May 15, 1956 E. W. LAUTENBERGER 2,746,020

ELECTRIC COIL ASSEMBLY

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Fig. 1.

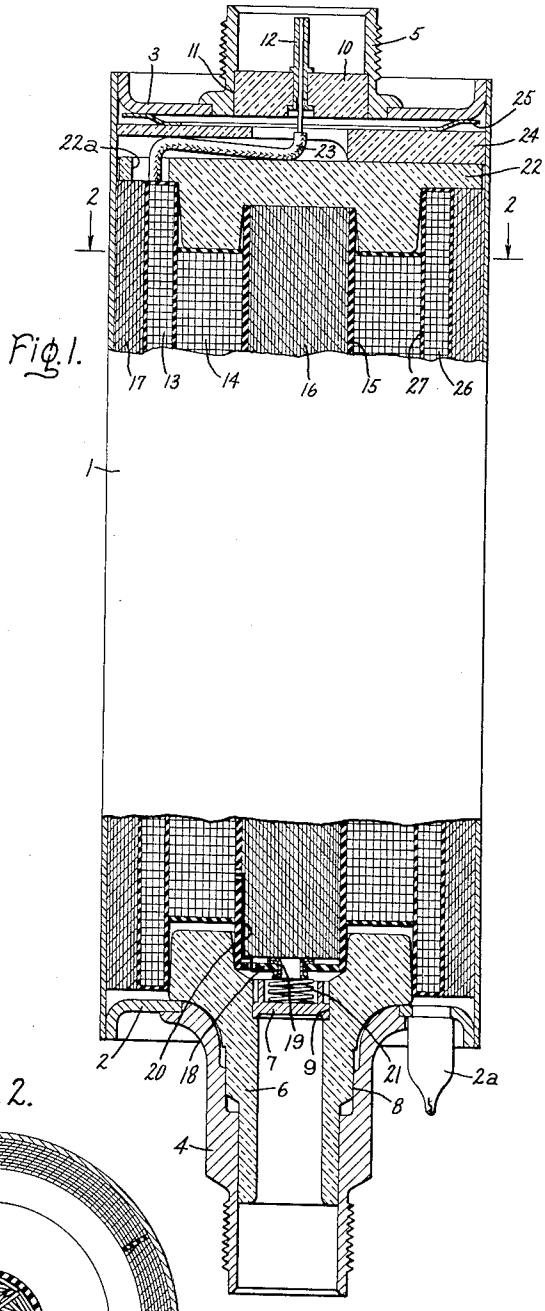
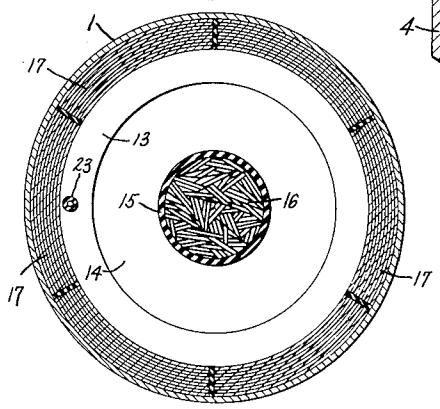


Fig. 2.



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ELECTRIC COIL ASSEMBLY

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6 Claims. (Cl. 336—55)

My invention relates to electric coil assemblies, and more particularly to high temperature, high voltage electric ignition coils for transformers.

In ignition systems for aircraft gas turbines, jet engines and the like, it has been found expedient to mount ignition transformers or coils in locations subject to very high temperatures, i. e., temperatures of the order of 200 to 400° F. At such temperatures, conventional ignition coils of high voltage rating, such as 20 to 30 kilovolts, have been subject to severe corona loss and to eventual breakdown as a result of overheating and decomposition of the insulating materials utilized in the assembly.

Accordingly, therefore, it is a principal object of my invention to provide a new and improved electric coil assembly capable of withstanding excessively high ambient temperatures without experiencing breakdown or appreciable deterioration.

It is a further object of my invention to provide a high voltage electric ignition coil capable of withstanding excessively high ambient temperatures without deterioration or undue corona loss.

It is a still further object of my invention to provide a new and improved electric ignition coil of the foregoing type while, at the same time, reducing the physical size and weight of the coil with respect to the most nearly comparable coils heretofore known.

In carrying out my invention in one form, I provide a multilayer winding of insulated electric conducting wire having interlayer insulation of sheet material, the entire winding being impregnated with an insulating liquid such as a polysiloxane liquid in the form of either an oil, a gel, or a grease. Preferably, the interlayer insulation is formed of an asbestos-bearing sheet material and the turn insulation is a resin bonded, comminuted ceramic material electrophoretically deposited upon the coil wire. The coil thus formed is mounted in a sealed container which is then filled with an insulating gas under pressure. Preferably the insulating gas is constituted principally of nitrogen and includes a trace of a halogen-bearing gas, such as sulfur hexafluoride, a fluorinated hydrocarbon or the like. I have discovered that a liquid impregnated winding thus mounted in a gas-filled container under pressure provides a very substantially improved coil, especially in respect to its corona suppression characteristics, and in respect to its permissible ambient temperature rating since the gas enclosed within the container accommodates thermal expansion and contraction of the liquid impregnant in the coil windings.

My invention itself will be more fully understood and its various objects and advantages further appreciated by referring now to the following detailed specification taken in conjunction with the accompanying drawing, in which Fig. 1 is an axial cross-sectional view of an electric ignition coil assembly embodying my invention, and Fig. 2 is a transverse cross-sectional view of the coil shown at Fig. 1 taken along the line 2—2 of Fig. 1.

Referring now to the drawing, I have there illustrated as a preferred embodiment of my invention an electric

ignition transformer mounted in a cylindrical sealed container. The container comprises a cylindrical metal casing 1 having a pair of end caps or covers 2 and 3 fastened in opposite ends thereof, as by welding, brazing, or the like. Each end cap is centrally apertured and has mounted thereon an outwardly protruding tubular metallic sleeve arranged to accommodate an electric terminal connector. Thus, the end cap 2 has fixed thereto, as by copper brazing, a tubular sleeve 4, and on the end cap 3 is mounted a tubular sleeve 5. Within the end sleeve 4 there is fixedly mounted a tubular high-voltage insulator 6 having an enlarged annular shoulder at its inner end and having fixed in the central bore thereof an electric terminal cap 7. The insulator 6 is preferably formed of a high temperature ceramic material, such as aluminum oxide or the like. A gas-tight seal between the end sleeve 4 and the ceramic insulator 6 is formed at an annular region 8, and a similar seal between the insulator 6 and terminal contact 7 is formed at an annular region 9 by any suitable ceramic-to-metal sealing process. The end sleeve 5 is provided internally with a ceramic insulating disk 10 formed of the same material as the insulator 6 and similarly sealed to the end sleeve 5 in an annular region 11. The insulator 10 is centrally apertured and has mounted therein and sealed thereto a metal terminal stud 12.

Within the sealed container described above, there is fixedly mounted a transformer coil unit comprising concentrically wound primary and secondary windings 13 and 14, respectively, mounted upon a tubular insulating spool 15. The insulating spool 15 is tightly filled with strips 16 of magnetizable material, such as a silicon steel or the like, and the external periphery of the primary winding 13 is encased in a laminated cylindrical body 17 of similar magnetizable material. As shown at Fig. 2, the cylindrical outer core member 17 is preferably split radially into a plurality of arcuate segments for the purpose of minimizing eddy current losses.

The enlarged inner end of the high-voltage insulator 6 is provided with an annular central recess into which one end of the tubular insulating spool body 15 fits loosely. At this end, the insulating tube 15 is provided with a nonmetallic end cap 18 in which is fixed a metal terminal rivet 19. A lead wire 20 from one end of the secondary winding 14 is connected to the rivet 19. Electric connection between the terminal rivet 19 and the high-voltage terminal contact 7 is made by a helical contact spring 21, which may be fixed to the end cap 18 by the rivet 19.

At the opposite end of the transformer coil unit there is provided an insulating end cap 22 fitting loosely over the end of the insulating tube 15 and apertured at 22*a* to accommodate a low-voltage lead wire 23. The wire 23 leads from one end of the primary winding 13 to the terminal stud 12. The other coil leads may be connected in any suitable manner. For example, the other coil leads may be connected together and grounded to the casing, or the other secondary lead may be connected to the lead 23 and the other primary lead grounded. To complete the assembly, there is provided, adjacent the insulating end cap 22, a ceramic insulating spacer 24 and a resilient spring ring 25 disposed between the spacer 24 and the metal end cap 3 of the container. Preferably the insulating end cap 22 and insulating spacer 24 are formed of a high temperature ceramic insulating material, such as a glass-bonded, finely divided mica, commercially known as Mycalex.

In a preferred embodiment of my invention, the primary and secondary windings 13 and 14, respectively, are multilayer windings of insulated electric conducting wire 26 having interlayer insulation 27 of high temperature sheet material. In such preferred form, the turn in-

sulation is formed as an integral ceramic covering upon the wire itself, such as by electrophoretic deposition of a comminuted refractory material in the manner described and claimed in Patent 2,386,634—Robinson. A particularly suitable high temperature interlayer insulation is an asbestos bentonite sheet material known commercially as terratex, such as described and claimed in Patent 2,493,604—Walters.

Prior to assembly in the container the coil unit, including the core members 16 and 17 and the primary and secondary windings 13 and 14, insulated as previously described, is saturated with an impregnant consisting of a suitable high temperature insulating liquid. Preferably such insulating liquid is a polysiloxane liquid, such as methyl polysiloxane oil or the like, described and claimed in Patent 2,469,890—Patnode. It will be entirely apparent to those skilled in the art that the liquid insulating impregnant may equally well be in the form of an oil, a gel, or a grease, and it is my intention that the term "liquid" as used in this specification and the claims appended hereto shall include all such substances, as distinguished from fluids of the gaseous type.

After liquid impregnation of the coil unit, the unit is inserted in the container and positioned in the manner shown in Fig. 1, with the coil unit disposed in spaced relation to walls of the container and the liquid impregnant carried wholly within the coil unit. Preferably the coil unit is inserted from the low-voltage end of the container and positioned with the contact spring 21 in firm contacting engagement with the terminal cap 7. The insulating spacer 24 and the spring disk 25 are then positioned adjacent the end of the coil unit, and the end cap 3 finally welded in place.

Following the foregoing assembly of the liquid impregnated coil unit in the sealed container, all spaces between the impregnated coil unit and the walls of the container are filled around the impregnated coil unit with a suitable insulating gas under pressure. For this purpose, the end cap 2 is provided with a short length of gas inlet conduit 2*a* which is connected to a suitable source of gas supply and then pinched off and sealed under pressure. I have found that a highly satisfactory insulating gas is nitrogen. Preferably a halogen-bearing gas, such as a fluorinated hydrocarbon or sulfur hexafluoride, may be mixed with the nitrogen or other insulating gas, and when so mixed it contributes to corona suppression and permits detection of leakage by use of a halogen detector. Such halogen-bearing gas may be mixed in any desired proportion from a mere trace to a major proportion, but I prefer to utilize a major proportion of nitrogen and a trace of sulfur hexafluoride.

While the pressure under which the gas is maintained in the container is not particularly critical, and a wide range of pressures may be advantageously utilized, I have found that an optimum pressure is approximately 75 lbs./eq. in. above atmospheric. It will be understood, of course, by those skilled in the art that the actual pressure of the gas varies in use in accordance with the coil temperature under operating conditions, the 75 lbs./sq. in. pressure previously referred to being the initial or filling pressure under normal room temperature conditions.

While I have described a preferred embodiment of my invention by way of illustration, many modifications will occur to those skilled in the art. I therefore wish to have it understood that I intend in the appended claims to cover all such modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. An electric coil assembly comprising a sealed container, a winding of insulated electric conducting wire impregnated with a polysiloxane liquid and mounted within said container, said liquid being carried wholly within said winding, and a quantity of an insulating gas sealed under greater than atmospheric pressure in said container.

2. An electric coil assembly comprising a sealed container, a multilayer winding of insulated wire including interlayer insulation of sheet material and mounted within said container, a high temperature electrical insulating liquid impregnant carried wholly within and saturating said winding, and a quantity of insulating gas including a major proportion of nitrogen sealed under greater than atmospheric pressure in said container.

3. An electric coil assembly comprising a sealed container, a multilayer winding of ceramic insulated wire including interlayer insulation of asbestos bentonite sheet material mounted in said container, an insulating impregnant saturating said winding and including a polysiloxane liquid, and a quantity of insulating gas sealed under greater than atmospheric pressure in said container and including a major proportion of nitrogen and a trace of a halogen-bearing gas.

4. An electric coil assembly comprising a sealed container, a winding of insulated electric conducting wire mounted in said container in spaced relation with walls of said container, a quantity of a polysiloxane insulating liquid in said container carried wholly within said winding and saturating said winding, and a quantity of an insulating gas under greater than atmospheric pressure in said container around said winding filling all spaces between said winding and the walls of said container.

5. An electric coil assembly comprising a sealed container, a winding of insulated electric conducting wire mounted in said container in spaced relation with walls of said container, a quantity of a polysiloxane insulating liquid in said container carried wholly within said winding and saturating said winding, and a quantity of nitrogen gas under greater than atmospheric pressure in said container around said winding filling all spaces between said winding and the walls of said container.

6. An electric coil assembly comprising a sealed container, a multilayer winding of insulated electric conducting wire including interlayer insulation of sheet material mounted in said container in spaced relation with walls of said container, a quantity of a polysiloxane insulating liquid in said container carried wholly within said winding and saturating said winding, and a quantity of an insulating gas under greater than atmospheric pressure in said container around said winding filling all spaces between said winding and the walls of said container.

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