United States Patent [19]

Kocsis

[11] **3,835,430**

[45] **Sept. 10, 1974**

[54] **TUBULAR CORE ELECTRIC TRANSFORMER**

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[73] Assignee: **Transelectro Magyar villamossagi Kulkereskedelmi Vallalat,** Budapest, Hungary

[22] Filed: **Apr. 5, 1972**

[21] Appl. No.: **241,473**

Related U.S. Application Data

[63] Continuation of Ser. No. 37,467, May 18, 1970, abandoned, which is a continuation of Ser. No. 774,986, Nov. 12, 1968, abandoned.

[30] **Foreign Application Priority Data**

Sept. 20, 1968 Hungary ..... KO 2192

[52] **U.S. Cl.** **336/83,** 336/73, 336/174, 336/175, 336/212

[51] **Int. Cl.** **H01f 17/06**

[58] **Field of Search** 336/83, 212, 210, 73, 174, 336/175

[56] **References Cited**

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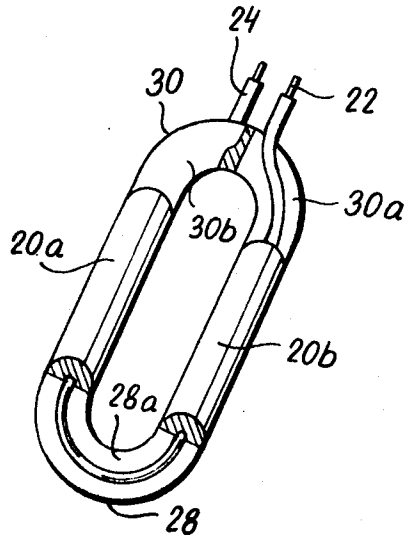
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Primary Examiner—Thomas J. Kozma
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[57] **ABSTRACT**

An electric transformer has a tubular iron core and its primary is located within the tube which can serve for secondary. In such case, the tubular iron core is short-circuited by a conductor connected to the tube extremities. The transformer may also have a secondary separate from the tubular iron core in which case the secondary has, preferably, likewise the form of a tube located within the tubular iron core and surrounding the primary. Both the primary and the secondary may consist of several turns. Such transformers are distinguished by exceptionally high values of power factor and efficiency, and are particularly suitable for heating, heat storing and energy shock absorbing purposes.

4 Claims, 12 Drawing Figures



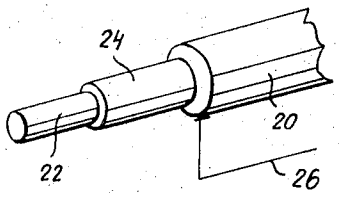


Fig. 1

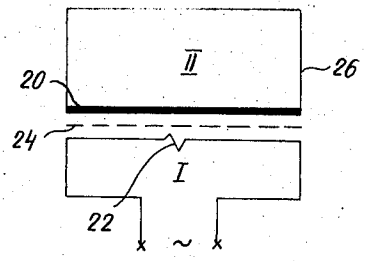


Fig. 2

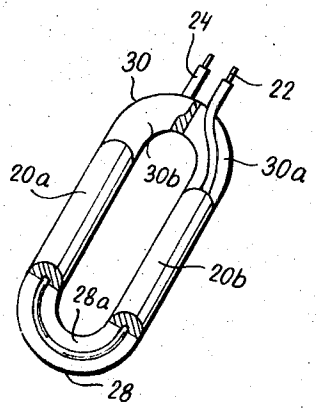


Fig. 3

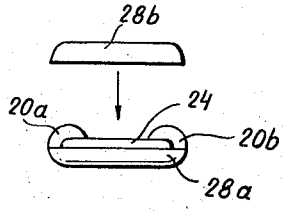


Fig. 4

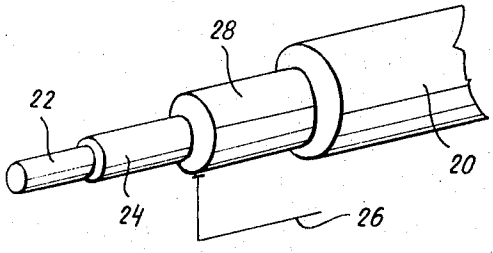


Fig. 5

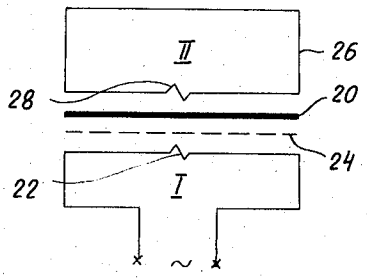


Fig. 6

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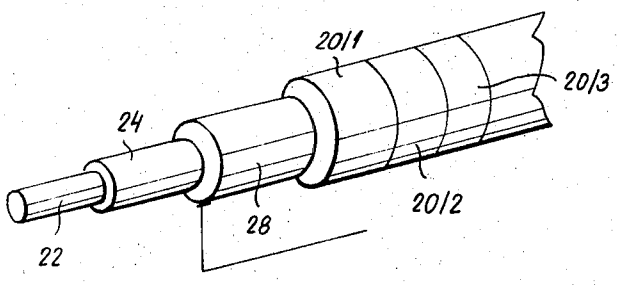


Fig. 7

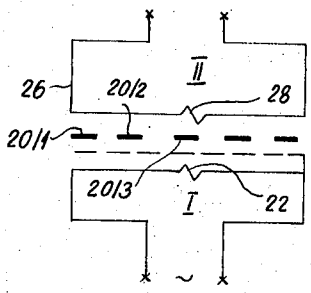


Fig. 8

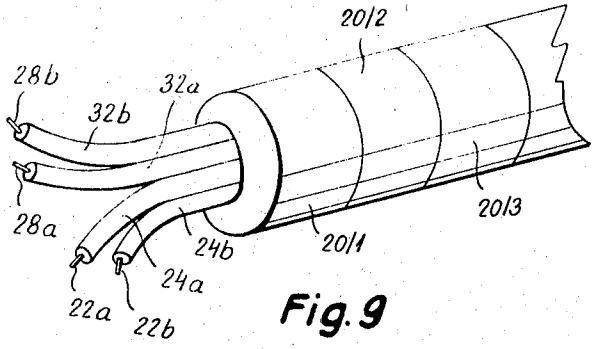


Fig. 9

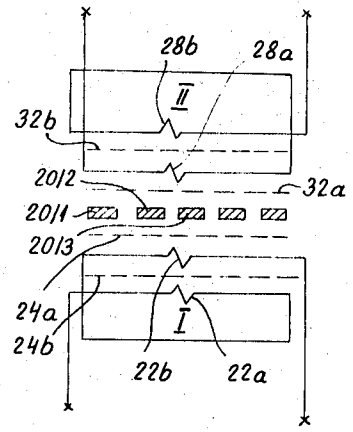


Fig. 10

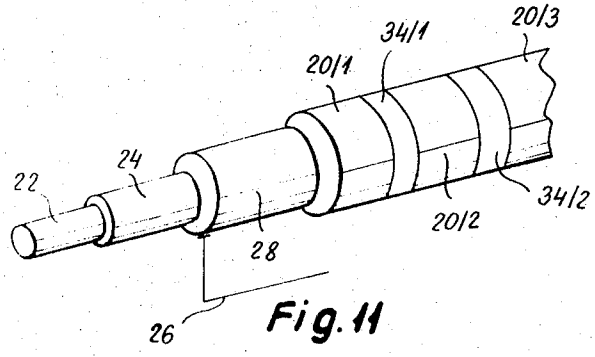


Fig. 11

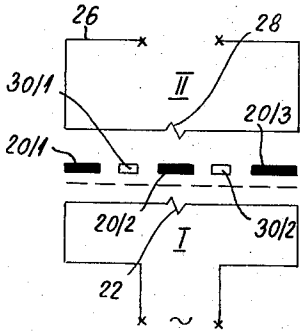


Fig. 12

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TUBULAR CORE ELECTRIC TRANSFORMER

This is a continuation of application Ser. No. 37,467, filed May 18, 1970, which is a continuation of application Ser. No. 774,986 filed Nov. 12, 1968; both are now abandoned.

This invention relates to electric transformers.

As is known, in case of high secondary amperages the power factor of conventional transformers is substantially less than unity. This is due to considerable stray fields by which also the short-circuit current of a transformer is materially reduced.

The invention aims at eliminating such inconveniences by providing a transformer which is suitable for yielding high secondary amperages at a power factor of at least 0.9 and even more.

For this purpose, the invention suggests to employ a tubular iron core with a primary therein. Viz., the basic idea of the invention is that with such tubular iron cores the flux path is the shortest and, therefore, the required exciting current the smallest. At the same time, due to its ferromagnetic nature, the tubular iron core may also serve for secondary.

Further and closer details of the invention will be described hereinafter by taking reference to the accompanying drawings which show various exemplified embodiments of the new transformer and in which:

FIG. **1** is a perspective view showing the principal features of the invention.

FIG. **2** illustrates an equivalent electric circuit to FIG. **1.**

FIG. **3** shows a perspective view of a practical embodiment of the invention.

FIG. **4** is an exploded view of a detail of FIG. **3.**

FIG. **5** represents a perspective view of another exemplified embodiment of the invention.

FIG. **6** illustrates an equivalent electric circuit to FIG. **5.**

FIGS. **7** to **12** show similar views of further exemplified embodiments.

Similar details are referred to by same reference characters throughout the drawings.

As is shown in FIGS. **1** and **2,** the transformer has a tubular iron core **20** made of ferromagnetic material such as iron. In the tubular iron core **20** there is a primary **22** made of electrically conductive material such as copper (Cu) and forming a primary circuit I between not specified terminals. The iron core **20** and the primary **22** are separated from one another by an insulation **24** such as mica. Moreover, the iron core **20** being of ferromagnetic material may serve for secondary as well for which purpose it is short-circuited by a conductor **26** with which it forms a secondary circuit II.

In operation, the transformer works in the usual manner. A primary a.c. voltage is applied to the terminals of the circuit I whereby a secondary voltage is excited in the secondary circuit II so that a secondary current will flow through the iron core **20** and the conductor **26.**

Such transformer is distinguished by a power factor of about 0.9 and is particularly suitable for heating purposes, storing of heat, and taking up high shock loads if the insulation **24** is of refractory nature as in the instant case.

A practical embodiment of the transformer according to the invention for heating purposes is illustrated in FIGS. **3** and **4.** It is seen that there are a pair of tubular iron cores **20***a* and **20***b* which are electrically connected with one another at their extremities to a closed electric circuit by a pair of tubular yokes **28** and **30** made likewise of ferromagnetic material such as iron. Both yokes **28** and **30** are, in a common plane of the tubular iron cores **20***a* and **20***b*, subdivided into a pair of crescent-shaped parts **28***a*, **28***b* and **30***a*, **30***b*, respectively. FIG. **4** shows the subdivision of the tubular yoke **28.** After the primary **22** with its insulation **24** has been placed in the tubes **20***a* and **20***b* as well as in suitable grooves of yoke parts **28***a* and **30***a*, the upper portions **28***b* and **30***b* of the yokes are placed on top yoke parts **28***a* and **28***b*, respectively, and bonded with them by means of e.g. welding or brasing. The tubular yokes **28***a*, **28***b* and **30***a*, **30***b* are connected with the tubular iron cores **20***a* and **20***b* in a similar manner.

Obviously, the short-circuiting conductor **26** of FIGS. **1** and **2** is formed here by the tubular yokes **28** and **30** which means that, on the one hand, there is practically no stray flux and, on the other hand, the secondary current will flow in an iron body **20***a*, **20***b*, **28, 30** which not only protects the primary **22** but also serves as a no-voltage heating means.

The exemplified embodiment illustrated in FIGS. **5** and **6** differs from the previous one in that its secondary consists of a separate winding **28** rather than of the tubular iron core **20** proper. It is made of non-magnetic but electrically conductive material such as brass so that its resistance is lower than the resistance of the ferromagnetic tubular iron core **20.** Moreover, it is likewise of tubular shape and is located within the tubular iron core **20.** Thereby, the secondary current will flow close to the primary **22** on a path well defined by the secondary **28.** A transformer of such special arrangement may reach a power factor of about 0.99.

FIGS. **7** and **8** show an exemplified embodiment which is distinguished from the previous one by a tubular iron core composed of axially juxtaposed annular pieces such as rings punched out of core metal sheets as if it were subdivided along planes transverse of the axial direction of the transformer. Such subdivided annular pieces are referred to by reference characters **20**/1, 20/2, 20/3. The significance of such embodiment consists in that there are practically no Foucault currents (eddy currents) which would flow in an integral tubular core **20.** Thus, a high transformer efficiency is obtained. Furthermore, the secondary circuit is, in the instant case, provided with terminals at which a load may be connected since a transformer of such construction already permits to take off a secondary output and is distinguished by a maximum value of the power factor.

The exemplified embodiment illustrated in FIGS. **9** and **10** shows that the transformer according to the invention may have several turns of primary and/or secondary. In the instant case, there are one pair of primary windings **22***a* and **22***b*, and one pair of secondary windings **28***a* and **28***b*, their corresponding insulations being designated by reference characters **24***a*, **24***b* and **32***a*, **32***b*, respectively, and made e.g., of rubber.

FIGS. **11** and **12** represent an exemplified embodiment which differs from that according to FIGS. **7** and **8** in that some of the annular parts of the tubular iron core are made of a material of reduced electrical conductivity. In the instant case, annular parts **20**/1, 20/2, 20/3 made of a ferromagnetic material of greater conductivity such as iron pairwise sandwich annular parts

34/1 and 34/2, respectively, of lower conductivity such as cast iron or, preferably, some antimagnetic steel. Moreover, all parts 20/1, 34/1, 20/2, 34/2, 20/3, etc., are mutually fixed, e.g., by means of applying an axial compressive force to them exceeding the yield points of the materials employed. Hereby, a rigid and very stable structure is obtained in which the iron core proper may serve for supporting the other parts of the transformer.

It will be seen that the transformer according to the invention has the special feature of almost a complete lack of stray fluxes which is due to the primary and, possibly, the secondary being disposed coaxially inside a tubular iron core which itself may serve also for secondary if such use has special advantages as in case of heating transformers. Measuring results obtained by conventional transformers and transformers according to the invention of same quality of iron cores and same values of induction as well as similar turn numbers are compared in the following table:

Magnitude	Conventional transformer	Transformer according to the invention
Weight	1	0.75
No-load current	1	0.7
Short-circuit current	1	2.8

where values characteristic of conventional transformers have been taken for unity. It has to be pointed out that all values figuring in the table can be obtained simultaneously. However, if dependent on the nature of use, a certain magnitude has still to be improved, it is possible to size the transformer correspondingly at the expense of the remaining pair of values.

What we claim is:

1. In an electric heating transformer, a tubular solid iron core and a transformer primary within said tubular core and insulation within said tubular core surrounding said transformer primary; the improvement in which said tubular core is in the form of a closed loop comprised by a plurality of iron core elements electrically conductively bonded together by welding or brazing in electrically short-circuited relation.

2. A structure as claimed in claim **1,** said tubular iron core comprising a pair of tubular iron core elements disposed in a common plane and interconnected at their ends by tubular iron yokes which are divided in said plane into pairs of crescent-shaped parts.

3. A structure as claimed in claim **2,** which is elongated in the direction of said tubular iron core elements, said transformer primary and insulation being continuous through one of said yokes and emerging from said core through the other of said yokes.

4. A structure as claimed in claim **3,** said yokes being semi-circular.

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