Aug. 19, 1924. 1,505,762

J. H. BARNARD

IGNITION DEVICE

Filed Sept. 10, 1921

Fig.1.

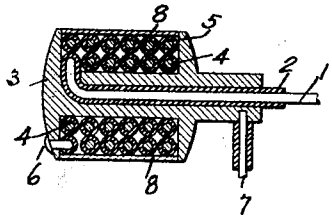


Fig.2.

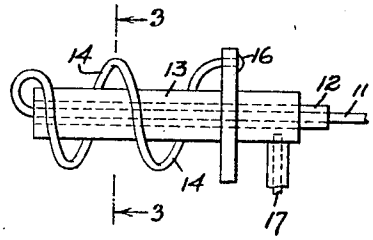


Fig.3.

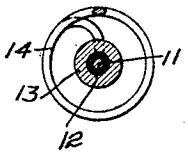


Fig.4.

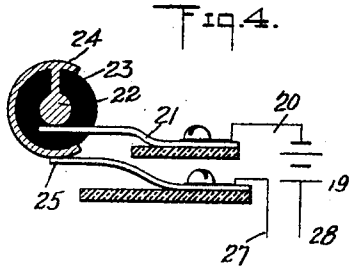


Fig.6.

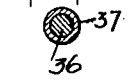


Fig.5.

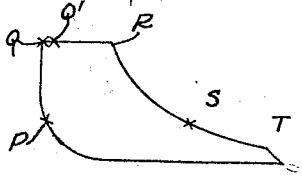


Fig.7.

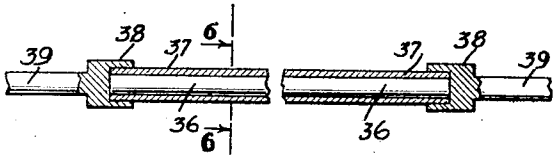
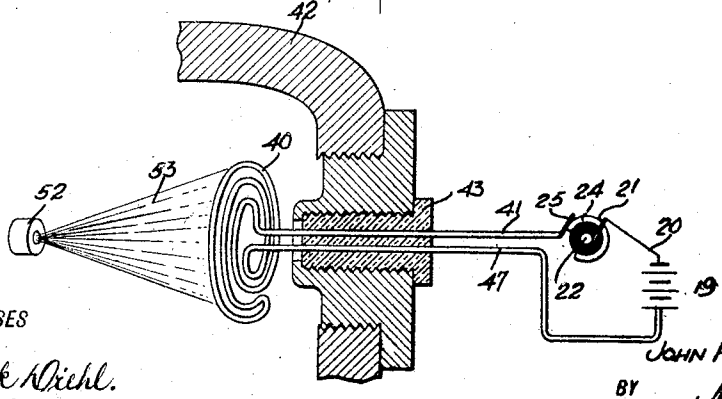


Fig.8.



WITNESSES

Frederick Diehl.

Percy Horstkotte

INVENTOR

JOHN H. BARNARD

BY Munn & Co.

ATTORNEYS

Patented Aug. 19, 1924. 1,505,762

UNITED STATES PATENT OFFICE.

JOHN HALL BARNARD, OF BROOKLYN, NEW YORK.

IGNITION DEVICE.

Application filed September 10, 1921. Serial No. 499,681

To all whom it may concern:

Be it known that I, JOHN H. BARNARD, a citizen of the United States, and a resident of the city of New York, borough of Brooklyn, in the county of Kings and State of New York, have invented new and useful Improvements in Ignition Devices, of which the following is a full, clear, and exact description.

My invention relates to new and useful improvements in means of igniting combustible mixtures, as in internal cumbustion engines, and, more particularly, in that class of such engines as includes those in which no fuel component is included in the power cylinder until just before or during the beginning of the power stroke. It may also be advantageously employed for providing a source of heat, or ignition, for other purposes wherein the conditions require sustained surface temperatures under intermittent demand.

In previous attempts by me to secure prompt and positive ignition in the heavy oil internal combustion engine described in my application, Serial No. 281,364, filed March 8, 1919, I have tried a wide variety of ignition devices, with but limited success; and among them have employed coils and helices of wires of low electric conductivity heated by a current through them only to find them but short-lived for reasons herein set forth.

In the drawings attached and forming part of these specifications,

Figure 1 is a longitudinal cross section of a usual form of heating coil wound of wire of suitable composition covered with proper insulation and the whole protected from deleterious surroundings by a shield of heat conducting material;

Figure 2 is an elevation of an ordinary open helix wound of bare resistance wire of selected composition more or less unaffected by surrounding conditions;

Figure 3 is an enlarged cross section of the helix along line 3—3 of Figure 2;

Figure 4 represents a simple form of current interrupter in series with the coil, or helix, and the source of electric current supply;

Figure 5 is an indicator card from a constant pressure internal combustion engine whereon are indicated the points in the power stroke between which the current is broken by the interrupter shown in Figure 4;

Figure 6 is a cross section of a composite wire which may be used in straight sections of suitable length or wound into helices as illustrated in Figure 2;

Figure 7 is a longitudinal cross section of such a composite wire as is shown in Figure 6 when made up ready for winding into a helix; and

Figure 8 is a perspective view of one form of my improved ignition or heating element as applied to the combustion chamber of a surface ignition internal combustion engine, the combustion chamber being shown in section.

In Figure 1 the current enters by the lead 1 separated by the insulation 2 from the metal of the spool 3 and passing through the inner and outer coils of insulated wires 4 and 5 is grounded on the reel at 6 and returns by the lead 7. The metal sleeve 8 protects the coils 4 and 5 and is raised to desired temperature by the heat radiated by them. Now it is not difficult to so adjust the flow of current so that, on the test stand, a balance can be reached between the energy converted in the coils and the heat radiated by the exterior surfaces that the sleeve may be raised to a bright glow and maintained at such for a reasonably long life. When, however, such a unit is used as an ignition element the task becomes one of much difficulty by reason of the rapid and violent changes in the rate of radiation. In such a cycle as mine, for instance, it is surrounded from the point P, in Figure 5, to the point Q by a heat absorbing mass of air and pulverized fuel which rapidly lowers the temperature. Then from Q to R there is a violent reversal of surrounding conditions in that the envelope becomes one of hydrocarbon vapors at a temperature of, possibly, 2500° F. From R to T the surrounding gases drop through a range from the point mentioned to possibly 1000° F. and from the opening of the exhaust at T to the completion of scavenging at P there is a further drop to the repetition of the cycle just traced. If, however, it could be assured that the variable conditions just enumerated would always be exactly repeated it would not be impossible to so regulate the flow of heating current that again a balance might be struck; but, instead, there is encountered the fur-

ther variations inseparable from starting a cold engine or in handling one in accordance with signals, the coming or the nature of which cannot be foretold. If, in starting, a misfire should occur the coils are simply subjected to the chilling effects without the sequence of a high surrounding temperature so that the calculated amount of current is insufficient to initiate the cycle. A signal to start cannot always be anticipated with the flow of current necessary to insure ignition yet be safe against a burn-out due to excess of current.

Under these conditions the requirements are best met by an open helix of the style shown in Figures 2 and 3 which can respond quickly to the renewal of a current interrupted by such a device as is shown in Figure 4 and may be so actuated by the engine that current shall never flow during those portions of the cycle when the wire may be expected to be surrounded by high temperatures. With such an arrangement in the circuit the wire cannot be subjected to internal heating while it is absorbing heat instead of radiating it. Relieved of such double heating a strength of current may be shown which will both suffice and prove safe under "stand-by" conditions.

In Figures 2 and 3 the current again enters by the lead 11 separated by the insulation 12 from the metal of the spindle 13, traverses the bare coil 14, is grounded at the point 16 and returns by the lead 17. In Figure 4 a source of current supply is shown, at the battery 19, whence the current flows through the wire 20 to the brush 21 bearing against the revolving spindle 22. From this the current reaches the segment 24 mounted on the insulation 23 and passes intermittently by the brush 25 to the lead 27 of the igniter. Thence it returns by the lead 28 to its source.

As used by me the segment 24 extends through 240° and the interruption of the current lasts through the remaining 120°. The spindle 22 is so connected with the engine that the current flow ceases about the point Q', which is practically at the center, and the circuit is completed again at about the point S in Figure 5.

In such an arrangement as has been so far described there may be used for the helix any resistor which has a sufficiently high fusing point to withstand the momentary temperatures to which it is subjected during combustion and is not very seriously affected by the products of combustion; but, for best results, and for durability, no single material, so far obtainable, is comparable with a composite conductor constructed as in Figures 6 and 7 of materials chosen with the following points in view.

It will be appreciated that when the glowing wire 14 in Figures 2 and 3 is intermittently and suddenly surrounded by a heat absorbing mist its surface temperature tends to fall except as it is sustained by heat conductivity from its center. It will further be realized that, with a cylindrical conductor, the ratio of its radiating surface is to its sustaining volume as is the diameter of the wire to the square of its diameter. From this it follows that the larger the wire the less is its surface temperature varied by intermittent abstractions; and, likewise, that the larger the diameter of the wire the less need be the original heat to prevent the surface temperature being too seriously reduced. From these considerations it follows that a larger wire of any given material offers a larger margin of safety than a smaller wire and, therefore, greater durability. Beyond the matter of size there remains a further factor to be considered and that is the contained mass and the heat absorptive qualities of the material to be employed and, for any given volume, the measure of the value of various possible materials is simply the product of the specific gravity by its specific heat. Applying this measure there will be found a surprising approach to equality through a wide range of very diverse materials with platinum standing very high with a product a little above 0.7. For this reason and because platinum has a particularly high fusing point and is little affected by the products of combustion of the hydrocarbons it ranks better than any single material except that its conductivity is fairly good or its resistivity is relatively very low. But, it so happens, that platinum is particularly ductile and can be drawn over, and caused to contain any more easily fused or more easily affected material which might otherwise be suitable. Such a material is Monel metal of which the product of its specific gravity and its specific heat is as high as 0.98, is easily drawn into wire and has a relatively high fusing point with a relatively low conductivity, its resistivity being about four times that of platinum. Under these circumstances I find it possible to form a composite wire as in Figures 6 and 7 which meets the requirements far better than any single material but, in so doing, I do not limit myself to platinum and Monel metal as the principles I have evolved and herein disclose are applicable to any other combination which may hereafter be recognized as better meeting the requirements I have enumerated.

In Figures 6 and 7, an outer coating 37 composed of a ductile metal which has a high fusing point and is little affected by the substances to be heated, is drawn over an inner core wire 36 which has a relatively high product of specific gravity by specific heat with an electrical conductivity lower than that of the coating wire. The ter-

minals are formed of metal of characteristics rather similar to those of the coating wire and are welded or otherwise securely fastened at 38 to seal and contain the core wire 36.

In Figure 8 there is shown a section of my composite resistor 40 coiled in pancake form as it may be installed within the combustion chamber of a surface ignition or "hot-bulb" internal combustion engine, and heat insulated from the walls of the "hot-bulb." Current from a battery 19 passes through an interrupter similar to that shown in Figure 4 and suitably driven from the engine. The leads 41 and 47 are separated from the metal of the walls 42 by the insulator 43. From the spray nozzle 52 the atomized non-volatile fuel 53 is projected upon the coil 40 which radiates sufficient heat to first vaporize and then ignite it. After a sufficient number of strokes for the coil and walls to become sufficiently heated the current may be discontinued.

While not confining myself to the special forms of construction shown nor to the particular materials named, what I have invented and desire to secure by Letters Patent is:

1. A resistance element composed of two concentrically disposed materials, of which at least one affords a relatively high value for the product of the respective coefficients of specific gravity and specific heat.

2. A resistance element composed of two concentrically disposed materials affording a relatively high combined value for the product of their respective coefficients of specific gravity and specific heat.

3. A resistance element composed of two concentrically disposed materials whereof the outer assures suitable surface characteristics and the inner one affords a relatively high product of its coefficients of specific gravity and specific heat.

4. A resistance element composed of two concentrically disposed materials one or both affording a relatively high value for the product of their respective coefficients of specific gravity and specific heat and whereof their combined electric characteristics render them suitable as an electric resistor.

5. A resistance element composed of two concentrically disposed materials in such proportions of each that they jointly afford the characteristics of an electric resistor with a relatively high combined value for the product of the respective coefficients of specific gravity and specific heat.

6. A resistance element composed of two concentrically disposed materials which when heated will momentarily afford a surface heat relatively high in proportion to its cross section.

7. A resistance element composed of two concentrically disposed materials which when electrically heated will intermittently afford surface heat relatively high in proportion to its cross section.

8. A resistance element for internal combustion engines comprising an electric resistor formed of a plurality of associated materials of which at least one affords a relatively high value for the product of the respective coefficients of specific gravity and specific heat.

9. A resistance element for use in the combustion chamber of an internal combustion engine comprising an electric resistor formed of a core and a shell enclosing the same, the core affording a relatively high product of its coefficients of specific gravity and specific heat and the said shell having a high fusing point, the said core having an electrical conductivity lower than the said shell.

10. A resistance element for use in the combustion chamber of an internal combustion engine comprising an electric resistor formed of an outer and an inner member, of which the inner member affords a relatively high product of its coefficients of specific gravity and specific heat and the outer member having a high fusing point and an electrical conductivity higher than that of the inner member.

11. A resistance element composed of two materials, of which at least one affords an exceptionally high value for the product of the respective coefficients of specific gravity and specific heat.

12. A resistance element including a body of Monel metal, and a covering of platinum.

JOHN HALL BARNARD.