Oct. 11, 1949. C. H. BENNETT ET AL 2,484,544

ELECTRICAL IGNITOR

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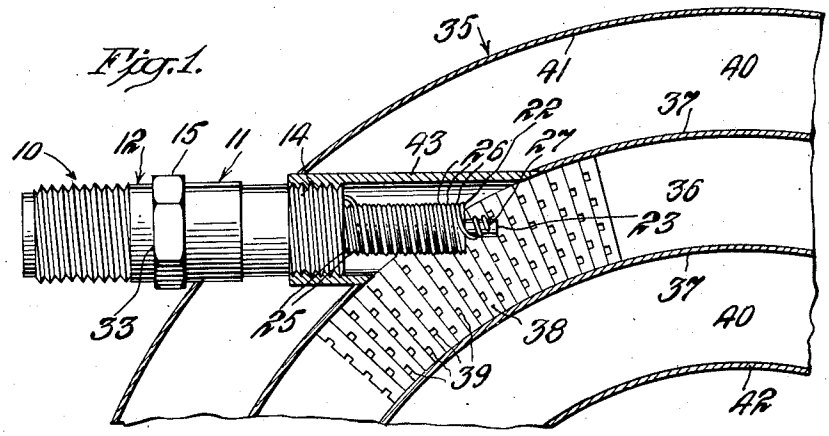
Fig. 1.



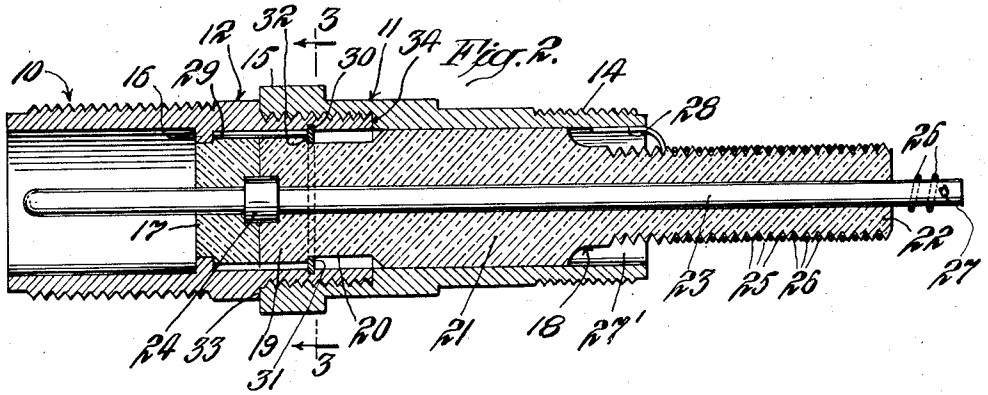


Fig. 2.

Fig. 3.

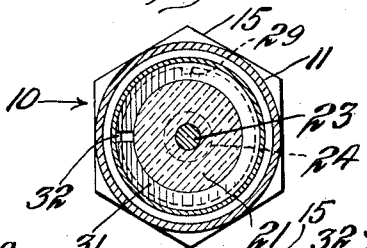
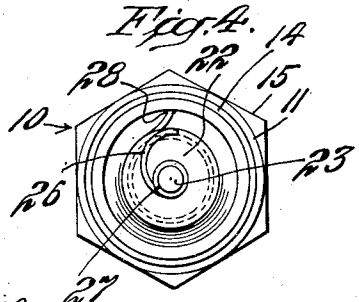


Fig. 4.



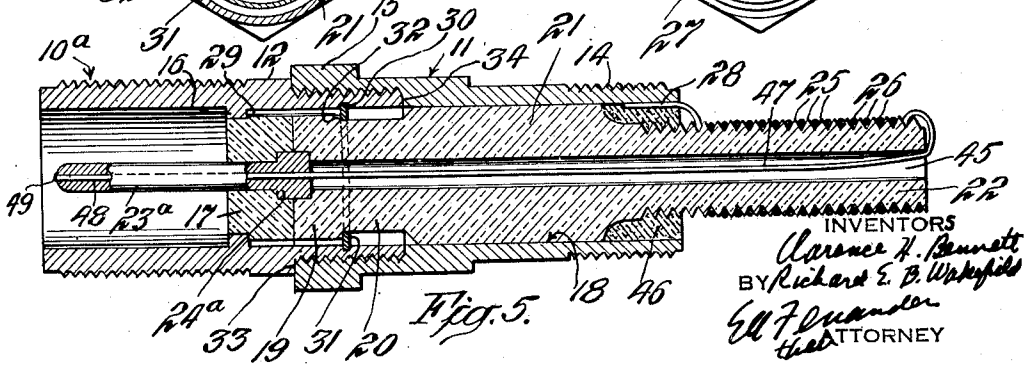


Fig. 5.

INVENTORS
Clarence H. Bennett
BY Richard E. B. Wakefield
Ellsworth Alexander
ATTORNEY

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ELECTRICAL IGNITER

Clarence H. Bennett, Philadelphia, and Richard E. B. Wakefield, Aldan, Pa., assignors to Selas Corporation of America, a corporation of Pennsylvania

Application February 1, 1944, Serial No. 520,640

1 Claim. (Cl. 219—32)

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This invention relates to electrical ignitors, and more particularly to such an ignitor having a high resistance wire heating element which is operated momentarily and for short intervals of time to instigate combustion of a combustible fuel mixture and thereafter disconnected from a source of electrical supply when combustion of the fuel mixture is effected.

Although not to be limited thereto, the improved electrical ignitor provided is especially useful in airplane heaters for initially effecting combustion therein. Airplane heaters now being provided operate with a combustible fuel mixture of gasoline and air inasmuch as gasoline is employed for operating the airplane motors and such fuel is available and readily lends itself for heater operation.

In order to effect ignition of a combustible mixture of gasoline and air, there is the initial requirement that an ignition temperature of about 1600° F. must be produced by the electrical ignitor. Further, the electrical ignitor must be equally effective to instigate combustion of the combustible fuel mixture at temperatures of 70° F. or as low as 60° F. below zero. In addition, the electrical ignitor must be capable of withstanding vibrations continuously produced and developed not only by the heater with which it is associated but also by the airplane in which the heater is installed.

The vibration problem has been an especially troublesome one in an effort to provide a satisfactory electrical ignitor for an airplane heater. Each time the ignitor is energized the heating element may be heated to a temperature of 200 or 300° F. above the requisite ignition temperature of about 1600° F., and it is at such times, when the wire heating element is relatively soft and at red heat, that the vibrations imparted to the ignitor tend to shorten its life. This is particularly true when there is non-uniformity in the heating of the wire heating element and so-called localized overheating or "hot spots" develop.

Moreover, when an airplane heater is started at relatively low temperatures, as at 60° F. below zero, for example, the blast of air and gasoline mixture passing over the ignitor exercises a relatively strong cooling effect which must be overcome by the wire heating element in order to produce a source of heat at a sufficiently high temperature to ignite the air and gasoline mixture at the ignition temperature of about 1600° F. In addition, the electrical supply usually provided in an airplane is a 24 to 28 volt system instead of the usual 110 to 125 volt electrical supply

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available in a dwelling and any heavy current drain on the system is objectionable.

In accordance with this invention, an improved electrical ignitor is provided which is exceptionally rugged and capable of withstanding constant and continuous vibration for long periods of use. This is accomplished by providing an ignitor including a core formed of refractory material which is externally threaded and about which substantially the entire length of a resistance heating wire is helically wound. The individual turns are evenly spaced and adjacent turns are shielded from one another by a wall of refractory material, so that substantially uniform heating of the wire is effected and localized overheating or excessive "spot heating" is avoided.

The portion of the core externally threaded and wound with the wire heating element is uncovered and completely exposed, so that all portions of the heating element will be subjected substantially to the same temperature conditions produced and developed by the ignitor. By providing a core of refractory material for the heating element, such material is quickly heated to a red heat by the wire heating element under the most adverse temperature conditions, whereby rapid and reliable ignition of the combustible mixture is effected with a minimum current drain on the electrical supply system.

The invention, together with the objects and advantages thereof, will become apparent from the following description taken in conjunction with the accompanying drawing forming a part of this specification, and of which:

Fig. 1 is a view of an electrical ignitor embodying the invention and a fragmentary sectional view of an airplane heater into the combustion chamber of which the ignitor extends;

Fig. 2 is an enlarged vertical sectional view of the ignitor shown in Fig. 1 to illustrate the invention more clearly;

Fig. 3 is a sectional view taken on line 3—3 of Fig. 2;

Fig. 4 is an end view of the ignitor shown in Figs. 1 and 2; and

Fig. 5 is a sectional view similar to Fig. 2 illustrating a modification of the invention.

Referring to the drawing, the electrical ignitor 10 embodying the invention comprises an outer shell including two threadedly connected parts 11 and 12 which may be referred to as a body and a connector, respectively. The body 11 is provided with an externally threaded outer end 14 and a hexagonal-shaped inner end 15, so that it

may be threaded tightly to the connector 12 with the aid of a suitable tool.

The connector 12 intermediate its ends is formed with an internal shoulder 16 against which bears a plug 17 formed of a suitable refractory material. A core 18 also formed of refractory material is disposed within the outer shell and includes a collar or end portion 19 which fits snugly against the plug 17, a reduced neck portion 20, a main body portion 21, and a reduced end portion 22 projecting beyond the externally threaded end 14 of the body 11.

The plug 17 and core 18 are formed with openings to receive a pin 23 having one end projecting into the housing formed by connector 12, and the opposite end extending a short distance beyond the projecting end portion 22 of core 18. In order to anchor the pin 23 firmly in position, the annular plug 17 and collar 19 are recessed at their contacting faces to receive an enlarged head 24 formed intermediate the ends of pin 23.

The outer projecting end 22 of core 18 is threaded, as indicated at 25 in Fig. 2, to form a helical groove about which is wound a wire or heating element 26. The wire 26 is tightly wound about the external portion 22 of core 18 and secured at its outer end at 27, as by brazing or welding, for example, to the pin 23. The reduced end portion 22 extends a short distance within the body 11 to form an annular space 27' opposite the externally threaded portion 14, and the inner end of the wire 26 is secured at 28 to the inner surface of the body 11, as by brazing or welding, for example, at the region of the annular space 27'.

In order to secure the plug 17, core 18 and pin 23 in position within the outer shell without subjecting these parts to excessive force or strain when the body 11 and connector 12 are threadedly secured together, the inner wall of connector 12 is formed with a longitudinally extending ridge or key 29 which terminates at one end at the shoulder 16 and at the opposite end at a circumferential groove or slot 30. The peripheral surfaces of the plug 17 and collar 19 of core 18 are provided with longitudinally extending keyways or slots formed to receive the ridge or key 29, thereby preventing rotating movement of the plug 17 and core 18 within the outer shell formed by body 11 and connector 12.

In order to prevent lengthwise movement of the plug 17 and core 18, a ring 31 is snapped into position into the circumferential groove 30. The ring 31 is firmly held in position in the groove 30 and overlies a shoulder 32 formed at the juncture of collar 19 and neck portion 20 of core 18, so as to hold the collar 19 and plug 17 in position against the shoulder 16 formed within connector 12.

When the ignitor 10 is inserted into a combustion space, it is highly desirable to provide an air-tight seal within the outer shell of the ignitor, so that flow of air from within the housing of the connector 12 past the refractory plug 17, collar 18 and pin 23 into the combustion space, is avoided. In order to insure such an air-tight seal, the portion of the pin 23 extending into core 18 is coated with a suitable high temperature cement, such as, for example, sodium silicate or the like, before being inserted into the core 18. Likewise, the recessed portions of the plug 17 and the collar 19, which receive the enlarged head 24 of pin 23, are coated with such a high temperature cement before these parts are assembled.

It has been previously stated that the ignitor 10 is especially useful for effecting ignition of a combustible fuel mixture in airplane heaters. In Fig. 1 the ignitor 10 is shown applied to an airplane heater 35 of a type generally similar to that disclosed in Hess and Townsend Patent No. 2,314,089, granted March 16, 1943. In order to simplify the drawing, only that portion of the airplane heater with which the ignitor 10 is associated, is illustrated in Fig. 1.

The airplane heater 35 includes a vertically extending combustion chamber 36 of annular shape having side walls 37. At the bottom of combustion chamber 36 is provided a burner screen 38 which may be formed of thin plates of refractory material stacked together and having slots or recesses formed therein to provide a plurality of burner ports 39. A mixture of air and atomized gasoline is introduced through the ports 39 into the combustion chamber 36, and the upper ends of the ports 39 constitute the regions at which a plurality of flames are produced and maintained.

The heat liberated in combustion chamber 36 by the burning of the air and gas mixture is given up to air passing through annular spaces 40 formed by the side walls 37 of combustion chamber 36 and outer and inner walls 41 and 42, respectively. Although the side walls 37 are shown as being smooth, these walls may be provided with fins (not shown) which may extend therefrom into the combustion chamber 36 and also into the spaces 40, so as to provide a relatively extensive heat transfer surface for taking up heat in combustion chamber 36 and giving up such heat to air passing through the annular spaces 40. The products of combustion are discharged from the combustion chamber 36 in any suitable manner, and the air heated in spaces 40 may be utilized to effect heating of one or several spaces in an airplane in which the heater 35 is adapted to be installed.

Since the airplane heater 35 forms no part of the invention and is merely illustrative, further description thereof will not be made here. If desired, reference may be made to the aforementioned Hess and Townsend patent for a detailed description of the airplane heater, the disclosure of which may be considered to be incorporated in this application.

To accommodate the ignitor 10, the airplane heater 35 is provided with a hollow sleeve 43 at the region of an opening formed in the outer side wall 37 of combustion chamber 36. The sleeve 43 extends outwardly from the combustion chamber 36 at such an angle that the inner end of the ignitor 10 is disposed above the burner screen 38 and extends lengthwise thereof for a short distance. The outer wall 41 of the heater 35 is formed with a suitably shaped opening in alignment with the sleeve 43, so that the ignitor 10 may be inserted into the heater and threadedly secured to the outer end of the sleeve.

A suitable electrical fitting (not shown) is adapted to be connected within the housing formed in connector 12 to connect the pin 23 to a source of electrical supply. The circuit for the ignitor is completed from the pin 23 through the wire heating element 26 and body 11 to the sleeve 43 which serves as a ground connection. The ignitor 10 is of a type which is only operated momentarily and at short intervals of time to instigate combustion of the combustible fuel mixture, and, after combustion has been effected, is disconnected from the source of electrical supply.

When the ignitor 10 is energized, the wire heating element 26 instantly becomes heated to a red heat and immediately thereafter and in a relatively short interval of time, viz—a matter of a few seconds, the threaded projecting portion 22 of the refractory core 18 begins to glow and also reaches red heat at a temperature of at least 1600° F. to effect ignition of the mixture of air and gasoline introduced into the combustion chamber 36. While it is imperative to produce this ignition temperature in the shortest interval of time possible, it must be accomplished without raising the wire heating element 26 to such a high temperature approaching its critical destruction point.

It has been found that by providing a wire 26 which is fully exposed throughout its entire length and wound about the threaded refractory part 22, an ignitor is obtained which is extremely reliable and effective to instigate combustion of a fuel mixture of air and gasoline. The wire 26 is of such size and length that its resistance will develop the desired high temperature of at least 1600° F. when connected to a 24 to 28 volt source of electrical supply usually available in an airplane. The threaded refractory part 22 is preferably formed of a ceramic which will withstand high thermal shock, and may be formed of any well known refractory material of the mullite type. The threaded refractory part 22 about which the wire heating element is wound serves as a heat stabilizer and prevents the wire heating element from reaching excessively high temperatures tending to rupture the wire.

In order to insure a more or less unform heating of the wire throughout its length, it is desirable to space the adjacent turns as uniformly as possible, so as to avoid any concentration of heat at localized regions of the wire which would occur when two adjacent turns are too close together. To avoid localized overheating or "spot heating" tending to rupture the wire, the helical groove 25 is of sufficient depth so that the adjacent turns of the wire are effectively shielded from one another by a wall of refractory material. In this way heat is always radiated and conducted from the wire toward a refractory wall surface rather than directly between two adjacent turns of wire openly exposed to one another.

The threaded refractory part also facilitates ignition of the combustible fuel mixture at abnormally low temperatures, such as, for example, 60° F. below zero. Under such conditions the the cool blast of air and gas mixture introduced into the combustion chamber 36 exercises a considerable cooling effect when passing over the ignitor 10. However, heat is both radiated and conducted from the wire 26 to the threaded refractory part 22 at a sufficiently rapid rate to bring the projecting part 22 to a red heat in a relatively short interval of time. Hence, the refractory part 22 serves as a heat reservoir and soon reaches a temperature which is sufficiently high to effect ignition of the combustible fuel mixture even under the most adverse operating conditions. In order to bring the refractory part 22 to a red heat quickly, this outwardly projecting part of core 18 is of reduced cross section and considerably smaller in diameter than the main body portion 21.

One of the important features of the ignitor 10 contributing to its reliability, is that the wire heating element 26 is fully exposed and uncovered throughout its entire length. In this way no heat

pockets are formed which tend to rupture the wire heating element, and the wire is heated substantially uniformly over the entire portion which is wound about the threaded refractory part 22. It will be seen in Fig. 2 that the wire 26 is not wound about the threaded portion within space 27' at the end of body 11, and that the first turn of wire is formed about the refractory part 22 a short distance outwardly from the extreme end of the body 11.

It has been found that in an airplane heater 35 like that described, the ignitor 10 preferably should be located about ¾" above the burner screen 38 in order to effect reliable ignition of the combustible fuel mixture under all operating conditions encountered. After ignition has been effected and the ignitor is de-energized, the outer projecting end 22 of core 18 is then subjected to the heated products of combustion at a temperature of at least 2300° F. The outer refractory part 22 should be sufficiently massive so that heat may be dissipated therefrom at a sufficiently rapid rate to the main body portion 21 of core 18 and to other parts of the ignitor to prevent overheating of the wire heating element 26 when the airplane heater 35 is being operated.

The wire heating element 26 may be formed of any suitable high resistance metal, such as Nichrome or platinum, for example. By way of example only and without limitation, an ignitor like that described and illustrated has been successfully used in which a 27" length of No. 25 B. & S. gauge Nichrome wire is wound for a distance of about ⅞" about a threaded refractory part approximately ⅜" in diameter. When connected to a source of electrical supply varying between 24 to 28 volts, without any external resistance, the current drain is about 5 amperes.

When the electrical supply is at about 24 volts, a temperature of about 1600° F. is produced at about 6 watts per linear foot of wire; and when the electrical supply is at about 28 volts, a temperature of about 1900° F. is produced at about 7 watts per linear foot of wire. Since the fusion point of Nichrome wire is about 2200° F., it will be evident that 7 watts per linear foot represents about the maximum capacity of the wire in the example just given. However, even under the most adverse operating conditions and while being subjected to vibrations developed by the airplane heater, the ignitor has been exceptionally reliable and ignition of the combustible fuel mixture has always been effected in a relatively short interval of time.

In Fig. 5 is illustrated an ignitor 10*a* which is a modification of the embodiment described above and in which parts similar to those illustrated in Figs. 1 to 4 inclusive are referred to by the same reference numerals.

In Fig. 5 the pin 23*a* only includes the portion projecting into the housing formed by connector 12 and terminates at the enlarged head portion 24*a*. Since the pin 23*a* does not extend through the core 18, the bore 45 in the core remains open throughout its length from the recessed collar end 19 to the extreme end of the threaded projecting portion 22. As in the embodiment illustrated in Figs. 1 to 4 inclusive, the wire 26 is tightly wound in a helical groove in the outer projecting portion 22 and secured at its inner end at 28 to the body 11. The annular space formed by the reduced end portion 22 within the outer end of body 11 may be filled with a suitable high temperature cement 46.

The wire or heating element 26 includes an

outer end portion **47** which, from the outer end of the coiled part on the reduced end portion **22**, extends through the opening **45** in core **18** and a small opening **48** in pin **23***a*. The end of the wire passing through the opening **48** in pin **23***a* is secured at **49**, as by brazing or welding, for example, to the extreme tip of the pin. The opening **48** is relatively small so that, after securing the end of the wire to the pin at **49**, the opening **48** is closed and sealed without increasing the size of the pin **23***a*, wherefore the usual electrical fitting (not shown) may be readily positioned within the housing formed in connector **12**.

The embodiment of Fig. 5 possesses the advantage that, when positioned in an airplane heater like that shown in Fig. 1, no brazed region at the outer threaded projecting portion **22** is subject to the high temperature heat products of combustion in combustion chamber **36**.

It has been found that the ignitors **10** and **10***a* illustrated and described are exceptionally reliable under the most adverse operating conditions encountered in practice. The disposition of the wire heating element **26** about the reduced threaded projecting portion of the refractory core about which adjacent turns are uniformly spaced and shielded from each other, and having the coil **26** uncovered and exposed throughout its entire length on the refractory portion **22**, have contributed considerably to the reliability of the ignitor. Even when the ignitors **10** and **10***a* are not disconnected from the source of electrical supply after ignition of the combustible fuel mixture has been effected, the ignitors have not failed and have stood up remarkably although the ignitors are positioned only a short distance from the burner screen **38**. This has been accomplished, it is believed, by the complete exposure of the heating element **26** on the threaded projecting portion **22** in the combustion chamber **36** and the effective dissipation of heat from the latter to other parts of the ignitor.

While several embodiments of the invention have been shown and described, it will be apparent to those skilled in the art that various

modifications and changes may be made without departing from the spirit and scope of the invention. Thus, the annular space **27'** at the outer end of body **11** in Fig. 2, for example, may also be filled with a suitable high temperature cement. It is therefore contemplated to cover all modifications and changes which come within the spirit of the invention, as pointed out in the following claim.

What is claimed is:

In an ignitor, the combination of an outer metallic shell, an inner refractory core snugly received in said shell, said core having a cylindrical portion projecting beyond said shell, said projecting portion being of a reduced diameter and having a helical groove formed on its outer surface and extending from the end thereof toward said shell, a resistance wire wound in said groove from a point adjacent to the end of said projecting portion to a point near the end of said shell, said wire and groove being of such relative sizes that the wire is entirely received in said groove whereby adjacent turns thereof are not exposed to each other, a terminal extending through said core, one end of said wire being attached to said shell and the other end thereof being attached to said terminal.

CLARENCE H. BENNETT.
RICHARD E. B. WAKEFIELD.

REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
2,024,387	Rabezzana	Dec. 17, 1935
2,129,962	Rabezzana	Sept. 13, 1938
2,404,841	Hess et al.	July 30, 1946

FOREIGN PATENTS

Number	Country	Date
571,909	France	Nov. 1, 1923
764,956	France	Mar. 12, 1934