Feb. 16, 1960 H. E. STROCK 2,925,570

CURRENT TRANSFORMER

Filed Aug. 12, 1954

FIG. 1

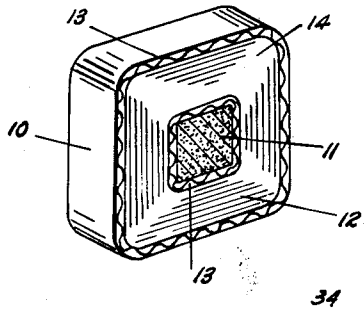


FIG. 2

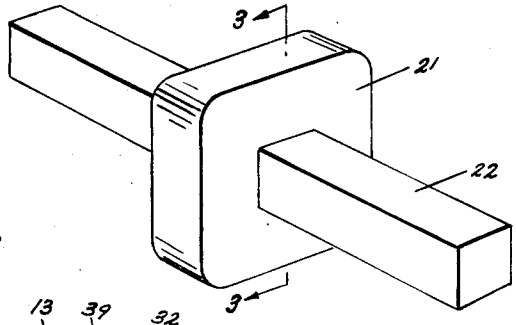


FIG. 3

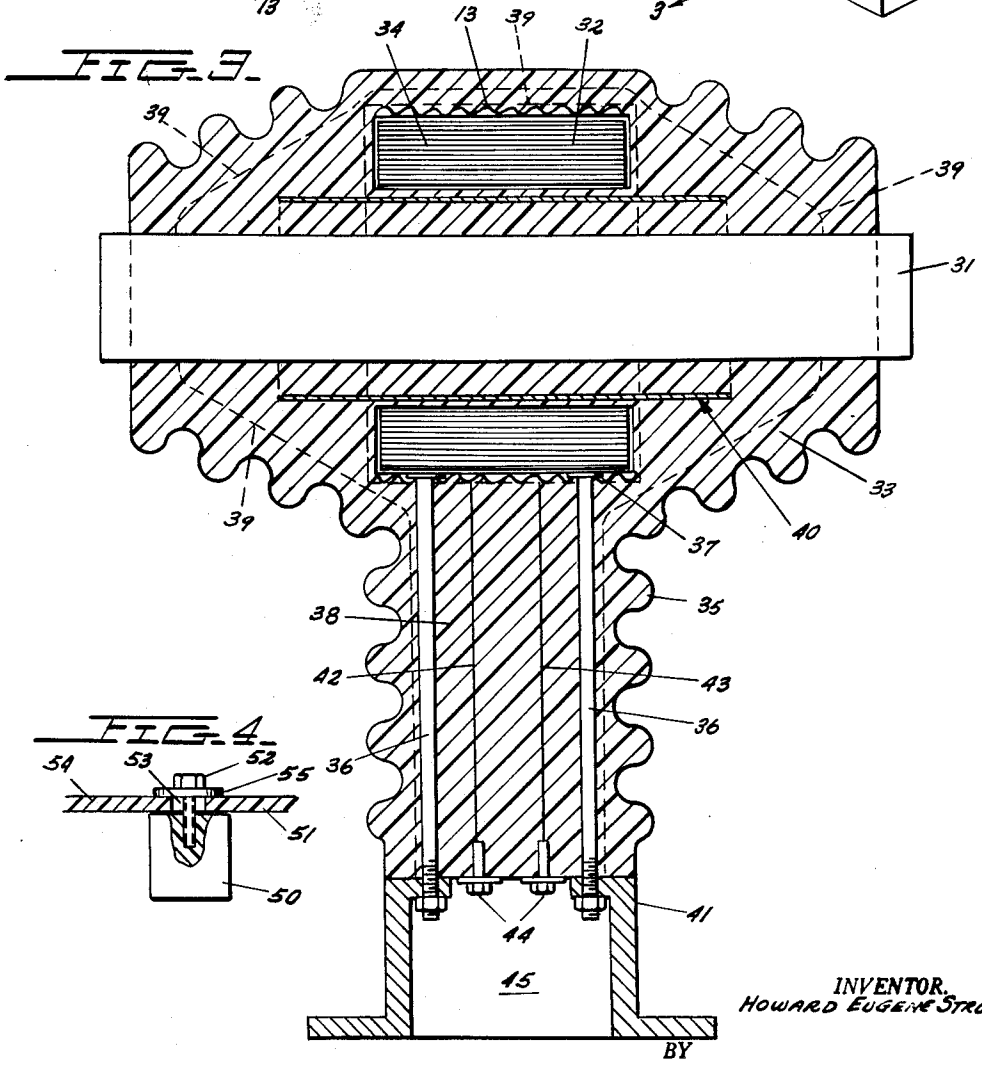


FIG. 4

INVENTOR.
HOWARD EUGENE STROCK

BY

Ostrolenk & Faber

ATTORNEYS

United States Patent Office 2,925,570 Patented Feb. 16, 1960

2,925,570

CURRENT TRANSFORMER

Howard Eugene Strock, Charlotte, N.C., assignor to Howard Eugene Strock and Mason F. Leftwich, Charlotte, N.C., a partnership

Application August 12, 1954, Serial No. 449,430

4 Claims. (Cl. 336—96)

My invention relates to a new and improved current or instrument transformer suitable for high voltage uses and the method of making such a transformer. More specifically, it relates to a method for providing a plastic housing for a transformer which will be free from stresses tending to crack or otherwise impair the efficiency of such a housing, and for providing a single transformer suitable for both indoor and outdoor use.

In the present method of constructing current or instrument potential transformers, it is the practice to surround the core and windings of the transformer with insulating material and then mount the insulated transformer in an aluminum or other type of metallic container. The terminals for the transformer are brought out of the container by suitable insulator bushings. The entire unit, including the container, must also be insulated.

This is the construction used for outdoor transformers. An indoor transformer consists simply of a core and protruding terminals with a tape insulation winding of some nature on the coil.

When the latter type of transformer is modified for outdoor purposes, the insulation of the terminal from the container and of the container itself presents a substantial problem and an element of considerable increase in cost of the entire unit.

In my present invention I propose to provide a transformer suitable for both indoor and outdoor use in which the core and windings are embedded in a suitable thermosetting plastic material with terminals protruding from the plastic. In this manner I obtain all of the required insulation and housing in one composition.

In embedding the transformer in a plastic encasing material, however, considerable difficulty has been encountered in the molding process, because of the necessary temperature variations occurring in such a process and the fact that the plastic has a much higher thermal coefficient of expansion and contraction than the metallic components of the transformer. This has resulted in excess shrinkage of the plastic upon cooling, which, in turn, sets up stresses and often cracks in the plastic casing. Thus in the molding operation a method must be found to compensate for the excess shrinkage of the plastic. In this respect attempts at changing the formulation of the plastic have not proven particularly successful or economical. Therefore, I also propose to eliminate or substantially reduce stresses or cracks which may occur in the plastic casing material by providing a cushioning unit as an integral part of the mold when the casting is made.

Another disadvantage of oil-filled or plastic-housed transformers of the prior art is apparent when the insulating medium is broken down by a high-voltage impulse. Often the breakdown occurs so quickly that gases are exploded through the breakdown path. I propose to provide a construction which does not explode under such circumstances.

I further propose to provide as the encasing material a resin and filler which will provide economies for the casting operation not heretofore realized.

Accordingly, it is an object of my invention to provide an improved current transformer encased in a plastic material.

It is another object of my invention to provide an improved method for producing a plastic-encased transformer in which the casing is free from stresses and cracks.

It is a further object of my invention to provide a cushioning means which will relieve stresses resulting from the cooling of a plastic casing material.

It is a still further object to utilize, in the casting of the plastic encasing material, a cushioning material in the portion of the transformer normally occupied by the primary winding which will allow the plastic casing material as the coils to expand inwardly into said space.

Another object of my invention is to provide a special filler of high dielectric strength for the plastic material used to encase a high voltage transformer.

A still further object of my invention is to provide an arrangement in the plastic encasing material whereby flexible movement may be provided for an insert placed in said encasing material.

Still another object of my invention is to provide an economical method of casting a transformer in which no external heat is required in the casting operation.

Another object is to provide a transformer which will not explode when broken down by an electrical impulse high enough to exceed its dielectric strength.

These and other objects of my invention will be more fully apparent from the detailed description of my invention when taken in connection with the accompanying drawings, in which:

Figure 1 is an isometric and schematic view of the transformer as it appears in cross section during the casting operation.

Figure 2 represents a schematic view of the same transformer ready for use and containing the primary conductor.

Figure 3 represents a cross-sectional view of an outdoor-indoor current transformer made in accordance with the present invention.

Figure 4 represents an enlarged cross section of the arrangement provided for placing an insert into the plastic casing material, e.g. insert 44 in Figure 3 turned upside down.

In accordance with my invention it has been found desirable to use as the encasing material a plastic which can be molded without requiring external heat or electrically or steam-heated molds, thereby reducing the cost of the final product.

I have found that these requirements are met by rigid, cross-linked thermosetting resins of the polyester family such as those going under the trade name of Vibrin or Permasil. The use of this type of resin makes it possible to set core and coil of an electric transformer into a mold and by proper formulation in mixing the polyester resin it can be poured into the mold which would in turn set-up and cure without requiring external heat.

In addition, I have found that the use of mica as a filler for this resin has proven particularly advantageous because of its good strength characteristics and dielectric qualities.

When making up my casing resin I have also found it desirable to include a polymerization promoter and a catalyst along with a substance which will decrease the moisture absorption of the final product.

A typical formulation is as follows:

	Grams
"Vibrin"	600
Calcium carbonate filler	60
Mica filler	180
Promoter	12
Catalyst	0.6
Silicone	10

The polymerization promoter and catalyst may be any of a variety of substances known to the art, and I have found that particularly satisfactory results have been obtained with a promoter called "Luprico JDB" and a catalyst comprising a hydroxy cobalt napthenate dispersion manufactured under the name of "Cobalt Nuodex."

It should be understood, however, that the proportions of promoter and catalyst can be regulated so that gelation and the final setting time can be varied anywhere between 15 minutes and 36 hours. It was found that in the above formula the best results were obtained by having a gelation time of about 35 minutes at room temperature (72° F.)

The silicone is added to reduce the moisture absorption factor of the finished casting to a point where the plastic material is entirely suitable for outdoor use or for submersion for long periods. The particular material selected for this function was silicone mixed in a dispersing agent of styrene. It is also possible to reduce moisture absorption by applying a silicone grease or dispersion to the outside of the casting.

The addition of the mica filler has been found to increase the dielectric strength of the plastic from 600 volts per mil thickness to 1170 volts per mil, based on standard ASA test procedures.

The curing of the thermosetting polyester resin is exothermic. This means that it is not necessary to apply outside heat in order for the resin to set. However, heat generation can be controlled by varying the relative amounts of catalyst and promoter. A substantial amount of heat generation is desirable in electrical castings in that it assists in drying out the core and coil and drying out any excess moisture which may happen to be in the core and coil. It was found that a temperature in the range of 135° to 175° F. in the gelation and setting of the casting was desirable.

In casting the transformer in a plastic it was found possible to eliminate the metal housing usually used in electric transformers and to eliminate the porcelain bushings, substituting the plastic material for the porcelain insulator. Thus, this method of casting eliminates considerable labor and material requirements and makes it possible to cast the entire insulator housing and molding terminals in one operation.

Various types of transformers may be cast in plastic. These shapes include the "unit type" that is the casting in which core and coil are embedded in one solid piece and the primary and secondary are brought out through the insulaor as part of the casing; or the "window type" which has a round or square hole through the core of the transformer to permit a single primary conductor to be passed through the core containing the secondary windings. This latter type of transformer may also be adapted for high voltage in a manner wherein the secondary leads are brought down through a pedestal type molding base which insulates the secondary windings from the primary. The pedestal is in the shape of an electrical outdoor type insulator but the casing is all in one piece with the housing.

In my drawings and the following description I shall refer to this type of transformer as my specific embodiment, but it should be clear that the principle of my novel casting method will be equally applicable to other types of transformers.

In casting a window type transformer it has been found that when setting, the plastic has a tendency to contract around the center hole. If, as in the case of an ordinary mold, this contraction is not allowed, stresses tend to be set up in the plastic casing and in more severe cases the casing has been known to crack. This occurs, particularly, where the "window" comprises a square or rectangular hole, the relatively sharp corners of which are particularly prone to stresses arising in the setting operation.

I have found that by covering the entire core and coils with a cushioning material such as corrugated cardboard it is possible to allow the plastic to contract around the core and coils without setting up undue stresses. More particularly it was found that corrugated cardboard put on with masking tape was the most economical method of providing a cushion to prevent stresses in the plastic material.

In order to eliminate stresses around the center, square hole which is cast into the transformer, the entire inside of the mold around the center hole is padded with corrugated paper and sealed with masking tape to allow a cushion around the center hole and to permit contraction around the hole to be relieved by this cushion.

The padding may be about ⅛ inch thick, for example, and sealed at all edges to prevent the plastic from running down behind and destroying the cushion effect.

The plastic material has an expansion or contraction rate of 2½ times that of the steel and copper core and coil and the depth or size of the cushioning material can be designed in different units in a fashion to accommodate this differential.

The mold may be filled in several ways: (1) Liquid plastic is poured into an opening in the bottom, top or sides of the mold. (2) Liquid plastic is drawn into the mold by means of a vacuum which to a great degree eliminates voids and air pockets.

Referring now to Figure 1, the transformer 10 illustrated here is of the window type with opening 11 as the window which will eventually carry the primary conductor. During the casting operation, a solid material occupies the space in order that a hole of the proper size may be molded. Surrounding the inner and outer portions of secondary windings of the core and coil of the secondary 12 is a layer of corrugated paper or cardboard 13 which acts as a cushion around the center hole 11 and thereby relieves the contraction of the plastic 14 in which the core and coil 12 are embedded.

Figure 2 illustrates schematically the transformer as it will appear from the outside after the casting operation is completed. The core and coil are all embedded in plastic housing 21 which carried a center opening through which the primary conductor 22 has been passed.

Figure 3 shows in more detail a cross-section of this transformer taken along the line 3—3 of Figure 2 and also includes the insulating base portion of the transformer as it would appear where it is used as an indoor-outdoor current transformer. This figure shows in more detail primary conductor 31 as it passed through the core of the secondary 32 and how the entire assembly is embedded in plastic 33.

The pedestal type molded base insulates the secondary windings 34 from the primary 31. The pedestal here is in the shape of an electrical outdoor type porcelain insulator with a corrugated surface 35 which offers increased resistance to creepage and is cast in one piece with the housing. Mounting bolts 36 are fastened to the core and perform the function of being reinforcing members and a grounding device to the core, and can be bolted or strapped to the core as indicated at 37 before or after winding. They provide the additional function of fastening the terminal box 45 and mounting device to the pedestal 38.

The core is surrounded by fibre glass material which is incorporated in the mold as a reinforcing material. This is shown by the dotted lines 39. This reinforcement prevents the casting from cracking from differential expansion during the curing period. Instead of fibre glass, asbestos, cotton or linen may also be used but glass has been found to have the best electrical characteristics and is therefore preferred. The secondary is also provided with concentric copper electrostatic shield 40.

The insulated transformer is supported on a metallic base 41 with secondary leads 42 and 43 extending down-

wardly to the base into insert 44 of which Figure 4 is a detailed cross-section.

Referring now to Figure 4 the insert 50 is placed on the inside of the mold 51 and held in place by means of screw 52. There is an over-sized hole 53 in the molding 54 and a cushioning washer made of rubber or any other flexible material 55 between the head of the screw 52 of the mold 51.

Thus, although the insert 50 is firmly held in place it has both longitudinal and transverse movement due to the over-sized hole 53 and the cushioning washer 55, respectively. The washer 55 then (1) provides a small amount of movement in the insert so that cracking will not occur around the insert because of expansion and contraction of the plastic, (2) prevents leakage of the plastic outside the mold, and (3) holds the insert in exact position.

It is to be understood that the transformer illustrated is illustrative of my invention and that other inserts and other transformer designs may also be used in practicing my casting technique.

In the foregoing, I have described my invention only in connection with preferred embodiment thereof. Many variations and modifications of the principles of my invention within the scope of the description herein are obvious. Accordingly, I prefer to be bound not by the specific disclosure herein but only by the appended claims.

I claim:

1. A transformer comprising a magnetic core and a secondary winding carried on said core; said secondary winding including at least a first and second lead conductor; said magnetic core and said secondary winding being embedded in a moulded plastic encasing member; said moulded plastic encasing member having an extending pedestal portion for supporting said transformer; said first and second lead conductors of said secondary winding being embedded in said pedestal portion of said moulded plastic encasing member and extending to the exterior of said pedestal.

2. A transformer comprising a magnetic core and a secondary winding carried on said core; said secondary winding including at least a first and second lead conductor; said magnetic core and said secondary winding being embedded in a moulded plastic encasing member; at least a portion of the surface of said instrument transformer having a relatively flexible material interposed between its said surface portion and the adjacent surface portion of said plastic encasing member; said moulded plastic encasing member having an extending pedestal portion for supporting said transformer; said first and second lead conductors of said secondary winding being embedded in said pedestal portion of said moulded plastic encasing member and extending to the exterior of said pedestal.

3. A transformer comprising a magnetic core and a secondary winding carried on said core; said secondary winding including at least a first and second lead conductor; said magnetic core and said secondary winding being embedded in a moulded plastic encasing member; said moulded plastic encasing member having an extending pedestal portion for supporting said transformer; said first and second lead conductors of said secondary winding being embedded in said pedestal portion of said moulded plastic encasing member and extending to the exterior of said pedestal; said pedestal further including an embedded post means extending from and secured to said core to an area external of the bottom of said pedestal; the external portions of said post means forming mechanical connecting means for connecting said pedestal to a support structure.

4. A transformer suitable for both indoor and outdoor use which comprises a magnetic core having a secondary winding thereon; said transformer being embedded in an integral moulded plastic encasing comprising a polyester resin and a mica filler; the portions of said integral moulded plastic encasing toward said transformer embedded therein including a glass fibre material for reinforcing said integral moulded plastic encasing during construction thereof and for increasing the dielectric constant of said moulded plastic encasing.

References Cited in the file of this patent

UNITED STATES PATENTS

1,333,004	Vaughn	Mar. 9, 1920
1,427,324	Priestly	Aug. 29, 1922
2,136,609	Butterfield et al.	Nov. 15, 1938
2,185,831	Camilli	Jan. 2, 1940
2,222,729	Ver Planck et al.	Nov. 26, 1940
2,352,166	Camilli	June 27, 1944
2,382,199	Brink	Aug. 14, 1945
2,464,029	Ehrman	Mar. 18, 1949
2,559,141	Williams	July 3, 1951
2,572,590	Borjklund	Oct. 23, 1951
2,618,689	Cook	Nov. 18, 1952
2,700,185	Lee	Jan. 25, 1955
2,701,392	Eich	Feb. 8, 1955
2,731,607	Gould et al.	Jan. 17, 1956
2,738,466	Niederman	Mar. 13, 1956
2,795,009	Gosnell et al.	June 11, 1957