Aug. 26, 1958 D. C. PRINCE 2,849,694

CURRENT TRANSFORMER

Filed July 12, 1954

Fig. 1.

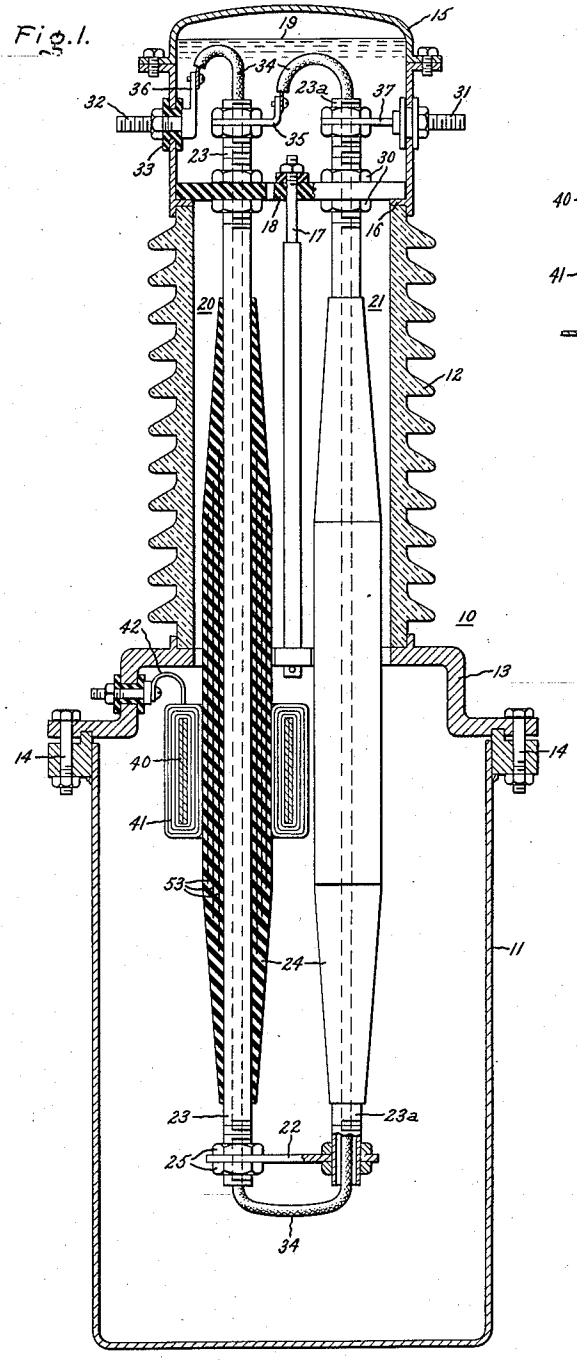
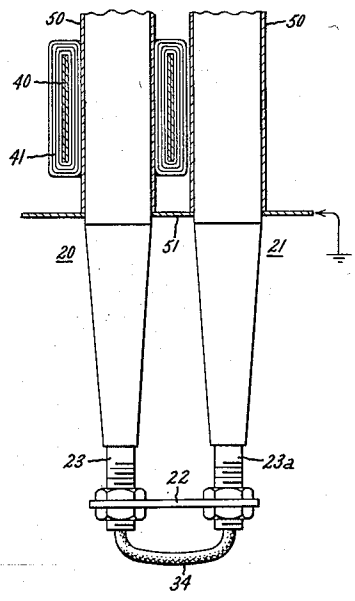


Fig. 2.



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CURRENT TRANSFORMER

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2 Claims. (Cl. 336—174)

This invention relates to a high voltage current transformer and, more particularly, to the type of transformer which is provided with a loop-shaped primary winding disposed within an insulating housing.

To meet the severe insulation requirements present in such a transformer, it has been conventional in the past to form the loop-shaped primary structure of the transformer in the shape of an eye-bolt with the primary conductor coated by a thick unitary, insulating sheath. An example of this construction is illustrated in U. S. Patent No. 2,300,910—Camilli, assigned to the assignee of the present invention. Not only is the insulation coating process for such a primary quite costly because of the intricate configuration of the primary conductor, but the resulting primary structure does not lend itself to being readily linked with the usual core and secondary winding of the transformer. With such a primary construction, the core, which is a closed annulus, cannot be preformed, but must be formed with the looped primary structure present at its center during the formation process. The presence of the primary conductor not only complicates the process of core formation but also complicates the process of linking the secondary winding to the core.

Accordingly, it is an object of the present invention to provide an improved current transformer which readily lends itself to being constructed and assembled at very low cost.

It is a further object of my invention to provide a current transformer constructed in a manner which readily permits its various components to be preformed and subsequently assembled with a minimum of difficulty.

Another object is to construct and arrange the components of the transformer in a manner which not only fulfills the necessary insulation requirements but also permits the components to be enclosed by a housing of a small and very compact form.

In accordance with one form of my invention, the current transformer assembly includes a pair of elongated bushing cores closely surrounded by a ceramic insulating shell. The bushing cores are mounted to extend throughout their lengths in closely-spaced, substantially-parallel relationship. Each of the bushing cores comprises an elongated conductive stud extending in an essentially rectilinear path and an insulating sheath disposed about the stud. The studs are connected in series circuit relationship by a conductive member detachably clamped across their ends. Mounted about one of the sheaths is an annular magnetic core having a secondary winding inductively linked thereto.

The invention will be best understood by referring to the drawing in which Fig. 1 is a cross-sectional view of one form of current transformer embodying my invention. Fig. 2 is a fragmentary view illustrating the adaptability of the current transformer of Fig. 1 to use with shielding structure.

Referring to Fig. 1 of the drawing, the transformer is provided with an enclosing housing **10** comprising a grounded metallic tank **11** and a tubular ceramic shell **12** (preferably of porcelain) supported on the tank by means of a cover **13**. The cover **13** and the tank **11** are provided with flanges suitably clamped together in sealing relationship by a series of bolts **14**. Supported at the

upper end of the porcelain shell **12** is an enclosing dome **15** having an annular flange **16** providing a seat for supporting the dome on the porcelain shell **12**. The dome and the porcelain shell are maintained in assembled relationship on the cover **13** by tensioning means in the form of suitable elongated insulating bolts such as **17** acting through a clamping plate, or compression member, **18** which bears against the seating flange **16** of the dome **15**. The housing **10** is filled with a suitable insulating fluid to a level **19**, as indicated near the top in Fig. 1.

In accordance with my invention, the primary winding of the transformer comprises a pair of bushing cores **20** and **21** which are interconnected at their lower ends by a conductive strap **22**. Each of these bushing cores comprises an elongated tubular stud about which there is disposed an insulating sheath **24**. These studs are respectively designated as **23** and **23***a*. Each of the sheaths **24** is preferably formed of superimposed layers of insulating paper tightly wound about the stud as a center. The winding process is carried out prior to assembly of the bushing core within the housing **10** and is considerably facilitated by the fact that each of the studs has an essentially rectilinear axis. As a result, the winding process is a simple operation which may be performed by machine simply by turning the core at high speed whereby to wind the insulating paper thereabout. Because of the simple rectilinear configuration of the stud, I have obviated the need for the manual winding operation which has generally been found necessary in order to apply insulation to the primary of those transformers having an eyebolt-shaped primary.

For electrically connecting the conductive strap **22** to the lower ends of the studs **23** and **23***a*, each of the studs is provided with a pair of clamping nuts **25** threaded thereon. These nuts are arranged to tightly clamp the strap **22** therebetween so as to provide a good electrical connection between the studs.

To support the bushing cores within housing **10**, the upper end of each stud is provided with a pair of clamping nuts **30** suitably threaded thereon. These nuts are arranged to tightly clamp the supporting plate **18** therebetween, thereby to rigidly suspend the bushing cores from this plate **18**. Suitable leads for the primary are provided by means of a pair of threaded terminal members **31** and **32** mounted at opposite sides of the dome **15**. The terminal member **32** is insulated from the dome **15**, as by an insulating gasket **33**.

Although not limited to such a construction, the transformer of my invention is readily adapted for use as a current transformer having a multiple turn primary winding. These multiple turns may readily be provided by utilizing the open-ended tubular studs **23**, **23***a* as a single turn which houses a second turn in a generally coaxial relationship. For example, one turn of the primary winding is generally constituted by the series-connected tubular stud **23***a*, strap **22**, and tubular stud **23**, whereas the second turn of the primary is constituted by a flexible conductor **34** extending coaxially and downwardly through tubular stud **23***a*, across the lower open ends of the studs, and then coaxially and upwardly through stud **23**. At one of its ends the flexible conductor **34** is electrically connected in series circuit relationship to the stud **23** by a lug **35**, whereas at its other end the conductor is electrically joined to terminal member **32** by suitable conductive connecting structure **36**. The stud **23***a* is connected to the opposite terminal member **31** by means of a lug **37**. To prevent short circuiting of the primary turns, the conductor **34** is provided with a suitable insulating covering. Since the voltage between the primary turns is comparatively small, this insulating covering may be relatively thin.

If more than two turns is required for the primary of

the current transformer, the flexible conductor could be wound once again through the tubular studs **23***a*, **23** before being connected to terminal member **32**.

Alternatively, if only a single turn is required for the primary, the flexible conductor **34** can be omitted and the upper ends of the studs **23***a* and **23** directly connected to the respective terminal bolts **31** and **32**.

The secondary structure of the transformer comprises an annular magnetic core **40** about which is wound a multiple-turn secondary winding **41** having suitable terminal leads **42**. The turns of the secondary winding are insulated from each other and from the core **40** in a conventional manner. Since it is possible to assemble this secondary structure about the primary simply by sliding the secondary structure over the lower end of the bushing core **23**, it is therefore possible to preform the magnetic core **40** and to link the secondary winding **41** to the core prior to assemblying this structure in its final position about the primary. Since this preformation of the secondary may be accomplished without any interference from the primary structure about which it is to be later assembled, such preformation is a simple operation which may be carried out at high speed and low expense essentially by machine. Thus, after the secondary structure has been completed, it is slid over the lower end of the bushing core **23** and is positioned thereabout by suitable mounting structure (not shown). This assembly operation takes place before the lower ends of the bushing cores are interconnected by the strap **22** or the cable **34**. Then, after the secondary structure is properly positioned, the detachable strap **22** is clamped in place across the lower ends of the cores and the flexible conductor **34** is drawn through the tubular studs.

As described in Application Serial No. 432,127 filed on May 25, 1954, now Patent No. 2,804,577, by A. W. Roth and assigned to the assignee of the present invention, it is often necessary to provide the primary structure with grounded shielding in order to insure correct energization of the secondary winding (**41**) in response to faults which might occur within the housing **10**. The current transformer assembly of my invention readily lends itself to the incorporation of such shielding. For example, as shown in the Roth application and as illustrated in Fig. 2 of my drawing, a conductive sleeve **50** may be mounted concentrically about each of the cylindrical bushing cores, and these sleeves may be interconnected by suitably grounded conducting structure **51**. Since each of the bushing cores extends in an essentially rectilinear path, these conductive sleeves may take the form of simple, cylindrical metal tubes. Since the conductive structure **22**, **34** bridging the studs **23**, **23***a* is removable, the shielding may readily be incorporated into the current transformer simply by sliding the composite shielding structure over the lower ends of the bushing in a manner similar to that described for assemblying the secondary structure **40**, **41**.

Although, as described above, the primary structure of my transformer readily lends itself to use with shielding **50**, **51**, it is to be understood that this shielding forms no part of my present invention. Such shielding structure and its relationship to other parts of the electrical system are described and claimed in the aforesaid Roth application.

To provide a uniform distribution of high voltage stresses throughout each of the insulating sheaths **24**, a series of generally concentric electrostatic shields **53** are provided within each of the sheaths. These shields may conveniently be formed by providing the insulating paper from which the sheath is wound with spaced areas coated with a conductive composition. A high voltage bushing core which is provided with such electrostatic shields is generally known as a "capacitance type" bushing core. Because the low voltage parts such as cover **13** and secondary structure **40**, **41** are in closest proximity to the bushing cores at the axially central regions of the cores, it is in this region that each insulating sheath **24** has its greatest wall thickness.

Bushing cores constructed and arranged in accordance with the present invention permit the use of a very compact insulating housing. For example, since the bushing cores extend in straight line paths they may be arranged in closely-spaced, substantially-parallel relationship. The only limitation on the closeness of the spacing is that sufficient space must be allowed for the radial thickness of the secondary structure **40**, **41**. With the cores in this closely-spaced, substantially-parallel relationship the diameter of both the tank and the porcelain shell may be minimized. Additionally, since the secondary structure is mounted within the tank instead of within the porcelain shell, this secondary structure offers no obstacle to reducing the diameter of the shell to the minimum required to enclose the bushing cores.

While I have shown and described a particular embodiment of my invention, it will be obvious to those skilled in the art that various changes and modifications may be made without departing from my invention in its broader aspects and I, therefore, aim in the appended claims to cover all such changes and 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. In a current transformer assembly, a pair of elongated bushing cores, each having a rectilinear configuration and comprising an elongated conductive stud and an insulating sheath disposed thereabout, means for mounting said cores to extend throughout their lengths in closely-spaced, substantially-parallel relationship, a singular tubular ceramic insulating shell closely surrounding said pair of bushing cores, said core-mounting means comprising an insulating plate secured to one end of said ceramic insulating shell and means rigidly clamping said studs to said plate adjacent one end of said studs to thereby suspend said studs from said plate, a conductive member detachably secured to the other end of said studs and electrically interconnecting said studs in series circuit relationship, an annular magnetic core mounted about one of said sheaths, and a secondary winding inductively linked with said magnetic core.

2. In a current transformer assembly, a pair of elongated bushing cores, each having a rectilinear configuration, means for mounting said cores to extend throughout their lengths in closely-spaced, substantially parallel relationship, a metal tank surrounding the lower portions of said bushing cores, a cover mounted on said tank, a tubular ceramic shell mounted upon said cover and closely surrounding the upper portion of said pair of bushing cores, each of said bushing cores comprising an elongated conductive stud and an insulating sheath disposed thereabout said core mounting means comprising a compression member seated atop said ceramic shell and extending transversely thereacross, means for securing said studs to said compression member, and tension means extending between said cover and said compression member for applying to said compression member a force which acts to clamp said compression member in position and to place said ceramic shell in compression; a conductive member detachably interconnecting said studs, an annular magnetic core mounted within said metal tank and about of of said bushing cores, and a secondary winding inductively linked with said magnetic core.

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