March 19, 1963 J. L. SETTLES ETAL 3,082,389

CURRENT TRANSFORMER

Filed Jan. 25, 1960

Fig. 1

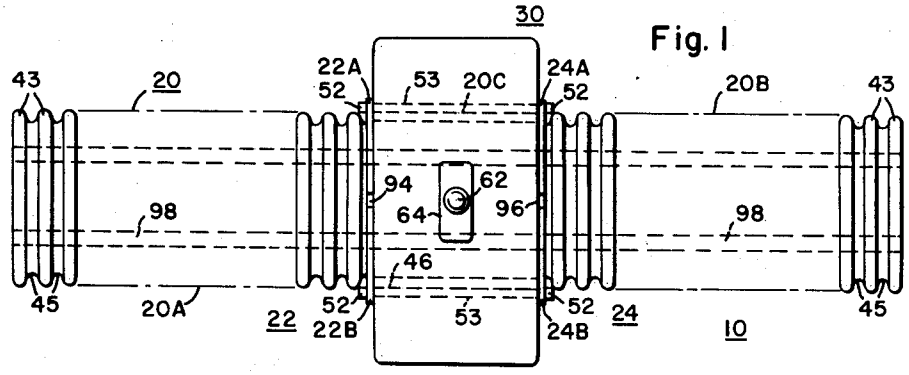


Fig. 2

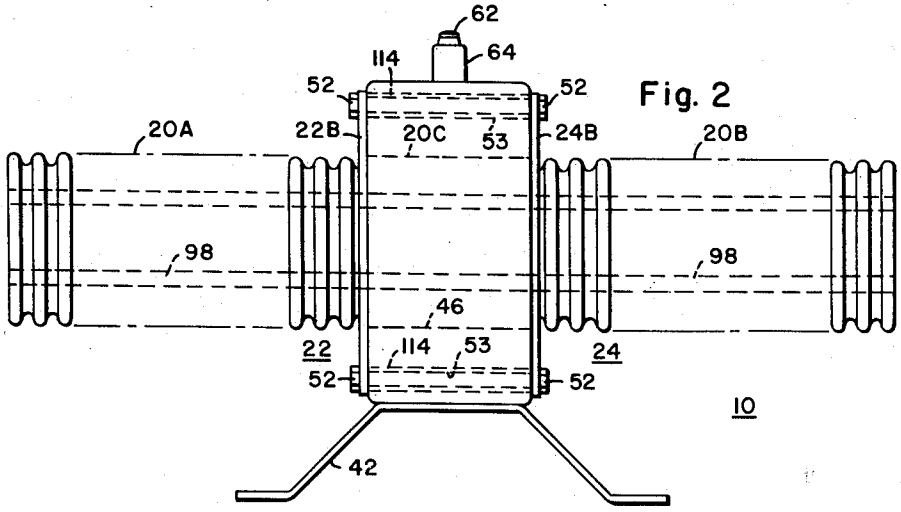
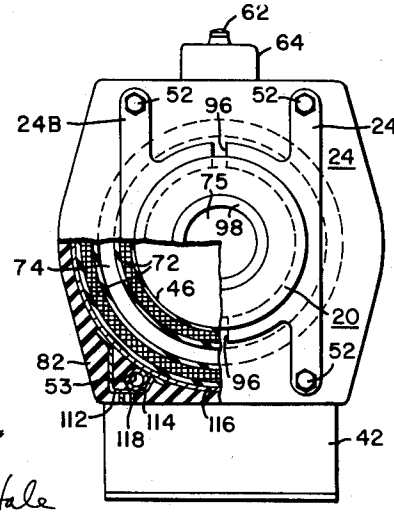


Fig. 3



WITNESSES

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United States Patent Office 3,082,389
Patented Mar. 19, 1963

3,082,389

CURRENT TRANSFORMER

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Filed Jan. 25, 1960, Ser. No. 4,288
4 Claims. (Cl. 336—174)

This invention relates to electrical induction apparatus and, more particularly, to current transformers.

In conventional current transformers of the types which are known as the "through-type" and the "bar-type," the effective primary winding comprises a current-carrying electrical conductor, which may take the form of a bar-type electrical conductor which is provided as part of the current transformer assembly, and a secondary winding which is toroidal in configuration and which is disposed in inductive relationship with said primary winding. Sufficent electrical insulation must be provided between the effective primary winding and the secondary winding of a current transformer of the type described, the amount and the type of electrical insulation depending upon the voltage of the electrical circuit with which the current transformer is to be employed. It is, therefore, desirable to provide and improved current transformer of the type described which more readily lends itself to convenient assembly for application at wherever circuit voltage is involved in a predetermined operating range of operating voltages.

It is an object of this invention to provide a new and improved current transformer.

Another object of this invention is to provide a new and improved current transformer which more readily lends itself to assembly for application at a predetermined voltage within a predetermined range of voltages.

A further object of this invention is to provide a new and improved current transformer in which the major insulation is formed from resilient, elastomeric material.

Other objects of the invention will, in part, be obvious and will, in part, appear hereinafter.

For a fuller understanding of the nature and objects of the invention, reference should be had to the following detailed description taken in connection with the accompaning drawing in which:

FIGURE 1 is a top plan view of a current transformer embodying the teachings of the invention;

FIG. 2 is a side elevational view of the current transformer shown in FIG. 1; and

FIG. 3 is an end elevational view, partly in section, of the current transformer shown in FIG. 1.

Referring now to the drawing and FIGS. 2 and 3 in particular, this invention is illustrated by reference to a current transformer shown generally at **10**. As illustrated in this embodiment, the current transformer **10** comprises the magnetic core **74** which may be of the ring or toroidal type, the secondary winding **72** which is also toroidal in shape and which is inductively disposed on the magnetic core **74**, the insulating casing **30** which is formed or molded around said core and secondary winding, and the insulating bushing **20** which passes through an opening in said casing and through which an associated primary winding (not shown), such as a current carrying conductor, passes. The current transformer **10** is illustrated as being of the type known in the art as the "through-type."

After the torodial winding **72** is assembled on the associated magnetic core **74** as best shown in FIG. 3, the insulating casing or housing **30** which is generally cylindrical in shape is preferably formed by a suitable method, such as molding, about the core **74** and the secondary

winding **72** from a resilient, elastomeric, electrically insulating, thermosettable composition or material **82**, such as a polyester resin of the type disclosed in U.S. Patent 2,871,420 by H. F. Minter et al. which issued January 27, 1959, and which is assigned to the same assignee as the present application, and in the copending applications Serial No. 647,748, filed March 22, 1957, and Serial No. 745,847, filed July 1, 1958, by H. F. Minter and also assigned to the same assignee as the present application. The casing **30** includes an axial opening or aperture therethrough, as indicated at **46**, which is adapted to receive the associated insulating bushing **20**, as will be explained hereinafter.

In order to support the core **74** and the toroidal secondary winding **72** during the forming or molding of the casing **30**, and for other purposes which will be described hereinafter, a generally ring-shaped bracket member **116** is provided which extends nearly around the outer periphery of the toroidal winding **72** and which extends axially along the longitudinal dimension of said core and secondary winding. To assist the bracket member **116** in supporting the core **74** and the secondary winding **72**, the supporting members or feet **112** are disposed at each side of the casing **30** and welded or otherwise secured to the underside of the bracket member **116**, as best shown in FIG. 3. The casing **30** is also provided with a plurality of smaller openings or apertures **53** which extend axially through said casing to receive the bolt means **52** for reasons which will be discused hereinafter. Each of the openings **53** may be provided with a suitable liner or tube member **114** which is preferably formed from a suitable corrosion-resistant material, such as brass, and which may be welded or otherwise secured to the bracket member **116** prior to the molding or forming of the casing **30**. Each of the supporting members or feet **112** may be provided with suitable means, such as the projection weld nuts **118**, which are adapted to receive suitable fastening means such as bolts (not shown) for securing the associated mounting bracket or base member **42**, which may be of any conventional type, to the bottom of the casing **30**, as best shown in FIGS. 2 and 3. The casing **30** may also include a terminal portion formed integrally therewith or a separate terminal cover **64** into which the terminals of the secondary winding **72** are brought and which is secured or fastened to the casing **30** by suitable means, such as the stud or bolt means **62**.

In order to make up the necessary electrical insulation required to apply the current transformer **10** at a particular voltage, the insulating bushing **20** is provided to add to or supplement the electrical insulation of the casing **30**. The bushing **20**, which is generally cylindrical in shape, is illustrated as being of the hollow cylindrical or tubular type having an axial opening or aperture therethrough, as indicated at **75**. The bushing **20** is preferably formed by a suitable method, such as molding, from a resilient, elastomeric, electrically insulating composition of material having anti-tracking properties, such as butyl rubber with an aluminum trihydrate filler.

In particular, the bushing **20** comprises a center or intermediate portion **20C** which is disposed substantially inside the opening **46** of the casing **30** and the first and second end portions **20A** and **20B** which extend outwardly from the opening **46** in the casing **30** at the opposite ends of said casing. The first and second end portions **20A** and **20B** of the bushing **20** are corrugated to increase the surface creepage path of the insulation provided by said bushing to thereby increase the voltage at which the current transformer may be applied, said end portions each including a plurality of ridge portions or petticoats **43** which extend around the outer periphery of said bushing

and which, in this instance, are uniformly spaced apart along the axis of the bushing **20**. The ridges **43** of the bushing **20** are spaced apart by a distance equal to the spaces between said ridges, as indicated at **45** in FIG. 1. The outer diameter or peripheral dimension of the intermediate portion **20C** of the bushing **20** is arranged to be less than the diameter or peripheral dimension of the opening or aperture **46** in the casing **30** so that the bushing **20** may readily pass through said opening when said bushing is assembled with the casing **30**. It is to be noted that the casing **30** may be readily assembled with a variety of bushings similar to the bushing **20** and having an outer diameter or peripheral dimension less than the diameter or peripheral dimension of the opening **46** in the casing **30** and having any suitable axial dimension required to provide the insulation supplemental to that of the casing **30** for application of the current transformer **10** at a particular voltage. The bushing **20** is preferably molded or formed about a suitable supporting member, such as the hollow cylindrical or tubular member **98**, which is preferably formed from a non-magnetic material, such as brass, having the necessary mechanical strength to support the end portions **20A** and **20B** of the bushing **20** when said bushing is assembled with the casing **30**.

As mentioned previously, the bushing **20** is adapted to receive the effective primary winding of the current transformer **10**, which may be any conventional type of current-carrying conductor of a size suitable to pass through the tubular member **98** of the bushing **20**. It is to be understood, however, that the current transformer **10** may be provided with a bushing similar to the bushing **20** having a generally cylindrical shape in which the resilient, elastomeric, electrically insulating material is molded or formed about a suitable current carrying conductor such as that of the bar-type to form a current transformer similar to the current transformer **10**, but of the bar-type rather than of the through-type as illustrated. The current-carrying conductor in the latter construction would normally be adapted for coupling or connection to the current-carrying conductors of an associated electrical circuit.

In order to hold the bushing **20** in assembled relationship with the casing **30** of the current transformer **10**, the current transformer **10** also includes the clamping means **22** and **24** which are disposed at the opposite ends of the casing **30** adjacent to the opening **46** in said casing and which are of the split ring type. The clamping means **24** includes the two generally C-shaped clamping members **24A** and **24B** which are arranged to substantially surround the outer periphery of the bushing **20** adjacent to the opening **46** of the casing **30** and which are secured to the casing **30** by the bolt means **52**. Similarly, the clamping means **22** at the opposite end of the casing **30** includes the two generally C-shaped clamping members **22A** and **22B** which are arranged to substantially surround the outer periphery of the bushing **20** adjacent to the opening **46** of said casing and which are similarly secured to the casing **30** by the bolt means **52** which extend through the openings or apertures **53** in said casing, as best shown in FIGS. 1 and 2. The clamping means **22** and **24** are arranged or adapted to apply axial clamping forces to the intermediate portion **20C** of the bushing **20** in opposite directions to hold said bushing in assembled relationship with the casing **30** as just mentioned. In order to prevent rotation of the bushing **20** with respect to the casing **30** after said bushing is assembled with said casing, the intermediate portion **20C** of the bushing **20** is provided with one or more projecting portions or lugs **96** at each end thereof which are engageable by the ends of the associated clamping members **22A** and **22B** and **24A** and **24B**, respectively, at the opposite ends of the casing **30**, as best shown in FIG. 3, if the bushing **20** should tend to rotate in place after assembly with the casing **30**. It is to be noted that the inner diameter or peripheral dimension of the closed loop defined or formed by the clamping means **22** and **24**, respectively, at the opposite ends of the casing **30** is conveniently arranged to be greater than the outer diameter or peripheral dimension of the bushing **20**, as indicated in the spaces **45**, but less than the outer diameter or peripheral dimension of the bushing **20** as taken at the top of the ridges **43**.

It is important to note that the insulating casing **30** provides an insulation level which permits the application of the current transformer **10** at a first predetermined voltage even without the additional insulation provided by the insulating bushing **20**. The insulating bushing **20** when assembled with the casing **30** in the manner previously described, then provides additional insulation which cooperates with the insulation of the casing **30** to permit the application of the current transformer **10** at voltages higher than the first predetermined voltage just mentioned and which varies with the axial dimension of the insulating bushing **20**. The manufacture or assembly of the current transformer **10** may therefore be conveniently accomplished in two steps. In the first step, the secondary winding **72** is assembled on the associated magnetic core **74** and then an insulating casing **30** is formed or molded about said core and winding as previously described. The second main step in the assembly of the current transformer **10** is to select a suitable insulating bushing similar to the bushing **20** in order to provide the additional insulation required for application of the transformer **10** at a particular voltage in an overall range of voltages. The insulating bushing **20** of a suitable axial dimension is then assembled with the casing **30** in the manner just described. It is important to note that if the current transformer **10** is to be applied at a different voltage, only the insulating bushing similar to the bushing **20** need be changed by removing the clamping means **22** and **24** and then assembling the casing **30** with a new insulating bushing as required for application at a particular voltage.

Although the clamping means **22** and **24** have been described in detail, it is to be understood that other suitable means may be employed to hold or secure the bushing **20** and the casing **30** in proper assembled relationship.

The apparatus embodying the teachings of this invention has several advantages. For example, a current transformer as disclosed more readily lends itself to convenient assembly for application at different voltages in a predetermined range of voltages. In addition, a current transformer as disclosed readily lends itself to application at a different voltage by the relatively simple operation of changing the insulating bushing which forms part of the overall assembled current transformer as described. Finally, a current transformer as disclosed permits a reduction in the number of subassemblies or components which must be available to provide a wide variety of current transformer ratings.

Since numerous changes may be made in the above-described apparatus and different embodiments of the invention may be made without departing from the spirit and scope thereof, it is intended that all the matter contained in the foregoing description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

We claim as our invention:

1. A current transformer comprising a closed loop magnetic core, a secondary winding inductively disposed on said core, a casing having an aperture therethrough molded around said core and winding from a resilient, elastomeric, electrically insulating, thermosetting material, a cylindrical bushing having an intermediate portion disposed to pass through said aperture and first and second end portions extending longitudinally in each direction outwardly from said aperture, said bushing being molded from a resilient, elastomeric electrically insulating material, and clamping means secured to said casing at each end thereof for applying longitudinal clamping forces to said bushing to hold said casing and said bushing in assembled relationship, said clamping means com-

prising split clamping rings disposed to substantially surround said bushing at each end of said casing adjacent to said opening and to bear longitudinally against the intermediate portion of said bushing.

2. A through-type current transformer comprising a toroidal magnetic core having a secondary winding disposed thereon and an axial opening therethrough, a casing molded around said core and winding from a resilient, elastomeric, electrically insulating, thermosettable resin, a hollow cylindrical bushing having an intermediate portion disposed substantially inside said opening and end portions extending outwardly in each direction from said opening, said bushing being formed from a resilient, elastomeric, electrically insulating material, and a pair of generally C-shaped clamping members secured to said casing adjacent to each end of said opening to substantially surround said bushing, said clamping members being arranged to apply axial clamping forces to the intermediate portion of said bushing to maintain said casing and bushing in assembled relationship.

3. A through-type current transformer comprising a toroidal magnetic core having a secondary winding disposed thereon and an axial opening therethrough, a casing molded around said core and winding from a resilient, elastomeric, electrically insulating, thermosettable resin, a hollow cylindrical bushing having an intermediate portion disposed substantially inside said opening and end portions extending in each direction outwardly from said opening, said bushing being formed from a resilient, elastomeric, electrically insulating material, and a pair of generally C-shaped clamping members secured to said casing adjacent to each end of said opening to substantially surround said bushing, said clamping members being arranged to apply axial clamping forces to the intermediate portion of said bushing to maintain said casing and bushing in assembled relationship, said intermediate portion including at least one axial projection at each end of said casing engageable by said clamping members to prevent rotation of said bushing with respect to said casing.

4. A transformer comprising a toroidal magnetic core having a winding disposed thereon and an axial opening therethrough, a casing molded around said core and winding from an elastomeric, electrically insulating, thermosetting material, a cylindrical bushing having an intermediate portion disposed substantially inside said opening and end portions extending outwardly from said opening in each axial direction and each including a plurality of alternate ridge portions and spaces on the outer periphery thereof, said bushing being formed from an electrically insulating, elastomeric material, and a pair of generally C-shaped clamping members secured to each end of said casing to substantially surround said bushing, the inner peripheral dimension of the opening defined by each pair of said clamping members being greater than the outer peripheral dimension of said bushing in said spaces but less than the outer peripheral dimension of said bushing at said ridge portions, said clamping members being arranged to apply axial clamping forces to the intermediate portion of said bushing.

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