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 TRANSFORMER ASSEMBLY FOR VARYING ELECTRICAL PARAMETERS
 AND METHOD OF CONSTRUCTING THE SAME
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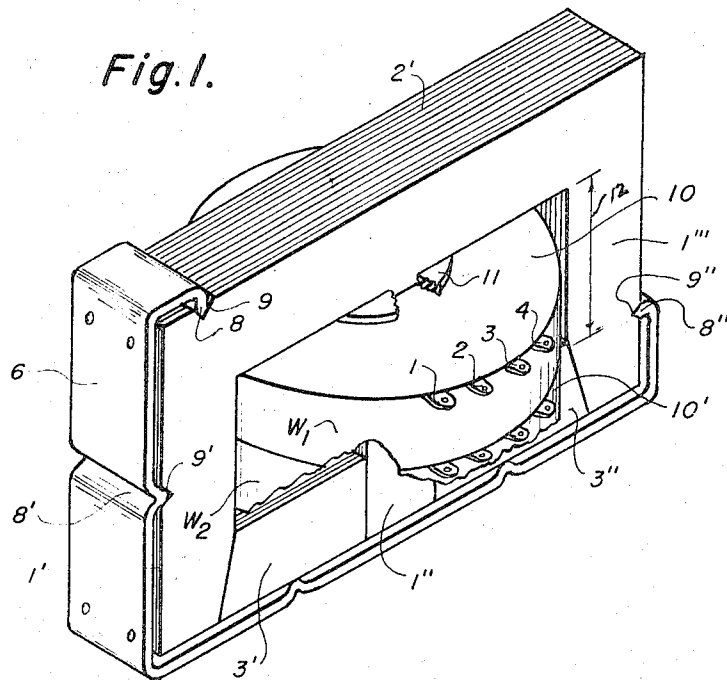
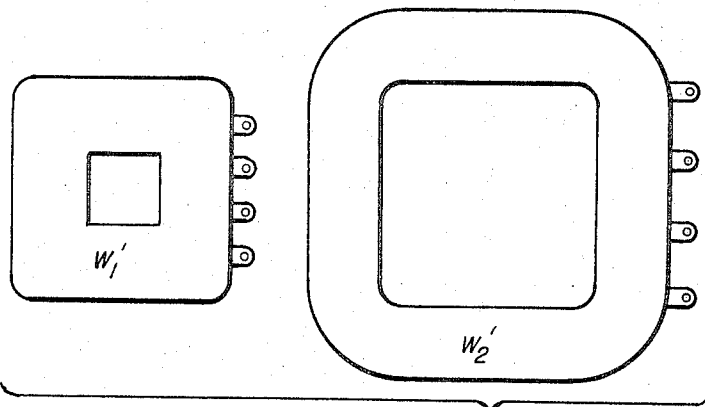


Fig. 2.

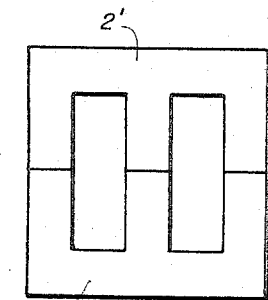


Fig. 4.

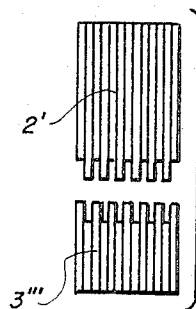


Fig. 3.

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TRANSFORMER ASSEMBLY FOR VARYING ELECTRICAL PARAMETERS AND METHOD OF CONSTRUCTING THE SAME

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ABSTRACT OF THE DISCLOSURE

This disclosure deals with a novel transformer assembly with standard interchangeable cores and fixed sets of windings that enables a wide variety of different transformer sizes to be readily attained.

The present invention relates to electrical transformer assemblies and to methods of construction of the same.

For many decades, the wide variety of different requirements in the transformer art has defied the kind of standardization and variable-parameter stocking long feasible in connection with other types of electrical components, such as resistors, capacitors and the like. Every electrical equipment manufacturer, at one time or another, has been plagued with delays and expense attendant upon the requirements for the winding of special transformers. Underlying this difficulty is the fact that not only different wattage ratings, but also the same wattage rating, may apply for a multiplicity of different voltages both in the primary and secondary.

An object of the present invention, however, is to provide novel standardized transformer cores and pluralities of windings adapted to be assembled in various combinations from stock items to enable the ready construction of any particular transformer with any desired primary and secondary voltage rating.

A further object is to provide a novel transformer assembly.

Still another object is to provide a novel method or process of construction which enables a user to choose appropriate sizes of standard core and windings to fit substantially any particular requirement.

Additional objects will be noted in the specification to follow and will be more particularly pointed out in connection with the appended claims.

The invention will now be described with reference to the accompanying drawing, FIG. 1 of which is an isometric view of an embodiment of the present invention, illustrating a side-by-side winding assembly;

FIG. 2 is a side elevation of modified windings for assembly coaxially in the structure of FIG. 1; and

FIGS. 3 and 4 are side elevations of modified core structures.

Referring to FIG. 1, a magnetic core 2', as of standard parallel-plane silicon-steel laminations, is shown in the form of a three-legged substantially E-shaped core 1'-1''-1''', oppositely tapered at the free ends of the legs 1' and 1''' to receive a pair of magnetic pole piece members 3' and 3''. The members 3' and 3'' are also correspondingly tapered to fit or snap into the space between the free end portions of the legs 1', 1'', and 1''', respectively, in order to complete the magnetic flux loop around the core 2'.

When the magnetic pole members 3' and 3'' are removed or separated from the rest of the core 2', a pair of separate annular windings W₁ and W₂, later described, may be assembled in side-by-side relationship upon the central leg 1'' of the core 2'. The separable magnetic pole members 3' and 3'' may then be applied to lock within the spaces between the terminal portions of respective legs 1'-1'' and 1''-1''' to complete the core magnetic

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flux loop, as previously mentioned. A resilient clamp or bracket 6, shown as substantially L-shaped and provided with terminal and intermediate projections 8, 8', 8'', etc., may then be applied to clamp the assembly, the projections engaging correspondingly positioned recesses 9, 9', 9'', etc. in the outer peripheral surface of the core 2.

Unlike customary transformers, the annular primary and secondary windings W₁ and W₂ of the present invention, as of copper wire, are wound upon separate coil forms and separately encapsulated in plastic or some other preferably somewhat resilient material, generally illustrated at 10 and 10', respectively. In the embodiment of FIG. 1, the inner configuration and dimensions of the windings W₁ and W₂ substantially correspond to those of the inner leg 1'' upon which the windings are assembled. A tight fit, as by a somewhat tapered leg, aided by the resilient character of the encapsulation 10 and 10', enables the holding of the assembled windings W₁ and W₂ in fixed relationship upon the leg 1'', with a resilient spacer, washer or spring insert member or members 11 also employed, if desired, to prevent relative movement of the assembled windings even during vibration of, or shock to, the equipment.

The separate core encapsulation construction of the windings W₁ and W₂ serves additional important functions to the fixed-position holding action above described. Not only is environmental protection thereby attained, but also considerable reduction in the necessary tolerances of the dimensions of the windings is effected while affording maximum utilization of winding space. Accurate and compact mechanical assembly is also thereby attained without the requirement for assembly skills or substantial assembly time. Facile adjustment of relative coupling of the windings and other relative adjustments, including ready interchangeability of windings, not possible with current total transformer encapsulation techniques, are also features of this construction.

While the preceding has dealt with a facile method and construction of transformer assembly that may readily be carried out in the stock room by unskilled clerks, it has not yet been explained how the problem of providing different wattage rating transformers with any desired primary and secondary voltages is attained without requiring the stocking of an impractically large number of different windings.

If it be assumed that, say, forty different wire sizes are necessary to supply the vast majority of possible voltage and currents in certain kinds of transformer, then, with one primary and one secondary, 1600 different double coils would have to be stocked in order to attain every possible combination. Since this would have to be duplicated for each wattage size, a practically impossible number of combinations would be required in stock. In view of the separate winding construction of the invention, only forty single windings would be stocked for each wattage size for the side by side configuration, and eighty single windings for the coaxial configuration, which is entirely practical. These winding coils are to be sold as separate components to be assembled together with a magnetic core structure and a bracket. A purchaser requests a specific core size for the wattage rating desired, a corresponding coil to a specific voltage for the primary, and another corresponding coil for the secondary voltage. The correct winding coil can be chosen by reference to a table or graph, or the actual voltage can be printed on the coil, as later discussed. To enable the coils to be more useful, moreover, taps can be put on the windings so that more voltages will be available. For example, if two extra taps are put on every coil, as later explained, then every voltage within $\pm 3\%$ can be had over a very wide voltage range. For forty wire sizes,

this range is almost 10,000 to 1. Further, the sizes of coils can be such that sub sizes will fit onto larger units to provide multiple secondaries. Identical primaries and secondaries can be supplied, or if the economics demand, center-tapped or split secondaries can be matched with non-identically constructed primary windings. Ideally, however, identical windings simplify the stocking problem.

In accordance with the invention, exposed terminals are provided, number 1, 2, 3, and 4 in connection with the primary winding W_1 of FIG. 1, with intermediate taps providing between terminals 1 and 2, for example, substantially six percent of the total winding turns, and substantially twelve percent between terminals 3 and 4. If x represents the number of turns between terminals 2 and 3, therefore, there will be available from the single winding W_1 voltages corresponding to the following numbers of turns: x (between terminals 2 and 3); $x+A$ (between 1 and 3); $x+2A$ (between 2 and 4); and $x+3A$ (between 1 and 4), where A is substantially the said six percent. With conventional wire sizes differing in cross sectional area by about 26% the next smaller or finer wire-size winding for stocking, in accordance with a preferred embodiment of the invention, would have taps providing $x+4A$, $x+5A$ and $x+6A$ (i.e., no less than substantially six percent more turns); and the next larger or heavier wire winding would provide tap positions for $x-A$, $x-2A$ and $x-3A$. (In actual practice, each successive copper wire size differs from the next larger by about 26 percent and, as is more particularly evident from the following Table I, A may be closer to five or seven percent, but is herein described as substantially six percent.) This has been found to result in the possible selection of any desired set of primary and secondary voltages for different wattages, within about 3 percent.

Table I represents the data for the selection from a plurality of standard windings W_1 , W_2 , etc., of any desired primary and secondary voltage for given wattages. With this table, one merely selects those windings having the appropriate terminal numbers which are applied to appropriate stock windings (listed vertically in the left-most column) for the desired design. Specifically, the desired output wattage (from 100 down to 10 watts in the vertical columns from left to right) is selected and, under that wattage column, all the required primary and secondary voltages are selected. The appropriate number terminals (of the set of stock windings) is then read (in the left-most column) for the selected primary and secondary voltages.

TABLE I

Terminal Numbers	Wire Size	Number of Turns	100 Watts	90 Watts	80 Watts	70 Watts	60 Watts	50 Watts	40 Watts	30 Watts	20 Watts	10 Watts
2-3-----	27	429	134	124	113	103	98.0	92.7	87.5	82.4	77.7	73.3
1-3-----	27	455	142	132	120	109	104	98.3	92.8	87.4	82.4	77.7
2-4-----	27	482	151	140	127	116	110	104	98.3	92.7	87.4	82.4
1-4-----	27	511	160	148	134	123	117	110	104	98.2	92.7	87.4
6-7-----	28	542	170	157	143	130	124	117	111	104	98.2	92.7
5-7-----	28	575	180	167	151	138	131	124	117	111	104	98.2
6-8-----	28	610	191	177	160	148	139	132	124	117	111	104
5-8-----	28	647	203	188	170	155	148	140	132	124	117	111
10-11-----	29	686	215	199	180	165	156	148	140	132	124	117
9-11-----	29	727	228	211	191	174	166	157	148	140	132	124
10-12-----	29	771	241	224	203	185	176	167	157	148	140	132
9-12-----	29	817	256	237	215	196	186	177	167	157	148	140
14-15-----	30	866	271	251	228	208	197	188	177	167	157	148
13-15-----	30	918	287	266	241	220	209	199	188	177	167	157
14-16-----	30	973	305	282	256	234	222	211	199	188	177	167
13-16-----	30	1,031	323	299	271	247	235	224	211	199	188	177
18-19-----	31	1,093	342	317	287	262	249	237	224	211	199	188
17-19-----	31	1,159	363	336	305	278	264	251	237	224	211	199
18-20-----	31	1,229	385	356	323	295	280	266	251	237	224	211
17-20-----	31	1,303	408	378	343	313	297	281	266	251	235	224

To enable the coils to be more useful, moreover, taps can be put on the windings so that more voltages will be available. For example, if two extra taps are put on every coil, as previously explained, then every voltage within $\pm 3\%$ can be had over a very wide voltage range. For forty wire sizes, this range is almost 10,000 to 1.

Further, the sizes of coils can be such that sub sizes will fit onto larger units to provide multiple secondaries. Primaries and secondaries can be supplied, both of which have the 6 and 12% taps, or if the economics demand, center tapped or split secondaries can be matched with the 6 and 12% tapped primary windings. Ideally, however, identical windings simplify the stocking problem.

As an example, for a 150-volt input primary winding in a 100-watt transformer, one finds "151" listed in the "100 watts" vertical column, and notes that the stock winding with terminals 2 and 4 (482 turns) is appropriate. Similarly, the desired secondary may be selected for any desired voltage, within 3 percent.

Thus, the provision of pluralities of separate encapsulated standard windings for each of a plurality of different wire sizes each of substantially 26 percent different area than the next larger wire size, with taps corresponding to substantially six and twelve percent of the corresponding winding length, with facile care and bracket construction, enables the stocking of standard parts and ready assembly of transformers of any desired parameters—a standardization and stocking result believed never before attainable with transformers.

As previously mentioned, multiple secondaries may be employed, and the width of the core legs 1', 1'', 1''' may be varied to accommodate the same; the core width, indeed, being a function of the wattage, with the width doubling as the wattage doubles. Refer to FIGURE 1, dimension 12.

The encapsulated windings W_1 and W_2 , moreover, may be constructed, also, in pluralities or groups adapted for partially or completely overlapping coaxial construction, as illustrated by the windings W_1' and W_2' of FIG. 2. These may, for example, be so coaxially assembled on the leg 1'' of the core 2' of FIG. 1. In this case, the inner configuration and dimensions of one group of windings W_2' will correspond to the outer configuration and dimensions of the group of windings W_1' to slip over the same, with the inner configuration and dimensions of the windings W_1' being adapted to fit over the core leg 1''. If a dual secondary winding construction is used, only two terminal taps will be needed for each. The windings may be connected both in series, both in parallel, or both in series with a center tap, with all adjustments achievable at the primary taps. The coaxial construction, moreover, provides only a fraction (about one-ninth, more or less) of the leakage attendant upon the side-by-side construction of FIG. 1 and involves less phase shift;

but it does not permit quite the universality of such one-size coil winding form.

The core 2' may also be modified, as desired, including not only snap-in separable pole members 3', 3'', but also an interlocking fitting between the core 2' and a flat or planar separable member 3''', FIG. 3; or a double E-

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construction, FIG. 4, with closely mating flat surfaces for juxtaposition with negligible gap loss. Clearly other configurations than symmetrical E-shaped cores may also be employed including non-symmetrical E cores, E and I shapes, F's, U's, L's and wound cores.

Further modifications will also occur to those skilled in the art and all such are considered to fall within the spirit and scope of the invention as defined in the appended claims.

What is claimed is:

1. For use in the assembly of transformers of varying electrical parameters, a plurality of separately encapsulated annular windings of different winding turns and of different wire sizes each of substantially 26 percent different area than the next larger wire size, at least certain of the windings having exposed terminals including taps at points corresponding substantially to six and twelve percent of the corresponding winding length, with 82% of the number of winding turns of the next smaller wire size having no less than substantially six percent more turns than the total number of turns of the next larger wire-size winding; magnetic core means receiving pluralities of the different wire-size windings and provided with magnetic leg means and a separable magnetic member that enables assembly of preselected encapsulated windings of the said plurality over the leg means as coupled primary and secondary windings and completes the magnetic flux loop thereof; means for holding the preselected assembled windings in fixed relationship upon the said leg means; and bracket means clamping the core means with the windings so-assembled.

2. Apparatus as claimed in claim 1 and in which the said preselection is effected substantially in accordance with Table I herein.

3. Apparatus as claimed in claim 1 and in which groups of the said windings are of substantially identical inner dimensions corresponding substantially to the dimensions of certain of the said core leg means upon which they are assembled in side-by-side relationship.

4. Apparatus as claimed in claim 1 and in which the inner dimensions of certain of the encapsulated windings

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correspond substantially to the outer dimensions of other encapsulated windings the inner dimensions of which correspond substantially to the dimensions of certain of the said core leg means upon which the preselected windings are assembled in overlapping coaxial relationship.

5. A method of transformer assembly, that comprises winding a plurality of separate annular windings of different winding turns and of a plurality of different wire sizes each of substantially 26 percent different area than the next larger wire size and with 82% of the number of winding turns of the next smaller wire size not less than substantially six percent more than the total number of turns of the next larger wire-size winding, providing electrical access to points of windings corresponding substantially to six and twelve percent of the corresponding winding turns, assembling preselected windings over the leg of a magnetic core in one of side-by-side and overlapping coaxial relationship, closing the magnetic flux loop of the core with the preselected windings so-assembled, and clamping the assembled windings and core.

6. A method as claimed in claim 5 and in which the further step is performed of preselecting windings substantially in accordance with Table I herein.

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