

Sept. 8, 1942.

G. R. MONROE

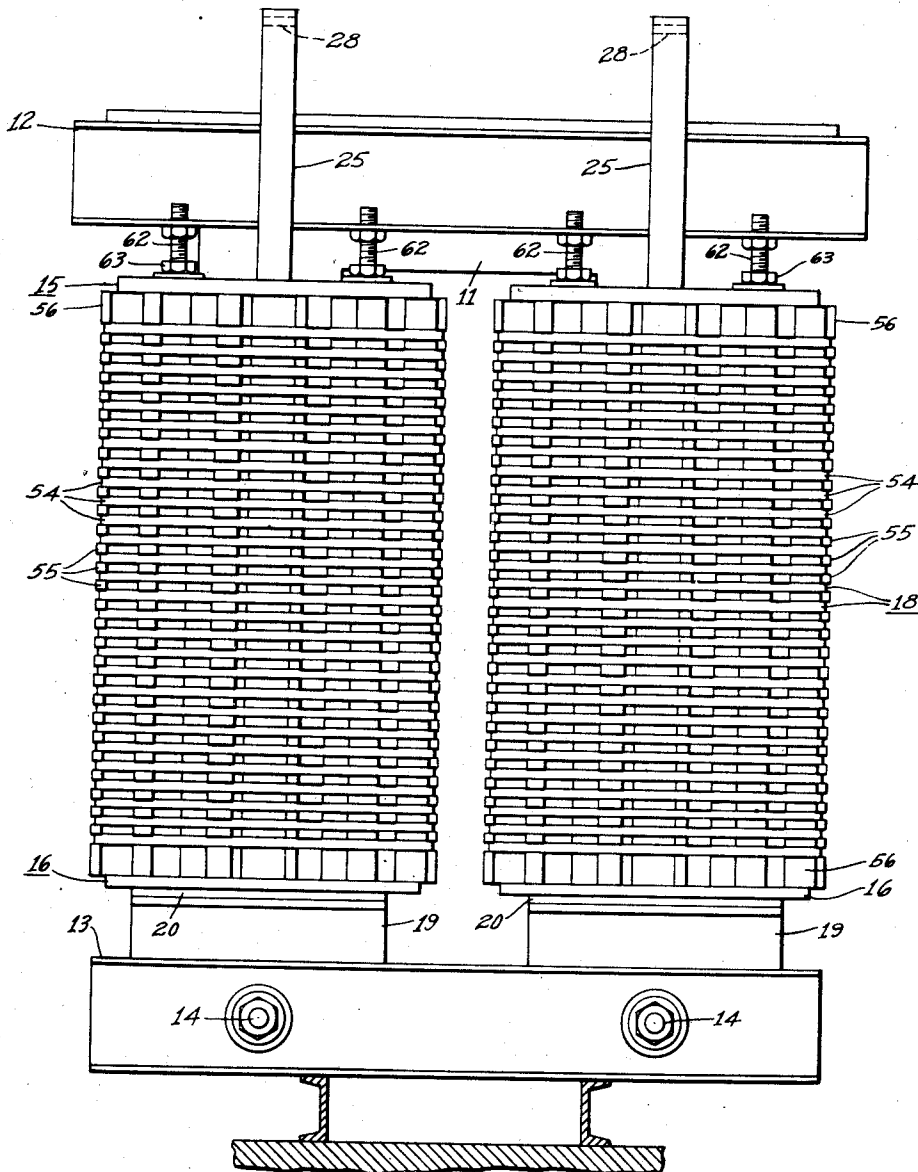
2,295,415

AIR-COOLED, AIR INSULATED TRANSFORMER

Filed Aug. 2, 1940

3 Sheets-Sheet 1

Fig. 1.



WITNESSES:

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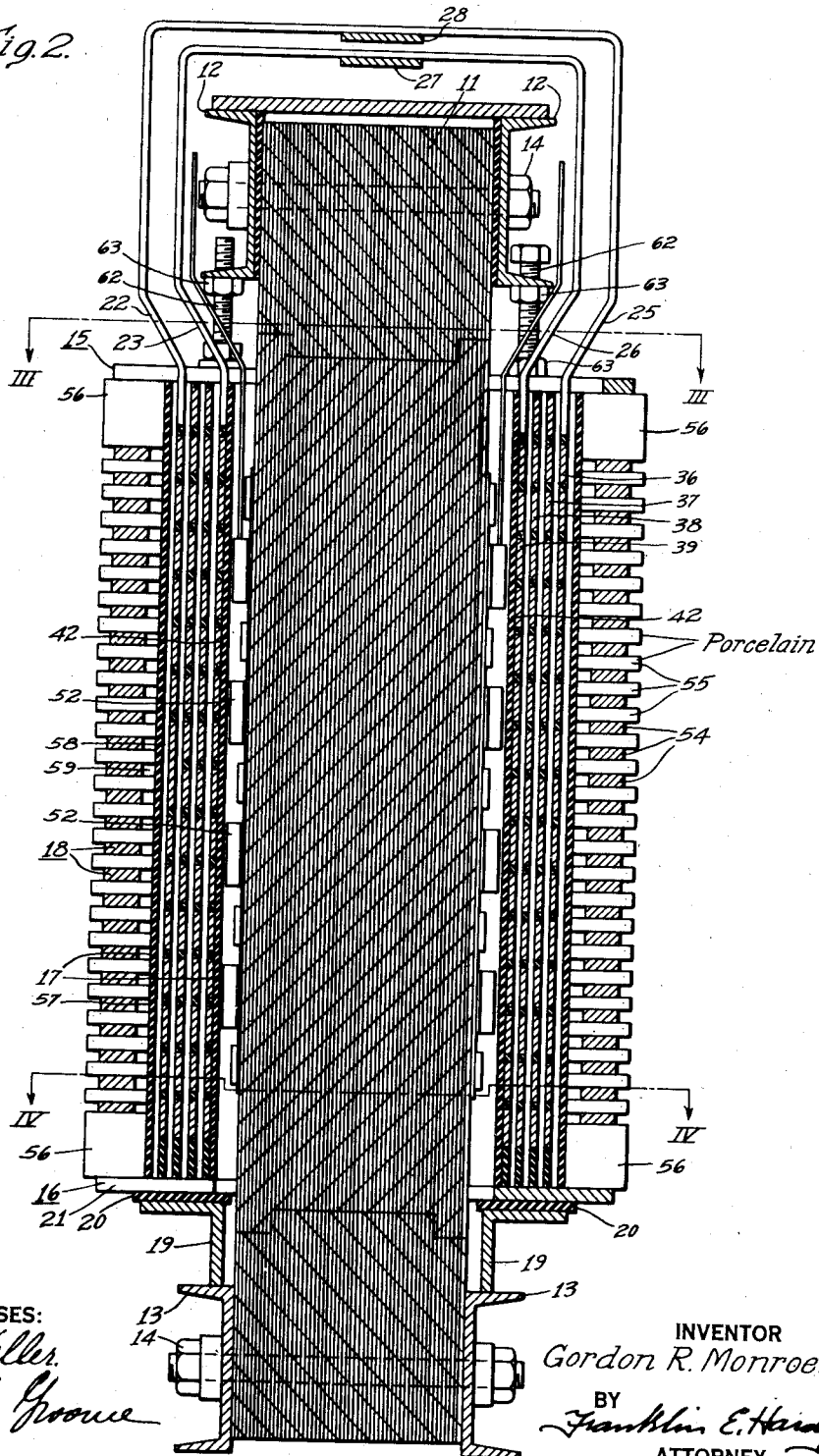
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3 Sheets-Sheet 2

Fig. 2.



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3 Sheets-Sheet 3

Fig. 3.

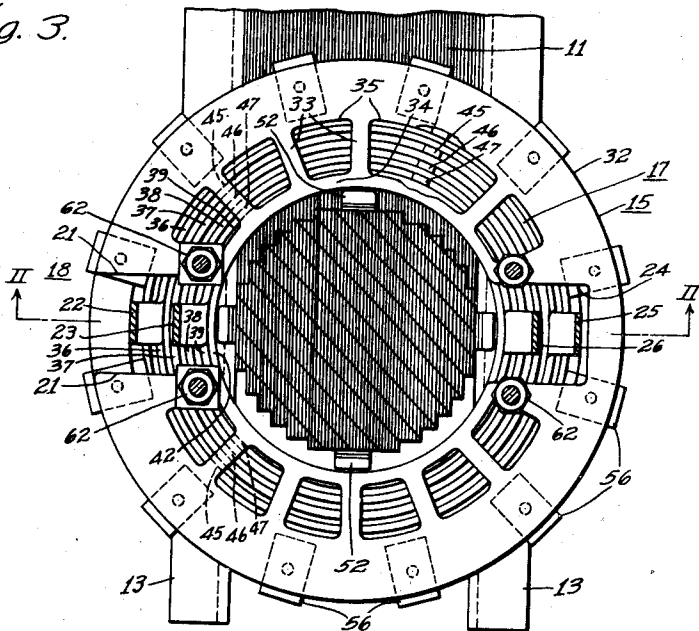
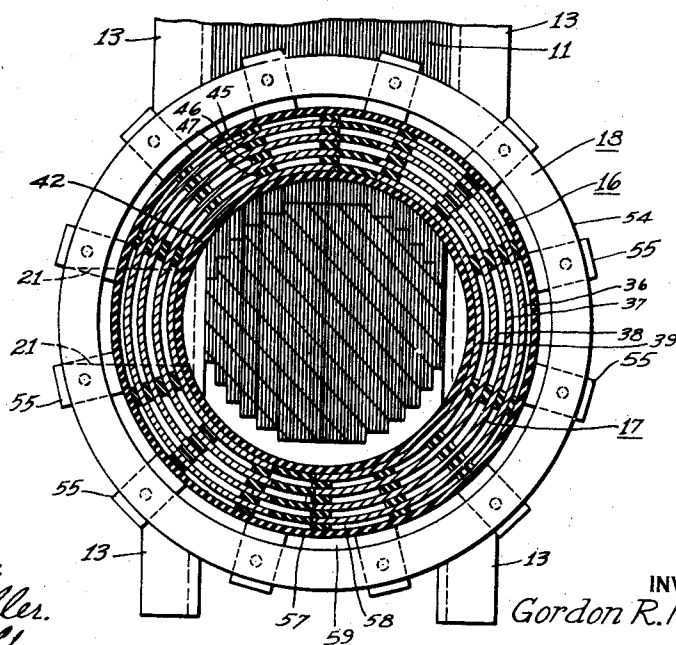


Fig. 4.



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UNITED STATES PATENT OFFICE

2,295,415

AIR-COOLED, AIR-INSULATED
TRANSFORMER

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inghouse Electric & Manufacturing Company,
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vania

Application August 2, 1940, Serial No. 349,427

5 Claims. (Cl. 175—356)

This apparatus relates to electrical induction apparatus such as transformers employing a core of magnetic material about which primary and secondary windings may be positioned in inductive relation to operate in a well known manner, and particularly to such apparatus in which the insulating materials are composed entirely of non-inflammable material.

In the construction of apparatus of the character indicated, it is the usual practice to insulate the individual copper coil conductors from adjacent strands with paper or cloth tape impregnated with varnish and to support and space the several coils or parts of the winding by the use of blocks or strips of material such as Micarta, wood, pressboard, paper or other similar organic material. All of these materials have a low burning point and may be a source of fire if the temperature is raised to the ignition point.

In many applications of induction apparatus, insulating oil is used which circulates to serve both as the insulating and cooling medium, and this material is also combustible under certain conditions. In accordance with the invention, the use of all organic material for insulating purposes is avoided and the parts so designed and arranged as to provide air cooled insulating apparatus. The individual conductors may be insulated from adjacent conductors by asbestos or woven glass tape and blocks of material such as porcelain or glass may be used for centering the low voltage winding on the core and for centering the low voltage and high voltage windings about the core as well as for spacing the several disc type coils of the high voltage winding. The use of such materials assists in providing an air cooled, air insulating transformer, all of the materials of which are non-combustible and are capable of withstanding high temperature for long periods of time.

It is an object of the invention to provide apparatus of the class described in which the coil spacing and supporting members are made of vitreous inorganic material such as porcelain and in which no organic insulating material is employed.

It is a further object of the invention to provide an air cooled, air insulated apparatus of the class described in which the coils are supported and spaced by a non-combustible material that will withstand high temperatures for long periods of time.

It is another object of the invention to provide apparatus of the character described, of which barriers of high dielectric strength are provided

between the windings and the core and between the high voltage and low voltage winding to provide high surge voltage insulating strength to the apparatus.

Other objects and advantages of the invention will be apparent from the following description of a preferred embodiment of the invention; in which

Figure 1 is a side elevational view of an air cooled air insulated transformer built in accordance with the invention, showing the core and coil assembly;

Fig. 2 is a vertical sectional view through one of the core winding legs taken on the line II—II of Fig. 3; and

Figs. 3 and 4 are horizontal sectional views taken along the lines III—III and IV—IV, respectively, of Fig. 2.

Referring to the drawings, a core type transformer is illustrated having a core structure 11 provided with two vertically positioned winding legs as best shown in Fig. 1 connected by two horizontal yoke portions clamped between channels 12 at the top of the structure and between channels 13 at the bottom of the structure, respectively, and held in position by bolts 14 for clamping the channel members together. Upper and lower steel pressure plates or rings 15 and 16, respectively, are provided for assisting and holding a low voltage winding 17 and a high voltage winding 18 in their proper positions about the winding leg of the core 11. The lower pressure plates 16 are supported from the channel irons 13 upon angle iron members 19 and insulating strips 20.

The pressure plates 15 and 16, as best shown in Figs. 3 and 4, are cut away at 21 so as not to provide a continuous short circuited turn about the winding leg and also to accommodate the low voltage terminal conductors 22 and 23 which extend upwardly through the upper plate 15. The plate 15 is also cut away, as shown at 24, to provide for similar low voltage terminals 25 and 26 which extend upwardly from the opposite side of the low voltage winding 17, the conductors 23 and 26 being joined at 27 and the conductors 22 and 25 being joined at 28, as best shown in Fig. 2, to provide terminals for the low voltage winding. As best shown in Fig. 3, the pressure plates comprise an outer ring 32 of considerable width joined by spokes 33 to a narrow inner rim 34, thus providing openings 35 between the spokes to permit the flow of air upwardly about the coils of the low voltage winding.

The low voltage winding 17 comprises a plu-

rality of cylindrical coils 36, 37, 38 and 39 wound about a central tube of non-combustible insulating material 42, the tube and coils extending from the lower pressure plate 16 to the upper pressure plate 15. As best shown in Fig. 2, each of the individual coils comprising a winding is made up of two conductors which may be made up of a number of conductor strands if so desired, the two conductors starting at the end of the coil on opposite sides of the center as, for example, the conductors 22 and 25 of the outer coil 36 which alternate vertically through the coil, the first half turn of each conductor displacing it vertically an amount corresponding to the vertical dimension of the conductor. Asbestos or similar insulating tubing may be provided between the last half turn of each conductor adjacent the ends of the coil so as to complete the coil structure to provide a right cylinder having ends pressed against the opposite pressure plates 15 and 16 at opposite ends of the winding structure. Vertical spacers 45, 46, 47 are provided between the several coils 36, 37, 38 extending vertically between the spokes 33 of the pressure plates 15 and 16 to provide spaces between the coils for the free circulation of air by thermal conduction upwardly through the openings 35 in the bottom pressure plate 16 and about the several coils comprising the low voltage winding 17 upwardly through the openings 35 between the spokes 33 of the upper pressure plate.

The low voltage winding 17 is spaced from the winding leg of the core 11 by a plurality of coil block centering spacers 52 which are mounted on small pins extending from the core structure and are of such dimensions as to fit snugly within the inner insulating tube 42 about which the low voltage winding coils are positioned.

The high voltage winding 18 may consist of a plurality of flat or disc type coils 54 separated by spacers 55 of insulating material such as porcelain. As best shown in Fig. 1, the spacers 55 are arranged in vertical columns between adjacent coils and are spaced about the circumference of the winding in a manner to provide openings radially of the winding between the adjacent coils. The winding is positioned between blocks 56 between the pressure ring 16 and the lower end of the winding and between the pressure block 15 and the upper end of the winding to assist in clamping the winding 18 firmly in place between the pressure plates 15 and 16.

A tube 57 of insulating material is provided between the high voltage and low voltage windings extending from the lower pressure plate 16 to the upper pressure plate 15 and fitting on the inner side of the blocks 56, thus providing a space 58 between the tube 57 and the outer side of the low voltage winding and a space 59 between the tube 57 and the inner side of the high voltage winding.

It will be noted that the blocks 56 are so spaced as to permit the flow of air inwardly across the lower end of the stack of high voltage winding coils 54 to rise upwardly between the high voltage winding and the insulating tube 57 and again outwardly between the upper blocks 56 and the pressure plate 15 to thus permit air to be conducted upwardly by thermal action within the interior of the coil 18. The arrangement of the structure above described with respect to the low voltage winding 17 permits the flow of air upwardly through the opening 35 in the upper and lower pressure plates and about the several coils comprising the low voltage winding.

Four pressure bolts 62 are provided extending through the lower flange of the upper channel irons 12 on the opposite side of the upper yoke sections of the core 11 for the purpose of bringing pressure against the pressure nut 63 carried on the pressure plate 15 for forcing the plate downwardly for securely positioning the winding assembly between the two pressure plates 15 and 16 and for centering the outer winding 18 about the core leg.

It will be obvious to one skilled in the art that many modifications of the details of construction described may be made within the spirit of the invention, and I do not wish to be limited otherwise than by the scope of the appended claims.

I claim as my invention:

1. An air-cooled, air-insulated transformer comprising a core of magnetic material having a vertically positioned winding leg, a frame structure for the core, a substantially circular upper pressure plate and a substantially circular lower pressure plate extending about the winding leg and operatively associated with the frame structure, tubular low-voltage and high-voltage windings spaced from each other and from the winding leg and positioned between said upper and lower pressure plates, a tubular insulating and supporting member positioned snugly within the inner of the two windings and a tubular insulating member positioned substantially midway between the two windings in a position to permit free circulation of air between the insulating member and each of the two windings, said tubular members and the inner of said two windings extending from the one to the other of the two pressure plates, the outer of said two windings comprising a stack of disc shaped coils spaced from each other and from the outer of the two tubular members by blocks of vitreous insulating material positioned between the coils about the tubular member, said outer winding being spaced from said pressure plates by means of blocks of vitreous insulating material spaced circumferentially along the ends of the winding between the winding and the pressure plates, to provide for free circulation of air by thermal conduction within and about the windings.

2. An air-cooled, air-insulated transformer comprising a core of magnetic material having a vertically positioned winding leg, a frame structure for the core, a substantially circular upper pressure plate and a substantially circular lower pressure plate extending about the winding leg and operatively associated with the frame structure, tubular low-voltage and high-voltage windings spaced from each other and from the winding leg and positioned between said upper and lower pressure plates by means of insulating blocks of vitreous material to provide a non-inflammable structure, said windings and supporting blocks being spaced radially to provide a space between the core and the inner winding and a space between the two windings for a free circulation of air by thermal conduction, a tubular insulating and supporting member positioned snugly within the inner of the two windings and a tubular insulating member positioned substantially midway between the two windings in a position to permit free circulation of air between the insulating member and each of the two windings, said tubular members and the inner of said two windings extending from the one to the other of the two pressure plates, the outer of said two windings comprising a stack

of disc shaped coils spaced from each other and from the outer of the two tubular members by blocks of vitreous insulating material positioned between the coils about the tubular member, said outer winding being spaced from said pressure plates by means of blocks of vitreous insulating material spaced circumferentially between the ends of the winding and the pressure plates, to provide for free circulation of air by thermal conduction within and about the windings.

3. An air-cooled, air-insulated transformer comprising a core of magnetic material having a vertically positioned winding leg, a frame structure for the core, a substantially circular upper pressure plate and a substantially circular lower pressure plate extending about the winding leg and operatively associated with the frame structure, tubular low-voltage and high-voltage windings positioned between said upper and lower pressure plates and spaced from each other and from the winding leg by means of insulating blocks of vitreous material to provide a non-inflammable structure, said windings and supporting blocks being spaced radially to provide a space between the core and the inner winding and a space between the two windings for a free circulation of air by thermal conduction, a tubular insulating and supporting member positioned snugly within the inner of the two windings and a tubular insulating member positioned substantially midway between the two windings in a position to permit free circulation of air between the insulating member and each of the two windings, said tubular members extending from the one to the other of the two pressure plates, the outer of said two windings being held in spaced relation from said pressure plates by means of certain of said blocks of vitreous insulating material spaced circumferentially between the winding and the pressure plates, to provide for the free circulation of air by thermal conduction within and about the winding, the inner of said two windings comprising a plurality of cylindrical winding sections extending from the one to the other of the two pressure plates and spaced from one another to provide for the free circulation of air therebetween, said upper and lower pressure plates having openings therein adjacent the ends of the inner of said two windings to permit the circulation of air upwardly therethrough.

4. An air-cooled, air-insulated transformer comprising a core of magnetic material having a vertically positioned winding leg, upper and lower end frame structures for the core, a substantially circular upper pressure plate and a substantially circular lower pressure plate extending about the winding leg and operatively associated with the frame structure, tubular low-voltage and high-voltage windings positioned between said upper and lower pressure plates, the low-voltage winding being spaced from the winding leg by means of insulating blocks of vitreous material to provide a non-inflammable structure, said windings and supporting blocks being spaced radially to provide a space between the core and the in-

ner winding and a space between the two windings for a free circulation of air by thermal conduction, a tubular insulating and supporting member positioned snugly within the inner of the two windings and a tubular insulating member positioned substantially midway between the two windings in a position to permit free circulation of air between the insulating member and each of the two windings, said tubular members extending from the one to the other of the two pressure plates, the outer of said two windings being spaced from said pressure plates by means of blocks of vitreous insulating material spaced circumferentially between the winding and the pressure plates, to provide for the free circulation of air by thermal conduction within and about the winding, the inner of said two windings comprising a plurality of cylindrical winding sections extending from the one to the other of the two pressure plates and spaced from one another to provide for the free circulation of air therebetween, said upper and lower pressure plates having openings therein adjacent the ends of the inner of said two windings to permit the circulation of air upwardly therethrough, and connecting means between the upper pressure plate and the upper end frame for centering the plate with respect to the frame and for applying pressure thereto.

5. An air-cooled, air-insulated transformer comprising a core of magnetic material having a vertically positioned winding leg, a frame structure for the core, a substantially circular upper pressure plate and a substantially circular lower pressure plate extending about the winding leg and operatively associated with the frame structure, tubular low-voltage and high-voltage windings spaced from each other and from the winding leg and positioned between said upper and lower pressure plates, a tubular insulating and supporting member positioned snugly within the inner of the two windings and a tubular insulating member positioned substantially midway between the two windings in a position to permit free circulation of air between the insulating member and each of the two windings, said tubular members and the inner of said two windings extending from the one to the other of the two pressure plates, the outer of said two windings being spaced from said pressure plates by means of blocks of vitreous insulating material spaced circumferentially along the ends of the winding between the winding and the pressure plates, to provide for free circulation of air by thermal conduction within and about the windings and across the ends of the outer winding between the winding and the pressure plates, said pressure plates being provided with a plurality of spaced openings adjacent the ends of the inner winding to permit the flow of air therethrough adjacent the inner winding, said upper pressure plate having recesses in its inner edges on opposite sides thereof to accommodate terminal conductors from said inner winding.

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