June 27, 1950 W. L. CARLSON 2,512,737

ELECTRICAL SHIELD

Filed Nov. 30, 1945

Fig. 1.

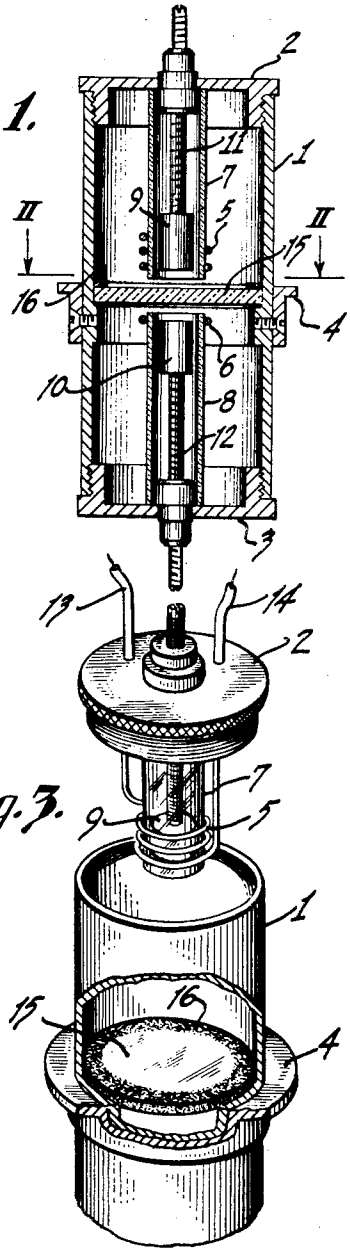


Fig. 3.

Fig. 2.

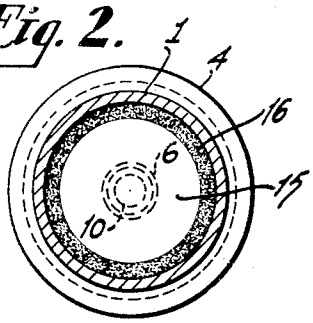


Fig. 4.

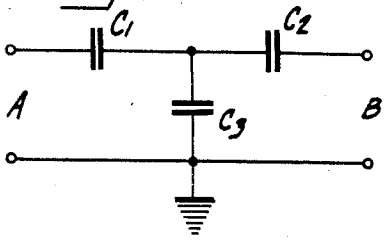
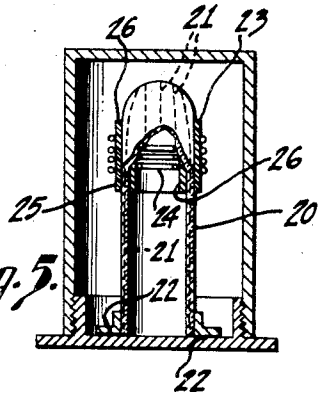


Fig. 5.



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ELECTRICAL SHIELD

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9 Claims. (Cl. 175—359)

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This invention relates to improvements in electrical shields for preventing undesired capacitive coupling between electrical devices, or parts thereof, and has for its principal object to provide a simple and reliable shield or housing for high frequency electric apparatus, and one which reduces or entirely eliminates the conducting wires of which such (Faraday) shields and housings are usually composed.

The present invention is predicated upon an appreciation of the fact, and its application to the shielding art, that materials which exhibit an extremely high dielectric constant (i. e. of the order of 1000 or more) are pervious to magnetic fields yet behave much like metal in their ability to conduct capacitive currents. Accordingly, the present invention contemplates the provision of an electrostatic shield constituted, at least in part, of an insulating material having an extremely high dielectric constant and wherein the said "insulating material" is effectively grounded.

The invention will be described in connection with the accompanying drawing, wherein:

Fig. 1 is a vertical section of an encased transformer unit incorporating an electrostatic shield within the invention; Fig. 2 is a sectional view taken on the line II—II of Fig. 1, Fig. 3 is an exploded view of the middle and upper parts of the device of Fig. 1, Fig. 4 is an electrical diagram which will be referred to in explaining the principle of the invention and Fig. 5 shows an alternative embodiment of the invention.

In Figs. 1, 2 and 3 there is shown a transformer unit comprising a tubular metal casing 1 which is closed at its opposite ends as by means of screw threaded caps 2 and 3 and which is provided with an external flange 4 for mounting said unit upon a metal chassis or other support, not shown.

The casing 1, contains a transformer comprising primary and secondary coils 5 and 6 wound upon separate axially spaced hollow coil forms 7 and 8 respectively within which inductance changing paramagnetic cores 9 and 10 are supported on adjusting screws 11 and 12. Appropriate leads exemplified by the wires 13 and 14 (Fig. 3), extend from the ends of each coil through the adjacent end pieces 2 and 3, respectively for connecting the said coils to a source of high frequency energy. The spacing between the coils 2 and 3 is such that, in the absence of a shield therebetween, the said coils are linked by both the electric (or "electrostatic") and the magnetic components of a radio frequency field. In order to attenuate the electric component of

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the R. F. field without substantially interfering with the passage of its magnetic component the said coils are shielded one from the other by a disc 15 which is formed, in accordance with the invention, of a ceramic material which exhibits an extremely high (i. e. 1000 or higher) dielectric constant. Among the materials which exhibit such a high dielectric constant, and are otherwise suitable for use in carrying the invention into effect, are the titanates, zirconates and stannate of barium, strontium and calcium, or mixtures of the same, with or without the addition of lead titanate or other fluxing material. At the present writing it appears that the peak composition from a dielectric constant standpoint is: 72% $BaTiO_3$ and 28% $SrTiO_3$ though there are numerous other mixtures containing titanium dioxide which when fired (at temperatures of the order of 2300°–2500° F.) possess the above described requisite electrical and mechanical properties.

The shield 15 is preferably provided about its periphery with an adherent conductive coating 16 formed, by way of example, of evaporated silver or the like, to insure a good electrical connection between the shield and the grounded metal casing. Other types of connectors may be employed for the purpose provided that suitable precautions are taken to prevent the presence of an air-gap in series with the shield.

The manner of which the ceramic insert 15 operates to shield the separate spaces or compartments A and B within which the primary and secondary coils 5 and 6 are connected will be apparent upon inspection of the electrical diagram of Fig. 4 wherein:

A and B designate, respectively, the separate compartments (or the primary or secondary circuits therein) to be shielded.

C_1=the small value of capacitance ordinarily present between the primary circuit and the shield.

C_2=the small value of capacitance ordinarily present between the secondary circuit and the shield.

C_3=the internal capacitance of the ceramic which, because of its high dielectric constant (k), is of high value and therefore of low reactance at the operating frequency.

In the embodiment of the invention shown in Fig. 5 the shield, which here assumes the form of cylinder 20 contains a few wires 21, in the form of a Faraday cage, molded in the ceramic to further improve its shielding properties. In

this case the auxiliary wires **21** extend beyond the end of the ceramic and are soldered or otherwise connected to the grounded metal casing as indicated at **22**. In most cases it will be found desirable to space the windings **23** and **24** a small distance from the high dielectric constant material. When the shield is used to support the wires the desired spacing may be achieved by the use of conventional low dielectric constant coil forms **25** and **26**.

It will now be apparent that the present invention provides a simple, reliable and novel shield for high frequency electric fields and one which reduces or entirely eliminates the conducting wires of which (Faraday) shields are usually composed. The essential feature of the invention includes the use of a very high dielectric grounded medium which is interposed between electric circuits separated from the high dielectric medium and from each other by low dielectric constant mediums. By way of example the high dielectric material may have a constant of the order of 1000 or more; the low dielectric material, which may include air, may have dielectric constants from the order of 1 to the order of 10. While the invention has been described with reference to currents of high frequency, the operating range extends throughout the radio frequency spectrum.

What is claimed is:

1. In electrical apparatus, a shield constituted of an insulating material having a dielectric constant of at least about 1000, a plurality of coils disposed in spaced apart magnetically coupled relationship on opposite sides of said shield, and insulating material having a dielectric constant of the order of from 1 to 10 interposed between said coils and said shield.

2. The invention as set forth in claim 1 and wherein said grounded insulating shield comprises a cylindrical element and said insulating material comprises coil forms for said coils disposed, respectively, upon the exterior and interior surfaces of said cylindrical element.

3. In combination, a source of electromagnetic energy and electrostatic energy, response means positioned to be excited by said electromagnetic energy, and an electrostatic insulating shield having a dielectric constant of at least 1000 interposed between said source and said response means.

4. The invention as set forth in claim 3 and wherein said shield is a body consisting essentially of a ceramic which is at least one of the class consisting of the titanates, zirconates and stannates of at least one of the alkaline earth metals.

5. The invention as set forth in claim 4 and wherein an adherent conductive coating is provided on a marginal portion only of the surface of said ceramic body.

6. The invention as set forth in claim 4 and wherein said ceramic body contains a Faraday cage having an electrical terminal extending to the exterior of said body.

7. A high frequency transformer having at least primary and secondary windings for the transfer of electrical energy therebetween, and a ceramic electrostatic shield interposed between said windings, said ceramic shield having a dielectric constant of at least 1000.

8. The invention as set forth in claim 7 and wherein said ceramic shield consists essentially of a mixture of barium and strontium titanates.

9. In electrical apparatus, an electrical conductor, an insulating material having a dielectric constant substantially no higher than 10 disposed in contact with and at least partially surrounding said conductor, a second insulating material having a dielectric constant substantially no lower than 1000 disposed in contact with and at least partially surrounding said first mentioned insulating material, and an electrical terminal intimately bonded to said second insulating material.

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