Aug. 21, 1956 F. T. ANDERSON 2,759,989

IGNITION APPARATUS

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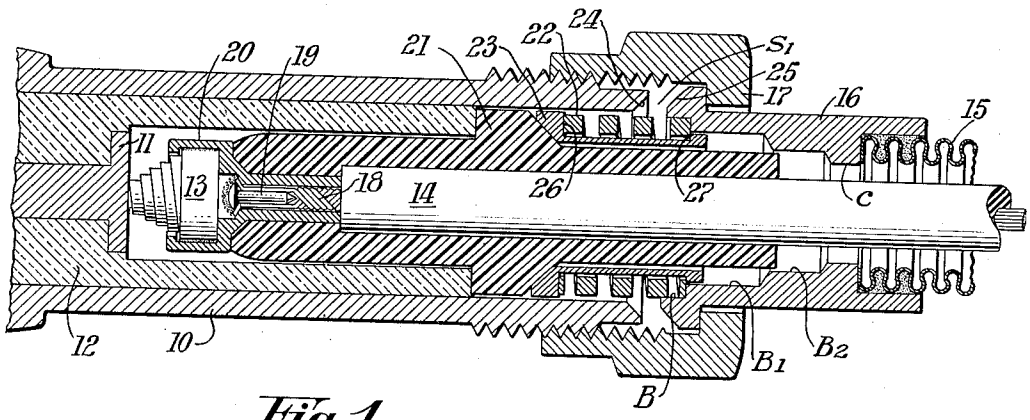


Fig. 1.

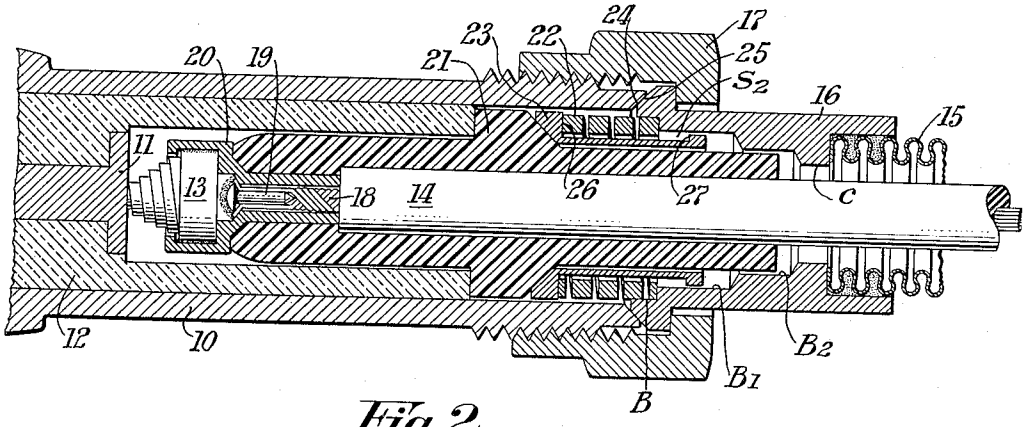


Fig. 2.

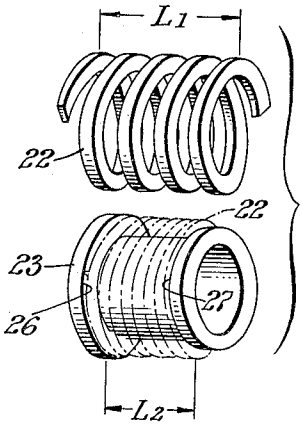


Fig. 3.

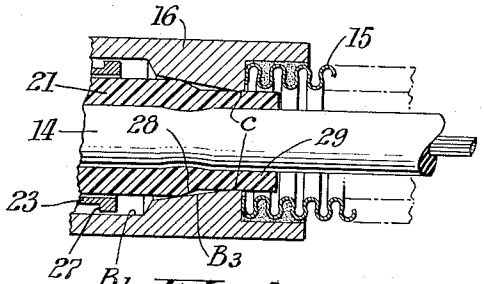


Fig. 4.

INVENTOR.
FRANKLIN T. ANDERSON
BY

AGENT

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IGNITION APPARATUS

Franklin T. Anderson, Westfield, N. J., assignor to Co-Operative Industries, Inc., Chester, N. J., a corporation of New Jersey

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4 Claims. (Cl. 174—35)

This invention relates to improvements in ignition apparatus. In particular, the invention is directed to improvements in sealed, high tension spark plug connections for aircraft power plants.

The spark plug for an aircraft engine, either reciprocating or turbine, must withstand conditions of relatively high temperature of the order of five hundred degrees Fahrenheit. To conduct current to the plug, a lead consisting of high tension cable is required, the lead being necessarily shielded to prevent the emanation of radio frequency current. A suitable connection is required to join the cable with the spark plug and the shield with the plug body. Like the plug, the components of the connection must be adapted for high temperature and, for optimum operation characteristics, the connection should afford the greatest possible protection against misfiring due to flashover from the current carrying conductor to ground, the likelihood of which increases as higher altitudes are attained where the danger of ionization of the air or gas is present in the vicinity of the high tension connection.

It is accordingly an object of this invention to provide a novel shielded spark plug connection which will withstand these higher temperature services with a minimum possibility of flashover at high altitude.

A further object of the invention is to provide a connection for a spark plug wherein the zone of the disconnectible electrode connection within the plug is sealed from the surrounding areas, and one which may be readily made-up and disconnected.

A still further object is to provide a rugged but simple, long life connection for shielded spark plugs which will satisfy the mechanical requirements of spark plug service and which may readily be fabricated of known materials and according to known practices.

With these and other objectives in mind which will become apparent during a consideration of a preferred physical embodiment of the invention disclosed herein, the present invention contemplates the usual type of shielded high tension spark plug and flexible shielding conduit through which a high tension cable is directed from a source of current. The customary spherical seat ferrule is attached to the conduit to make up with the internal chamfer of the shielding barrel of the plug and associated therewith is a generally accepted internal electrical contact. For an understanding of the novel features of the invention and their association with the abovementioned known parts, reference is made to the accompanying drawing forming a part of this specification, in which—

Figure 1 is a longitudinal cross-section view showing the improved connection of the invention,

Figure 2 is a view similar to Figure 1 with the electrical and mechanical joints fully secured,

Figure 3 is a perspective view showing components of the inner seal of the invention, and

Figure 4 is a fragmentary view in cross-section of modified elements in the made-up position of Figure 2.

Referring to Figures 1 and 2, numeral 10 indicates the well known shielded aircraft spark plug, only the connection portion of which is shown, centrally of which is the metallic electrode 11 which is insulated from the metallic plug shell by a fixed ceramic insulating bushing 12, the right hand end of which is hollow, terminating in a shoulder portion within the plug for a grommet seal. Electrical connection is effected within plug 10 by means of a helical compression spring 13 carrying current transmitted to the plug by the high tension cable 14, the latter extending from a suitable source, not shown, through a shielding flexible conduit 15. Conduit 15 is preferably of convoluted or bellows construction armored with the usual braid wire, on the terminal end of which is attached a ferrule 16 which closes against the spark plug barrel. Swivelably engaged over ferrule 16 is the spark plug nut 17 adapted to draw the ferrule against the plug into firm shielding contact.

Connection spring 13, providing the direct high tension connection with spark plug electrode 11 is nested in a known style of cylindrical retainer 20, electrical continuity between the spring and retainer being had by brazing or otherwise joining the parts. A through hole drilled axially of the retainer 20 permits the stranded conductor 18 of cable 14 to be threaded therethrough and secured as by the use of a small brass nail 19. A spot of solder or brazing material is used to cover the head of the nail further securing the stranded conductor 18 to retainer 20, and serving also to seal the hole.

A combination grommet and sleeve member 21, preferably of Teflon, is fitted over the end of cable 14 and encloses the necked down end of retainer 20 to abutment with the enlarged portion thereof which forms the well for spring 13. By adhering to an interference fit between sleeve 21 and retainer 20, an hermetic seal is effected therebetween. Further sealing the space surrounding the connection between spring 13 and electrode 11, as will be hereinafter more fully understood, is the engagement of the central flange portion of sleeve 21 and the open end of ceramic bushing insulator 12.

To effect pressure contact between the flange of sleeve 21 and insulator 12, I employ a pre-loaded spring assembly comprising a helical compression spring 22 and a hollow spring carrier 23, see Figure 3, the free length L1 of spring 22, as shown in the upper section of the view, being foreshortened to L2 by confinement between the end shoulders 26 and 27 on the carrier as illustrated in the phantom position below. Referring again to Figure 1, the spring carrier 23 with spring 22 is disposed over the right hand cylindrical end of the Teflon sleeve 21 with the internally chamfered end at the location of shoulder 26 mating with a corresponding tapered surface on the flange of insulator 21. On the opposite end of carrier 23 the spring overextends shoulder 27 diametrically to seat within the major bore B of ferrule 16. To the right of bore B is a somewhat smaller bore B–1 which will accommodate the right hand shoulder end of carrier 23 and a further bore B–2 adjacent bore B–1 in the ferrule 16 will admit the cylindrical end of sleeve 21. To the right of bore B–2 is a clearance bore C for the cable 14 to extend into flexible tube 15.

In the position of Figure 1 the connection has been made-up just to the positive abutment of the flange of sleeve 21 against the ceramic bushing 12. At this point there has been the slight compression of connector spring 13 against electrode 11 to ensure electrical continuity. Space S–1 remains between the internal chamfer 24 on the shielding body of the spark plug and the spherical seat 25 at the end of ferrule 16. Nut 17 has been threaded over the plug body for the first few turns but spring 22 has not been acted upon by the closure of the joint at this position. Thereafter, as nut 17 is threaded

to full engagement, as shown in Figure 2, space S–1 disappears to the extent that the faces 24 and 25 are in pressure contact. At the same time, the coil spring 22 has been substantially fully compressed thus urging carrier 23 against sleeve 21 which, in turn, will be pressed into sealing engagement with the end of insulator 12, completely closing the electrode contact zone.

During closure of the joint, shoulder 27 will move into bore B–1 and the end of sleeve 21 will extend further into bore B–2. It will be noted at this point, that ferrule 16 moves somewhat with respect to cable 14, the latter of which must remain in a fixed position during closure. By regulating the pre-loaded length L–2 and the corresponding elements of the connection, this relative movement of the shielding and cable may be kept advantageously small so that practically no buckling of the cable will result. At the same time, the full effectiveness of spring 22 may be had to produce a tight contact zone seal and furthermore, this seal may be had within the limits of a few threads of the shielding connection. The latter result is an advantage when it is considered that the initial make-up is effected without resistance except for that offered by the relatively minor effect of spring 13 used for electrode contact. By preloading a spring having optimum deflection versus pressure characteristics over the range of tolerances experienced with such connections, I thus attain the make-up advantage indicated without resorting to less desirable spring characteristics tending either to give poor seal or to overstress sleeve 21.

While the sleeve 21 may be constructed sufficiently long and with a sufficiently tight fit over cable 14 to prevent internal flashover from retainer 20 along the cable surface and to ground under normal circumstances, in cases where extreme altitude is experienced there is the increased possibility of such flashover. To avoid this type of failure I provide the components as modified according to Figure 4 with sleeve 21 sharply tapered as at 28 and extended through clearance C with a reduced section 29. In place of bore B–2 in ferrule 16, Figures 1 and 2, I substitute a tapered bore B–3 of deliberate mismatch with the tapered portion 28 of sleeve 21 and in interference therewith during make-up of the connection. Closure of the joint tends to constrict the sleeve 21 into firm, sealed engagement with the insulation of cable 14 and to thus prevent ionization of air between the cable and sleeve however slight, which would otherwise tend to shorten the effective path from high tension to ground. The mis-match of taper 28 and bore B–3 further makes this a possibility without losing the advantage of initially unrestricted make-up.

While I have herein illustrated my improvements in combination with the coil spring type of high tension connection, it is to be understood that this is illustrative only, and that the invention may be used with pin types of electrical connection which also require a pressure seal. It is also to be understood that the details in the foregoing are illustrative of a preferred physical embodiment of the invention and that changes may be made in the size, shape and material of the components of the invention without departing from the scope of the subjoined claim or claims.

Having thus described my invention, I claim:

1. In apparatus of the class described, in combination, a spark plug including a central electrode and a shielding shell and having insulation therebetween, a shielded current conducting cable terminating in a connector projecting from its shield and adapted to contact the spark plug electrode within the confines of the shell insulator, a grommet and insulating sleeve covering said conducting cable within the spark plug shell, said grommet and sleeve flanged to seal against the shell insulator and extending into the cable shield, means to connect the cable shield and spark plug shell a hollow, tubular spring carrier disposed over said grommet and sleeve extending between the flange thereon and the cable shield and telescopic within the shield, and a compression spring pre-loaded on said carrier and further compressible between said carrier and the cable shield.

2. In a connection for a high tension spark plug of the type having a shielding shell insulated from the central electrode, in combination, an insulated ignition cable, an ignition cable shield, a terminal for the cable projecting from the shield adapted to conduct current to a spark plug electrode, a sealed electrical connection between the terminal and cable, a flanged insulator sealed over the terminal end of the cable, a movable coupling to secure the cable shield to the spark plug shell a hollow, tubular spring carrier disposed over said flanged insulator extending between the flange thereon and the cable shield and telescopic within the shield, and a compression spring pre-loaded to a fractional part of its free length confined by said carrier and compressible between said carrier and the cable shield during telescoping of the carrier within the shield.

3. In apparatus for connecting two radio shielded, insulated conductors in the ignition system of an internal combustion engine or the like, the combination with one of said conductors of an insulating sleeve surrounding an end portion of said one conductor and projecting from its shielding enclosure, an annular flange on said sleeve for contact by the outer face thereof with an insulator of a second insulated conductor, a tubular spring carrier disposed over said insulating sleeve intermediate of said annular flange and the shielding enclosure of said one conductor, said carrier having a shoulder at one end to engage the inner face of the annular flange on said sleeve and having a shoulder on the opposite end thereof telescopic within said shielding enclosure, a compression spring member over said carrier deflected under stress to a fraction of its free length and retained between the said end shoulders of the carrier, and a stepped recess in said shielding enclosure engaging one end of said spring, but permitting said carrier to telescope therein.

4. Apparatus adapted for use in combination with a spark plug including a central electrode, a shielding shell and an insulator between said electrode and shell comprising a current conducting cable, a tubular shield for said cable, the latter terminating in a connector projecting from said shield and adapted to contact the spark plug electrode within the confines of said insulator, an insulating sleeve covering said conducting cable within the spark plug shell and extending into the cable shield, said sleeve having a flange thereon to seal against the shell insulator, means to connect the cable shield and spark plug shell, a hollow, tubular spring carrier disposed over said sleeve between the flange thereon and the cable shield and being telescopic within the shield, and a compression spring pre-loaded on said carrier and further compressible between said carrier and the cable shield.

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