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2,506,604

METHOD OF MAKING ELECTRONIC COILS

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2 Sheets-Sheet 1

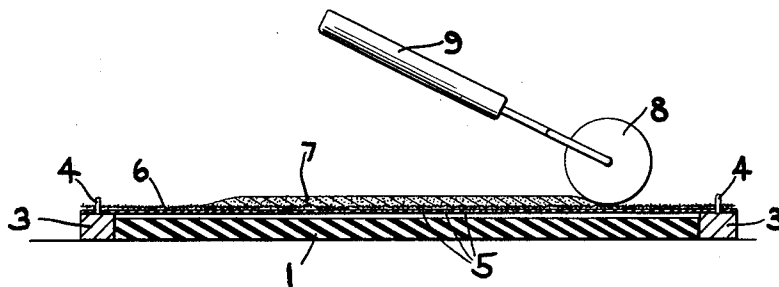


FIG. 1.

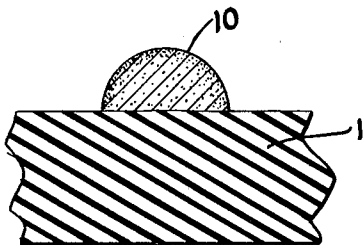


FIG. 3.

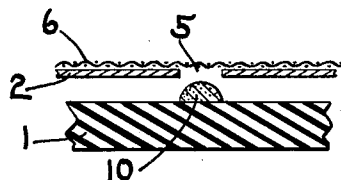


FIG. 2.

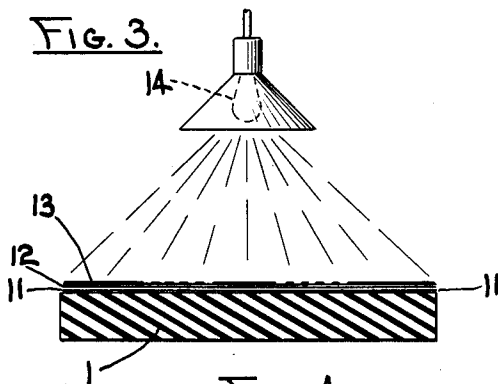


FIG. 4.

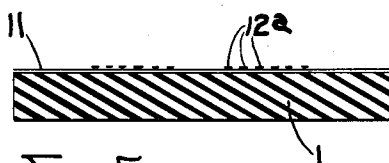


FIG. 5.



FIG. 6

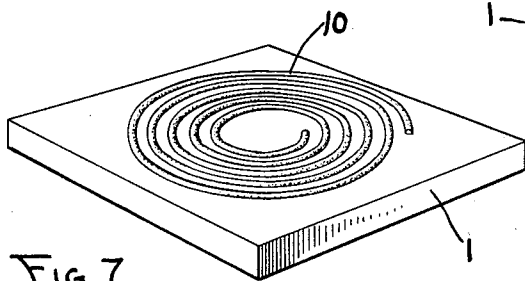


FIG. 7.

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2 Sheets-Sheet 2

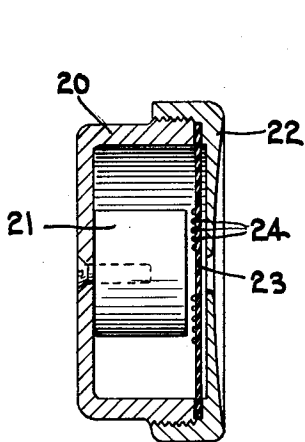


Fig. 8.

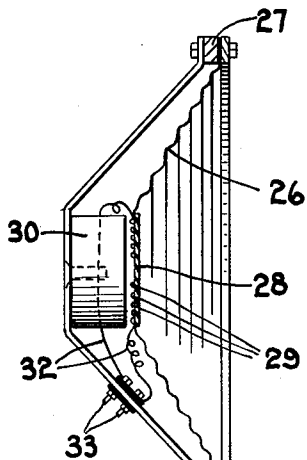


Fig. 9.

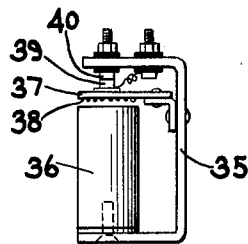


Fig. 10.

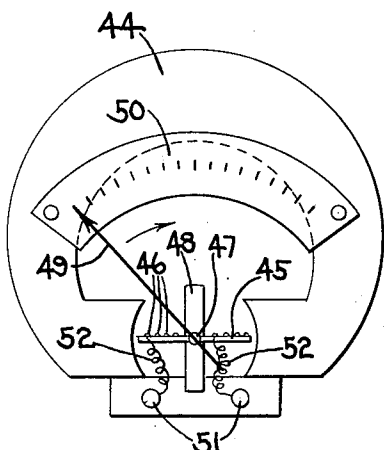


Fig. 11.

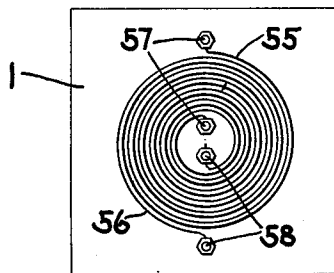


Fig. 12.

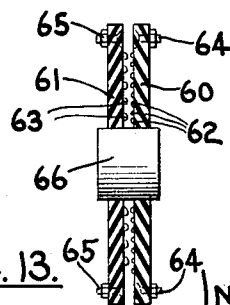


Fig. 13.

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METHOD OF MAKING ELECTRONIC COILS

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Application February 1, 1947, Serial No. 725,830

1 Claim. (Cl. 41—43)

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This invention relates to improvements in electronic coils and in the methods of making them.

In the usual electronic coil it is necessary to use a considerable amount of material and labor in making the coils. Large amounts of copper in the form of wire and insulation on the wire is used and many man-hours are used in winding the usual electronic coils. The present invention has for one of its objects the conservation of both copper or other conducting metal, the conservation of insulation and of man-hours in manufacturing electronic coils.

Other objects of the invention are to provide a coil which is easily adapted for many uses in the electronic field; to provide a coil which is easily and quickly formed; to provide a coil which is short-proof; to provide a coil which is well adapted for the moving or stationary parts of magnetic devices; to provide a coil which is very desirable in the making of transformers, inductances, chokes, resistances and electro-magnets.

Other objects and advantages of the present invention will become apparent during the following description taken in connection with the accompanying drawings, in which:

Figure 1 is a vertical sectional view through the apparatus for making an electronic coil by means of the silk screen stenciling process.

Figure 2 is an enlarged fragmentary vertical sectional view through the silk screen, stencil and coil panel or base.

Figure 3 is an enlarged fragmentary vertical sectional view through the coil base and coil.

Figure 4 is a vertical sectional view through the apparatus for making an electronic coil by means of the photo-etching process.

Figure 5 is a vertical sectional view through the coil base showing another step in the photo-etching process.

Figure 6 is a vertical sectional view through the completed coil made by the photo-etching process.

Figure 7 is a perspective view of an electronic coil made by the screen stenciling process.

Figure 8 is a vertical sectional view through an ear-phone showing the application of our coil thereto.

Figure 9 is a vertical sectional view through a dynamic speaker or dynamic microphone showing the application of the coil thereto.

Figure 10 is an elevational view of a moving-coil relay with our coil applied.

Figure 11 is an elevational view of an electronic meter showing our coil used thereon.

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Figure 12 is an elevational view of a radio frequency transformer made in accordance with our invention.

Figure 13 is a vertical sectional view of another form of radio frequency transformer.

Referring particularly to the drawings in which like reference numerals refer to like parts throughout the several views and more especially to Figure 1 which shows the silk-screen stenciling process for making electronic coils. In this process the base on panel 1, made of insulating or dielectric material such as rubber, mica, Bakelite or Formica, is located on a flat surface. A stencil 2 is located over the coil base 1 and is held spaced therefrom by means of the rectangular supporting frame 3 located around the coil panel 1. The supporting frame 3 is provided with pins 4 to which the stencil attaches. The stencil has openings therein of the desired shape of the resultant coil. A silk screen or porous fabric 6 is attached to pins 4 in stretched condition over the stencil. The material of which the coil is made is deposited in the top surface of the silk. This material is an air setting or hardening plastic impregnated with metal dust or particles. These metal particles may be made of silver, copper or aluminum or other good conductor. With this fluid coil material on the silk screen, a roller or squeegee 8, having a handle 9, is passed over the silk screen, squeezing the metal impregnated plastic through the screen and stencil onto the coil base. This plastic adheres to the coil base and each strand of coil flows to a semi-circular cross section as shown at 10 in Figure 3. The plastic polymerizes in this condition forming a continuous metal coil.

Another method of making an electronic coil is to set up the silk-screen stenciling apparatus as shown in Figure 1, and with a fluid adhesive on the silk screen 6, the adhesive is squeezed through the screen and stencil onto the coil base 1. Before the adhesive has set or dried, particles or dust of metal or other conducting material is sprinkled thereon and the adhesive allowed to dry or set. Thus a coil is formed of particles of conducting material held to the coil base by the adhesive formed the shape of the coil.

The photo-etching process is shown in Figures 4, 5 and 6 in which the coil base 1 of dielectric material is plated or painted with a coating 11 of silver, copper, aluminum or other conducting metal. A coat of light hardening emulsion is applied over the metal coating and then a negative photograph or drawing of the coil is placed over

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the emulsion. The surface of the negative is exposed to a light 14 which hardens the emulsion exposed thereto where the resultant coil is to be formed. The photograph is removed and the soft emulsion washed from the surface of the metal coat leaving the hard emulsion 120, the shape of the resultant coil, on the metal coating. The surface of the metal and hard emulsion is covered with an etching acid or compound which dissolves and removes the metal entirely, where there is no emulsion, leaving the hardened emulsion with the metal coil thereunder. Next the hard emulsion is removed leaving the metal coil pattern 102 on the dielectric base. This photo-etching process allows greater precision in making coils than with the silk screen stenciling process. This is especially desirable in making fine or thin line coils.

Some examples of application of coils of our construction are shown in Figures 8 to 13 inclusive. In Figure 8 is shown the use of a coil of our construction as applied to an ear-telephone. The ear-telephone has a case which supports a permanent magnet 21 therein and screw threadedly receives the cap 22. A disc 23 of dielectric material is supported between the case 20 and the cap 22. A coil 24 is formed over the face of the disc 23 and the passage of fluctuating current through the coil vibrates the disc 23 correspondingly by the variation in the magnetic field of the magnet 21 whereby sound is emitted therefrom.

In Figure 9 is shown the application of our new design coil to a dynamic speaker or microphone. The speaker has a vibratory cone 26 attached to a supporting ring 27. The central portion of the cone is provided with the attached dielectric disc 28 having the coil 29 etched or formed on the face thereof. A permanent magnet 30 is supported near the disc 28 and coil 29 on the bracket 31 attached to ring 27. The ends of the coil 29 are attached by flexible wires 32 to the binding posts 33 whereby a fluctuating current passing through the coil affects the magnetic field of the magnet vibrating the cone correspondingly and emitting sounds therefrom. When used as a microphone the electrical process is reversed.

In Figure 10 is shown the application of a coil of our design to a moving coil relay. This relay is provided with a mounting bracket 35 having the permanent magnet 36 secured thereto. A dielectric disc 37 is flexibly mounted on the bracket 35 in close proximity to the magnet. An electronic coil 38 of our new construction is printed or etched on the disc 37. A contact point 39 is attached to the disc 37 and another coacting point 40 is attached to the bracket 35. By passing current through the coil 38 the polarity of the coil 38 is charged to either open or close contacts 39 and 40.

Figure 11 shows our coil applied to an electronic meter. This meter has a horseshoe magnet 44 with a dielectric disc 45, having a coil 46 of our design applied thereto, rotatably mounted on the pivot pin 47. A central core 48 extends perpendicularly through the disc 45 and a hand 49 is mounted to rotate with the disc 46 and core 48 which sweeps the scale 50. The ends of the coil 46 are electrically connected to the binding posts 51 by means of the flexible wires 52. Thus the

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amount of current in a circuit may be indicated by connecting to the binding posts 51.

In Figure 12 is shown the construction of a transformer using the method herein described for the construction thereof. In this Figure 12 the base 1 has applied thereto two coils. One coil 55 is heavier or of larger cross section than the coil 56, both applied to the surface of base 1. The ends of the coil 55 are connected to binding posts 57 while the ends of the coil 56 are connected to binding posts 58. Thus the coil 55 forms the secondary coil of the transformer and the coil 56 acts as the primary coil.

Figure 13 shows the application of our coil to a slightly different transformer. This transformer comprises a pair of dielectric discs 60 and 61, the disc 60 having a primary coil 62 applied thereto in one of the methods described and the disc 61 having a secondary coil 63 similarly applied. The primary coil 62 is connected at each end to separate binding posts 64 while the secondary coil 63 is connected to the binding posts 65. A central iron or permeable core 66 extends through the center of the discs 60 and 61 to provide the transformer with a metal core.

It will thus be seen that with our new coil and method of making the same, that electronic coils may be produced quickly and efficiently with a saving of material and labor in producing them. The coils thus produced have many applications in electronics, resulting in more economical production of radios and radio controlled devices and with a consequent reduction in weight and space.

Having thus described our invention, what we desire to secure by Letters Patent is defined in the appended claim.

We claim:

The method of making a dielectric base with an electric conducting coil permanently attached thereto which consists of providing a dielectric base of the desired shape, permanently attaching a coating of electric conducting material to a surface of said base, covering said material with a coating of light hardening resist emulsion, placing an opaque coil pattern over said emulsion, exposing portions of said emulsion to light through said pattern, removing said pattern, washing away the unexposed portions of said emulsion thereby uncovering portions of said electric conducting material, and etching completely away the uncovered portions of said material, thereby leaving a coil of electric conducting material permanently attached to said base.

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