression members 16 and 17 and, when this operation has been completed, the compression members 16*a* and 17*a* are added together with the wedge 18*a* and said latter wedge is thereupon acted upon under great pressure to tighten the compression members 16*a* and 17*a*. Here there is formed a duplicate multiple seal

similar to the seal produced in the upper portion of the bushing in Figure 1, but duplicated with respect thereto, so that leakage cannot possibly occur, the elements 16*a*, 17*a* and 18*a* functioning like the elements 16, 17 and 18 and also operating on said latter elements to produce a seal of great tightness and effectiveness. If desired, this addition of seals, exemplified in Figure 4, may be increased to three or more, without departing from this invention, but this is not considered necessary. Furthermore instead of forming a flange 24, which corresponds to the flange 9, at the lower end of the bushing, as shown in Fig. 4, I may position it above the lower end of the bushing and associate with the bushing a lower ring corresponding to the ring 14 of Figure 1 without departing from this invention.

In the construction of Figure 5, the flange 25 is formed at the lower end of the bushing and two wedges 26 and 27 operate in directions toward one another on two spaced apart separate compression members 28 and 29 and a common interposed compression member 30 to produce the multiple seal to which I have referred. I may also associate with this construction the lower ring corresponding to the ring 14 as will be understood.

In the structure of Figure 6 the flange in the shell is dispensed with and in lieu thereof the bore of the shell is shown as formed with a taper 31 with which cooperates a compression member 32. Superimposed on the compression member 32 is an annulus of copper or other soft highly conductive material 33 upon which is seated a compression member 34 acted upon by a wedge 35.

In the foregoing detailed description, I have set forth different forms of the invention for the production of a multiple seal and at the same time the provision of a proper bridge for the flow of heat from the center electrode and the lower mica washers to the bushing in order to keep the center electrode at a proper temperature. In the structures illustrated the compression members should be made of good conducting material and should be sufficiently soft to properly conform with the center electrode. In some cases, it is thoroughly practical to make these compression members of solid annular form, though, if desired, said compression members may be longitudinally slit, as by one or more saw cuts running for the whole or a part of the length thereof, or they may be split as shown at 36 in Figure 7, so as to render said compression members more easily compressible by the wedges which cooperate with them. I find it desirable and conducive to very good results to incorporate in the structure compression members or rings of copper or other similar material of high conductivity and which may be actually flowed under the high pressures used to obtain the best possible heat conductive relation between these members and their adjacent parts in order that a very good heat path may thereby be produced. The metals employed in the construction shown may vary. For example, I have referred to the use of steel in the formation of the wedges, but I have found in this connection that a wedge of beryllium alloy comprising beryllium, cobalt and copper has given very highly satisfactory results because it will withstand the pressures which are employed and at the same time constitutes a better heat path than steel. Similarly I may utilize beryllium for the bushing of the plug for the same reason because it adds great tensile strength which enables it to withstand the reaction of the wedge or wedges employed. For the compression members the material may vary, but I preferably employ either brass or copper or a combination thereof in different compression members as this combination has been found to give highly satisfactory results in practice. The underlying principle of the invention, however, in its broad aspect, is the production of the multiple seal described.

In all of the structures which I have hereinbefore shown and described one or more wedges of relatively hard material are caused to act upon one or more compression members of relatively soft material in order to obtain the tight conductive seal to which I have referred. In all of these cases the structures as shown have utilized wedges and compression members which are complementarily tapered with an angle of taper on the one corresponding to the angle of taper on the other, but in an opposite direction. These constructions have given satisfactory results, but I have found that I obtain even better results if the tapers of these cooperating portions are not the same, but are different, with a more abrupt taper on the compression member and a correspondingly finer taper on the wedge. The difference in these cooperating tapers need not be great, but inasmuch as this difference in taper depends upon the compression strength of different portions of the length of the compression members, it may be readily calculated in accordance with the particular materials used. The inventive concept in this connection will be apparent from the fact that, when the compression members are tapered from a relatively thick section at one end to a relatively fine edge at the other end, the various portions of the length of such a member have a constantly decreasing resistance to compression in the direction of its small end. When such a member is acted upon by a wedge of harder material the thicker end of the wedge will act with greater force upon the thinner end of the compression member. However, I have found that by decreasing the angle of taper of the wedge the point of the wedge will take a hold before the thicker end of the wedge and the progressive portions of the wedge will thereafter successively coact with the compression member to effectually compensate for the difference in compressibility of various portions of the compression member, so as to produce a uniform unit of strain throughout the entire length of the compressed member. As a result the entire length of each compression member will be caused to conform with and tightly grip the spindle throughout its entire length. When different compression members are acted upon by a common wedge as, for example, in Figure 1, the foregoing difference in taper may be carried out as stated to cause the single wedge to act uniformly throughout the entire length of the compression members collectively. In the latter case, the difference in taper may result in successive compression of successive portions of successive compression members by a common wedge.

In the several forms of the invention disclosed, the central electrode is shown as mounted by the construction described within a bushing which is, in turn, screwed into the shell of the plug. It is possible of course to eliminate the bushing and mount the center electrode directly within the plug shell by forming the upper portion of the

bore of the shell of appropriate shapes to cooperate with the compression members and wedges as hereinbefore described. Consequently where the bushing is refered to in the appended claims, it is to be understood that such bushing may be made separate from or integral with the shell proper.

The foregoing detailed description sets forth the invention in its preferred practical forms, but the invention is to be understood as fully commensurate with the appended claims.

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

1. A spark plug comprising a bushing provided with a coaxial passage therethrough, a center electrode extending through the bushing, a plurality of relatively soft compression members of different metals having different coefficients of heat conductivity surrounding the center electrode, and electrically insulated therefrom, and relatively hard wedging means acting upon the several compression members and upon the bushing to form a multiple seal axially of the plug.

2. A spark plug comprising a bushing provided with a coaxial passage therethrough, a central electrode extending through the bushing, a plurality of relatively soft compression members of different metals having different coefficients of heat conductivity surroundeing the central electrode and electrically insulated therefrom, and a relatively hard wedge common to a plurality of such compression members and acting thereon and on the bushing to form gas tight seals between the bushing and the center electrode.

3. A spark plug comprising a bushing provided with an axial opening therethrough, an electrode spindle extending through said opening, and a plurality of leak-proof assemblies cooperating with the shell and electrode spindle at different portions of the length thereof and each of which assemblies embodies a plurality of relatively soft compression members of different metals having different coefficients of heat conductivity embracing the electrode spindle and electrically insulated therefrom, and a relatively hard wedge common to the compression members of each assembly and cooperating therewith and with the bushing to form leak-proof joints between the electrode spindle and the bushing.

4. A spark plug comprising a bushing provided with an axial opening therethrough, an electrode spindle extending through said opening, and a plurality of leak-proof assemblies cooperating with the shell and electrode spindle at different portions of the length thereof and each of which assemblies embodies a compression member of relatively soft material embracing the electrode spindle and electrically insulated therefrom, and a wedge of relatively hard material cooperating with such compression member and with the bushing to form leak-proof joints between the electrode spindle and the bushing.

5. A spark plug comprising a bushing provided with an opening therethrough and having within said opening an annular shoulder, an electrode spindle extending through the opening in the bushing, a plurality of relatively soft compression members of different metals having different coefficients of heat conductivity embracing the spindle and electrically insulated therefrom and positioned between the shoulder and the outer end of the bushing, and a relatively hard wedge forced into the opening of the bushing between the wall of the bushing and the compression members to form gas-tight joints between the spindle and the bushing.

6. A spark plug comprising a bushing provided with an opening therethrough and having within said opening an annular shoulder, an electrode spindle extending through the opening in the bushing, a plurality of relatively soft compression members of different metals having different coefficients of heat conductivity embracing the spindle and electrically insulated therefrom and positioned between the shoulder and the outer end of the bushing, and a relatively hard wedge forced into the opening of the bushing between the wall of the bushing and the compression members and in the direction of said shoulder to form gas-tight joints between the spindle and the bushing.

7. A spark plug comprising a bushing having an axial bore therethrough provided intermediate its ends with an internal flange having a substantially flat shoulder facing toward the inner end of the bushing, an electrode spindle passing through said bore and provided at its inner end with a spindle head, an insulating member, a metallic conductive ring embracing the spindle between the spindle head and the flange with said ring in engagement with said shoulder of the flange and electrically insulated from the spindle, and means for holding the spindle rigidly in position within the bushing with the ring and insulating member tightly clamped in position.

8. A spark plug comprising a bushing having an axial bore therethrough provided intermediate its ends with an internal flange having a substantially flat shoulder facing toward the inner end of the bushing, an electrode spindle passing through said bore and provided at its inner end with a spindle head, an insulating member, a metallic conductive ring embracing the spindle between the spindle head and the flange with said ring in engagement with said shoulder of the flange and electrically insulated from the spindle, and means for holding the spindle rigidly in position within the bushing with the ring and insulating member tightly clamped in position, said ring being of material of higher heat conductivity than the bushing.

9. A spark plug comprising a bushing having an axial bore therethrough provided intermediate its ends with an internal flange having a substantially flat shoulder facing toward the inner end of the bushing, an electrode spindle passing through said bore and provided at its inner end with a spindle head, an insulating member, a metallic conductive ring embracing the spindle between the spindle head and the flange with said ring in engagement with said shoulder of the flange and electrically insulated from the spindle, and means for holding the spindle rigidly in position within the bushing with the ring and insulating member tightly clamped in position, said ring being of material of higher heat conductivity than the bushing and also of higher heat conductivity than the body of the spindle.

10. A spark plug comprising a bushing having an axial bore therethrough provided intermediate its ends with an internal flange having a substantially flat shoulder facing toward the inner end of the bushing, an electrode spindle passing through said bore and provided at its inner end with a spindle head, an insulating member, a metallic conductive ring embracing the spindle between the spindle head and the flange with said ring in engagement with said shoulder of the flange and electrically insulated from the spin-

dle, and means for holding the spindle rigidly in position within the bushing with the ring and insulating member tightly clamped in position, said ring being of copper.

11. A spark plug comprising a bushing having an axial bore therethrough provided intermediate its ends with an internal flange having a substantially flat shoulder facing toward the inner end of the bushing, an electrode spindle passing through said bore and provided at its inner end with a spindle head, an insulating member, a metallic conductive ring embracing the spindle between the spindle head and the flange with said ring in engagement with said shoulder of the flange and electrically insulated from the spindle, a plurality of compression members embracing the spindle between the flange and the outer end of the bushing, and electrically insulated from the spindle, and a wedge forced between said compression members and the wall of the bushing to form gas-tight joints between the spindle and the bushing.

12. A spark plug comprising a bushing provided with a coaxial passage therethrough, a center electrode extending through the bushing, a compression member surrounding the center electrode and electrically insulated therefrom, and a wedge acting on the compression member to form a gas-tight seal between the bushing and the center electrode, said wedge and compression member having cooperating surfaces which, in the unstressed condition of the parts, have different tapers with the taper on the compression member greater than the taper on the wedge.

13. A spark plug comprising a bushing provided with a coaxial passage therethrough, a center electrode extending through the bushing, a compression member surrounding the center electrode, and a wedge interposed between the compression member and the bushing and coacting with a frusto conical surface on one of the latter, with the taper of said surface greater than the taper of the wedge when the wedge is in unstressed condition.

14. A spark plug comprising a bushing provided with a coaxial passage therethrough, a center electrode extending through the bushing, a plurality of compression members surrounding the center electrode, and a wedge interposed between the compression members and the bushing and coacting with a frusto conical surface on one of the latter, with the taper of said surface greater than the taper of the wedge when the wedge is in unstressed condition.

15. A spark plug comprising a shell, a bushing in the shell having a substantially flat shoulder facing toward the inner end of the bushing, an electrode spindle passing through the bushing, a head on said spindle, insulating elements embracing the spindle between the head and the bushing and abutting the flat shoulder of the latter, and a metallic ring embracing the spindle and interposed between the bushing and the insulating elements and in contact with both of them, said ring being of higher heat conductivity than the material of the bushing.

16. A spark plug comprising a bushing having an electrode spindle passing therethrough and electrically insulated therefrom, a head on the inner end of said spindle, there being formed on the bushing a substantially flat shoulder facing in the direction of the spindle head, a metallic ring interposed between said shoulder of the bushing and the head and embracing the spindle and electrically insulated therefrom, and an insulating element interposed between the ring and the head, said insulating element and ring being clamped tightly between the head and the bushing.

17. A spark plug comprising a bushing having an axial bore therethrough provided with an internal flange having a substantially flat shoulder facing toward the inner end of the bushing, an electrode spindle passing through said bore in insulated relation to the bushing and provided at its inner end with a spindle head, a metallic conductive ring embracing the spindle between the spindle head and said flat shoulder of the flange and electrically insulated from the spindle, and an insulating member embracing the spindle between the spindle head and the ring, said ring and insulating member being tightly clamped between the head and the flange.

18. A spark plug comprising a bushing having an axial bore therethrough provided with an internal flange having a substantially flat shoulder facing toward the inner end of the bushing, an electrode spindle passing through the bore and electrically insulated from the bushing and provided on its inner end with a head, a metallic heat conductive ring embracing the spindle between said flat shoulder of the flange and the head and electrically insulated from the spindle, but grounded with respect to the bushing, and an insulating member embracing the spindle between the ring and the head, said ring and insulating member being tightly clamped between the flange and the head.

19. A spark plug comprising a bushing having an axial bore therethrough and provided therein with a substantially flat shoulder facing toward the inner end of the bushing, a spindle passing through said bore, cigarette mica wrapped around the spindle to electrically insulate it from the bushing, a metal ring positioned between said shoulder of the bushing and the head and surrounding said cigarette mica, and mica washers interposed between said metal ring and the head, said ring and mica washers being clamped tightly between the bushing and the head.

20. A spark plug comprising a bushing having an axial bore therethrough, a spindle extending through said bore and provided at its inner end with a head, an internal flange within the bushing positioned intermediate the ends thereof and extending into spaced relation to the spindle, cigarette mica wrapped about the spindle, a metal ring embracing the cigarette mica below the flange and having a reduced extension projecting upwardly into the space between the flange and said cigarette mica, and mica washers positioned between the metal ring and the head, said metal ring and the mica washers being clamped tightly between said flange and the spindle head.

21. A spark plug comprising a bushing having therethrough an axial bore, a spindle extending through said bore and provided at its inner end with a head, cigarette mica wrapped around the spindle, an internal flange in the bushing extending into spaced relation to the mica wrapping of the spindle, a lower heat bridge of conductive metal embracing the mica wrapping of the spindle below the flange, a conductive metal heat bridge embracing the mica wrapping of the spindle above the flange with at least one of said heat bridges extending into the space between the flange and the mica wrapping into contact with the other heat bridge, and mica washers interposed between the lower heat bridge and the head with said mica washers and the lower heat bridge

tightly clamped between the flange and the head.

22. A spark plug comprising a bushing having therethrough an axial bore, a spindle extending through said bore and provided at its inner end with a head, cigarette mica wrapped around the spindle, an internal flange in the bushing extending into spaced relation to the mica wrapping of the spindle, a lower heat bridge of conductive metal embracing the mica wrapping of the spindle below the flange, an upper conductive metal heat bridge embracing the mica wrapping of the spindle above the flange with at least one of said heat bridges extending into the space between the flange and the mica wrapping into contact with the other heat bridge, mica washers interposed between the lower heat bridge and the head with said mica washers and the lower heat bridge tightly clamped between the flange and the head, and means for tightly securing the upper heat bridge in contact with the flange and with the cigarette mica wrapping of the spindle.

23. A spark plug comprising a bushing having an axial passage provided with an internal flange positioned in spaced relation to the inner end of the bushing, a spindle extending through the bushing and having a head at its inner end, cigarette mica wrapped around the spindle, a metallic ring embracing the cigarette mica wrapping and positioned between the head and the flange, and a mica insulating body interposed between the ring and the spindle head, said mica body and the ring being clamped tightly between the spindle head and the flange with the ring enclosed and protected from contact with burning motive fuel incident to plug operation.

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