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IGNITION COIL

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Fig. 1.

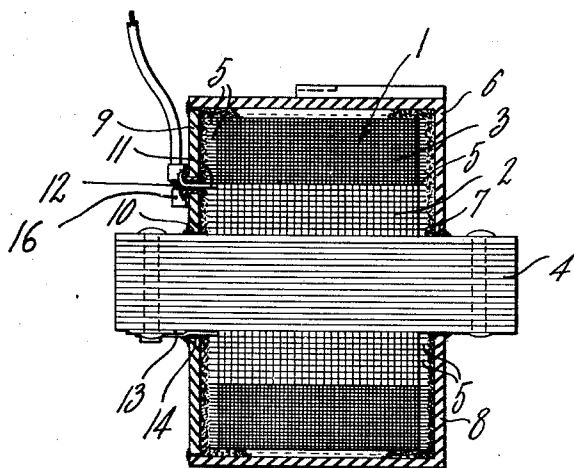
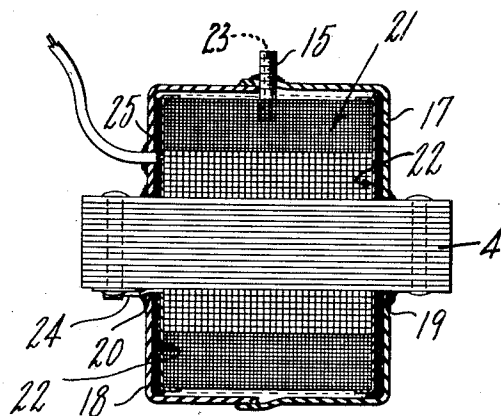


Fig. 2.



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IGNITION COIL

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7 Claims. (Cl. 175—361)

This invention relates to ignition coils, and particularly to ignition coils, preferably non-rotatable, for magneto electric generators and battery ignition systems in which the generating winding, usually primary and secondary turns arranged either one outside the other, surrounds an outwardly projecting magnetic core usually of laminated sheets of steel.

Ignition coils of this type contain superposed layers of turns of enameled or other insulated wires separated between layers and between the primary and secondary sections by paper sheets or other insulating material, the entire coil sometimes being vacuum impregnated with wax which when molten flows into the winding of the coil, and when cooled hardens into a hard solid mass. It is known that oil of suitable grade is a better insulation for high-voltage vacuum-impregnated ignition coils than is wax because the wax is more or less crystalline when solidified, and therefore does not then fill all the interstices of the paper or other insulation. But heretofore, while oil, being liquid, completely filled the interstices of the coil at all temperatures, it gradually escaped from the winding, particularly when the coil "breathed" upon being repeatedly subjected to heating and cooling in normal operation, and coils so treated eventually lost some of their resistance to electrical breakdown. To reduce the amount and rate of loss of the oil, the ignition coil is sometimes tightly taped and varnished by hand around the outside turns, and the end caps are machined and varnished, but this procedure is expensive without reliably overcoming the difficulty permanently.

It is a primary object of my invention to provide a high voltage ignition coil which is filled or over-saturated with or in effect bathed in oil and which retains a high degree of resistance to electrical breakdown throughout a longer period than heretofore possible. This is accomplished by sealing in a substantially fluid-tight manner the casing or container of the oil-filled coil, including the spaces around the laminated core, with material plastic or fluid when applied, which is flowed or spread and then squeezed into and around those places to fill them completely and which after hardening will not dissolve in or combine chemically with the oil within the range of temperatures of normal operation of the ignition coil.

Another object of my invention is to provide an ignition coil with a casing which is substantially sealed against the entrance of moisture and dust into the coil as well as against the loss of oil from the coil.

Another object of my invention is to provide an ignition coil of this kind which is inexpensive to manufacture and which is reliable in operation over long periods of normal operation.

These and other objects of my invention will be apparent from the ensuing description of two modifications of my ignition coil and from the accompanying drawing illustrating such coils, for magnetos as an example, in which:

Fig. 1 shows a longitudinal section through a coil constructed in accordance with the invention, and Fig. 2 shows a similar view of a modified form.

In the drawing, the reference numeral 1 indicates a coil comprising a section 2 of primary turns inside the section 3 of secondary turns and surrounding a laminated steel core 4 with projecting ends. The separate turns of the coils are insulated from one another by enamel and the separate layers are separated by a suitable insulation 5 as untreated linen or kraft paper sheets, the primary and secondary sections being suitably insulated from each other by cardboard or the like. The insulation 5 between layers projects beyond the end turns of the layers, but in my coils the extent of this projection may be less than formerly on account of the high and permanent insulating property of the oil impregnation hereinafter described. This entire coil structure is subjected to a temperature of 250° F. in a suitable impregnating tank for approximately five hours, and then for several hours more is also subjected to a high degree of vacuum, to thereby remove all air and moisture. While still under this vacuum, insulating oil of well known kind, preferably mineral, under atmospheric pressure and at a temperature of about 250° F., is allowed to enter the tank to a level above the top of the coil and to remain there until all insulations are thoroughly impregnated, and all interstices in the coil including the paper between the layers of turns and between the primary and secondary sections, and all spaces in and around the laminated core, are completely filled. After a sufficient period, the coil is removed from the tank and the excess oil wiped from the outside of the coil.

Having been so treated, the coil is ready for assembly in a housing which in the instance shown comprises a preformed cup-shaped member 6 of molded bakelite or bakelized paper having a central opening 7 in the closed end 8 thereof. The central opening 7 is slightly larger than the external dimensions of the core 4, and the tubular walls of the cup-shaped member 6 have an internal diameter somewhat larger than the external diameter of the coil to leave a small space therebetween for ease in assembly and to permit expansion of the oil within the casing under varying temperature conditions in normal operation of the coil. Prior to the insertion of the coil in the cup-shaped member, a liberal amount of high melting point compound, the properties of which are more fully described here-

inafter, is flowed over one end of the coil from a heated tank. The coil 1 is then inserted into the housing so that the core 4 projects through the opening 7, and is pressed down firmly into the casing so that the compound, still molten or plastic, flows through all clearances between the core 4 and the sides of the opening, and also uniformly over that end of the coil, and partly into the space between the outside periphery of the coil and the housing. A layer of the same compound is then placed over the other end surface of the coil, being applied liberally around the core 4 and around the edge or rim of the cup-shaped member 6. Before this compound has a chance to solidify, a preformed cover 9 with a central opening 10 likewise slightly larger than the core 4, and with the low tension lead 11 threaded through the opening 12 and the ground connection 13 accommodated in the cutout 14, is pressed down firmly so that the compound is squeezed into all spaces and interstices at and near that end of the coil including the clearance between the rim of the cup-shaped member 6 and the edge of the cover 9 and also around the lead 11 and connection 13. The compound also fills the clearances between the core and the edges of the opening 10. The cup-shaped member 6 is provided with a hollow high tension terminal 15 (see Fig. 2) for the secondary winding of the coil and a low tension terminal connector 16 for the primary winding. The openings of these terminals are suitably sealed with solder after the leads are pulled tightly therethrough. After the compound has hardened at all these places, the coil is sealed in a fluid-tight manner so that substantially none of the oil with which the coil has been filled is lost even upon repeatedly reaching operating temperatures as high as 220° F.

A compound which is of high melting point, that is one which will not sag from gravity below a temperature of 250° F., is used to prevent so-called "cold flow" at any temperature to which the coil is subjected in normal use. Also the compound is preferably of the kind which below that temperature will not readily dissolve in, or chemically combine with, the oil with which the wound core is filled. Preferably, a high melting coal tar rather than petroleum tar is used, and a mineral filler or other inert material, such as fuller's earth, chalk or talcum, may be mixed as a powder in the tar to further raise the desired high cold flow temperature.

It will be obvious that the Bakelite housing structure might be formed with two separate end caps instead of one integral closed end 8 and the single cap 9. Such a construction is cheaper to manufacture than the form shown since the casing may then be cut from a long tube, whereas the two end caps, as 9, can be stamped out of flat sheets. However, in such a construction more joints need be sealed against oil leakage.

The above described construction is desirable for use where the coil is placed in an exposed position. Where the coil is protected, as for example by enclosure in a magneto housing, I prefer the construction shown in Fig. 2 in which the coil core is encased in a housing of elastic material. Ordinary rubber is not suitable for this purpose since it deteriorates when in contact with oil, but synthetic rubber, such as neoprene, thiokol and the like, does not deteriorate on contact with oil and is therefore suitable for this purpose. As shown, two preformed cup-shaped members 17 and 18 having openings 19 and 20 of slightly less

cross-sectional area than the cross-sectional area of the core 4 of the coil 21, are pressed over the assembled core and coil with the projecting end portions of the core extending through the openings 19 and 20. The untreated coil windings of this construction are substantially the same as the ones previously described except that paper or varnished silk washers 22, having a diameter slightly larger than the secondary coil, with square holes punched in the center thereof, are placed over each end thereof prior to insertion in the cup-shaped members 17 and 18. These washers act as protective aprons which prevent the sealing compound from sealing the ends of the paper layers between the windings. The cup-shaped member 17 is slightly longer than the cup-shaped member 18 and the edges of the cup-shaped members overlap and are united by sealing with a neoprene or similar rubber cement which is first liquid or plastic and later vulcanized by heat to form a fluid-tight lap joint extending circumferentially around the coil. The openings in the housing at the core, the high tension terminal 15, the grounding connection 24 and the low tension wire 25 are originally of slightly less size than the parts they surround so as to tightly grip them. The joints there are also sealed with neoprene cement, thus forming a completely fluid-tight housing. The vulcanizing of the neoprene cement sealing all joints is accomplished by baking the entire assembly for two hours at a temperature of 260° F.

In this embodiment of Fig. 2, the coil may be first impregnated with oil before its insertion in the elastic housing as described in connection with the structure shown in Fig. 1, but preferably the casing is filled with oil after the housing structure has been vulcanized together and sealed as shown around the unimpregnated windings. In this latter case, the assembled coil structure is subjected to a vacuum impregnating process at 250° F. and then filled with insulating oil as previously described. The oil enters the casing through the opening 23 in the high tension terminal. As in the first embodiment, this hole is afterwards sealed by soldering.

This form provides an oil-tight elastic casing which permits the necessary amount of expansion and contraction of the oil within the casing under varying temperature conditions in normal operation of the coil without loss of oil. If in the process of heating the oil in the casing produces a pressure therein due to expansion of vapor, the elastic casing will expand slightly instead of permitting the oil to be forced out through some of the joints. On cooling, the casing will contract as the vapors condense, thus avoiding any tendency to draw external air and moisture into the casing.

Both constructions provide a structure in which the wires of the superposed layers of the windings of the coil, the sheets of insulating material between the layers, and the core are filled with oil and in which the casing is so sealed that the core will not dry out. Even if slight openings do form in the casing, the amount of leakage of oil is slight, particularly since the paper or other insulating material between the layers holds the oil by capillary action. In both embodiments herein described, all openings in the complete casing, including the spaces where the core passes through the end walls, around the high and low tension leads and at the joints between the parts of the casing, are tightly sealed in a fluid-tight manner with a material which is molten or plastic

when applied but which hardens or is hardened after being squeezed into all open spaces and cooled, and which when hardened does not dissolve in or chemically combine with the insulating oil in the range of normal operating temperatures of the coil extending up to 220° F.

Although there are herein described but two embodiments of the invention other embodiments within the scope of the appended claims will be obvious to those skilled in the art from a consideration of the forms shown. For instance, it will be obvious that the coil winding with its core may be vacuum treated under heat, filled with oil as aforesaid and then completely sealed in fluid-tight manner in a metal or other container by insulating material like that described in connection with the first embodiment which has a comparatively high temperature of cold flow but which melts at a suitably high temperature. Such ignition coils are particularly adapted for present battery ignition coils of well known forms which have insulating caps and no core portions projecting outside the containers, as for instance the type shown in Ehrlich et al. U. S. Patent No. 1,977,122.

Having thus described my invention, what I claim is:

1. A high-voltage ignition coil comprising windings of superposed layers of insulated wires; insulating sheets between said layers; a core for said coil; insulating oil filling the interstices of and the open spaces in and between said wires, sheets and core; and a fluid-tight casing comprising two preformed members of oil-resistant material surrounding said windings, each of said members forming an end wall of the casing and each of said end walls having a central aperture therethrough through which an end of the core projects; said casing being fluid-sealed interiorly at the joints between said end portions and said core with a material which below 220° F. does not flow or dissolve in or chemically combine with said insulating oil.

2. A high-voltage ignition coil comprising windings of superposed layers of insulated wires; insulating sheets between said layers; a core for said coil; insulating oil filling the interstices of and the open spaces in and between said wires, sheets and core; and a fluid-tight casing comprising two preformed members of oil-resistant material surrounding said windings, each of said members forming an end wall of the casing and each of said end walls having a central aperture therethrough through which an end of the core projects; said casing being fluid-sealed interiorly at the joints between said end portions and said core with a tar product of high cold flow temperature which has an inert filler.

3. A high-voltage ignition coil comprising windings of superposed layers of insulated wires; insulating sheets between said layers; a core for said coil having end portions projecting therefrom; insulating oil filling the interstices of and the open spaces in and between said wires, sheets and core; and a fluid-tight casing comprising two preformed members of oil-resistant material surrounding said windings, each of said members forming an apertured end wall through which said end portions of the core project; said casing being fluid-sealed interiorly at the joints between said end portions and said core with a material

which below 220° F. does not flow or dissolve in or chemically combine with said insulating oil.

4. A high voltage ignition coil comprising windings of superposed layers of insulated wires; insulating sheets between said layers; a core for said coil having end portions projecting therefrom; insulating oil filling the interstices of and the open spaces in and between said wires, sheets and core; and a non-metallic fluid-tight casing comprising two preformed members of oil-resistant material surrounding said windings each of said members forming an apertured end wall through which said end portions of the core project; said casing being fluid-sealed interiorly at the joints between said end portions and said core with a material which below 220° F. does not flow or dissolve in or chemically combine with said insulating oil.

5. A high-voltage ignition coil comprising windings of superposed layers of insulated wires; insulating sheets between said layers; a core for said coil; insulating oil filling the interstices of and the open spaces in and between said wires, sheets and core; and an elastic oil-resistant casing comprising two preformed members surrounding said windings, each of said members forming an end wall of the casing and each of said end walls having a central aperture therethrough through which an end of the core projects; said casing being fluid-sealed interiorly at the joints between said end portions and said core with a material which below 220° F. does not flow or dissolve in or chemically combine with said insulating oil.

6. A high-voltage ignition coil comprising windings of superposed layers of insulated wires; insulating sheets between said layers, a core for said coil having end portions projecting therefrom; insulating oil filling the interstices of and the open spaces in and between said wires, sheets and core; an elastic oil-resistant casing comprising two preformed members surrounding said windings, each of said members forming an apertured end wall through which said end portions project; and, extending through said casing from said winding, a sealed-off hollow high-voltage terminal which, when open, forms a passage for insulating oil to the interior of said casing; said casing being fluid-sealed interiorly at the joints between said end portions and said core with a material which below 220° F. does not flow or dissolve in or chemically combine with said insulating oil.

7. A high-voltage ignition coil comprising windings of superposed layers of insulated wires; insulating sheets between said layers, a core for said coil having end portions projecting therefrom; insulating oil filling the interstices of and the open spaces in and between said wires, sheets and core; and a fluid-tight casing comprising two preformed members of elastic material surrounding said windings each of said members forming an apertured end wall with openings of slightly smaller area than the cross-sectional area of said end portions of the core, whereby said elastic material grips tightly the projecting portions of the core when the latter are inserted into said openings; said casing being fluid-sealed interiorly at the joints between said end portions and said core with a material which below 220° F. does not flow or dissolve in or chemically combine with said insulating oil.

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