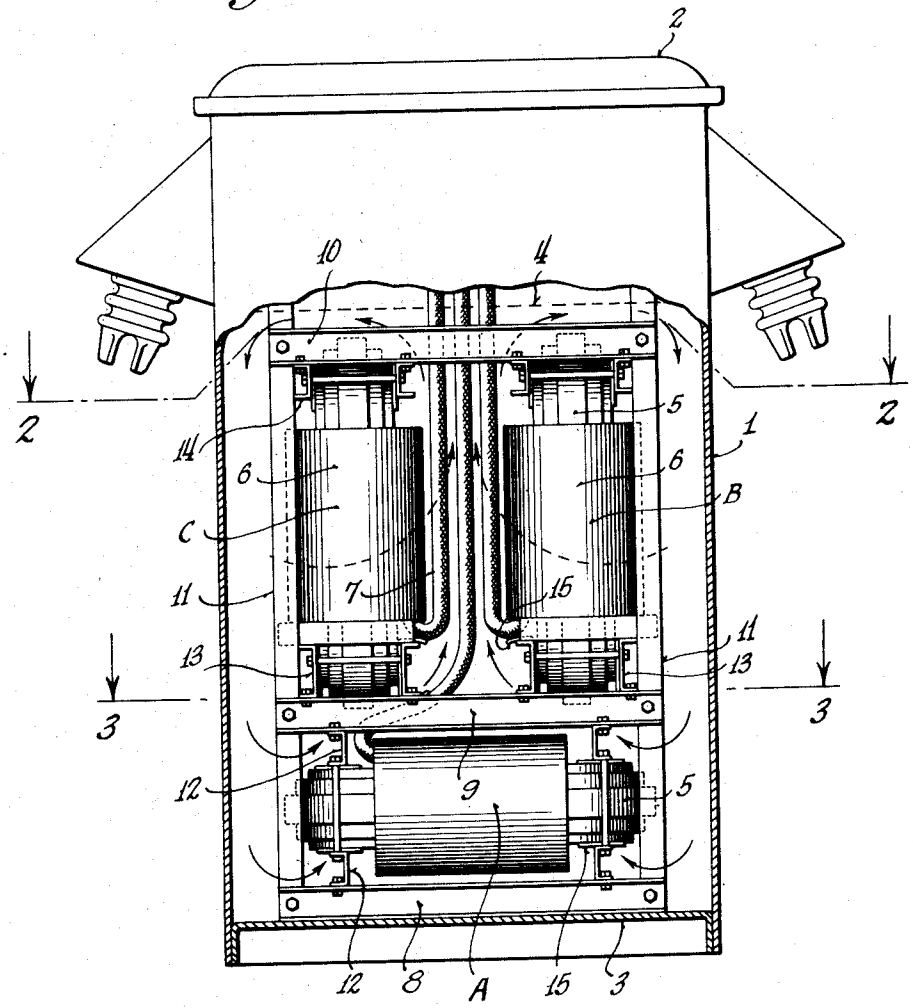
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THREE PHASE TRANSFORMER CONSTRUCTION

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Fig. 1



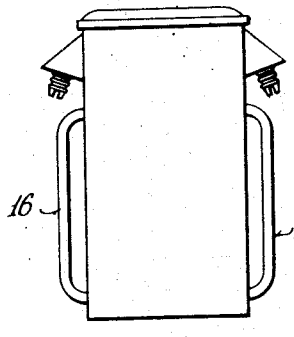


Fig. 5

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Fig. 2

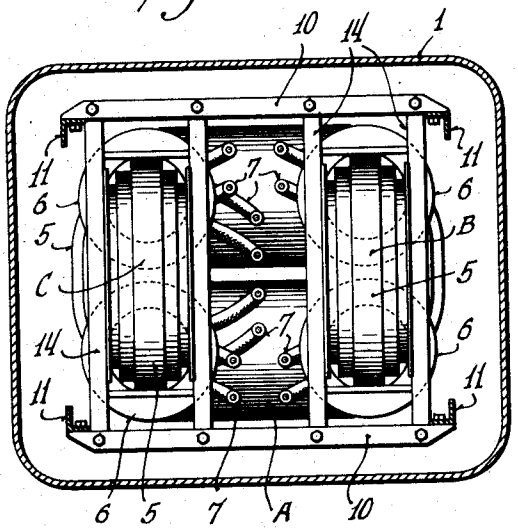


Fig. 4

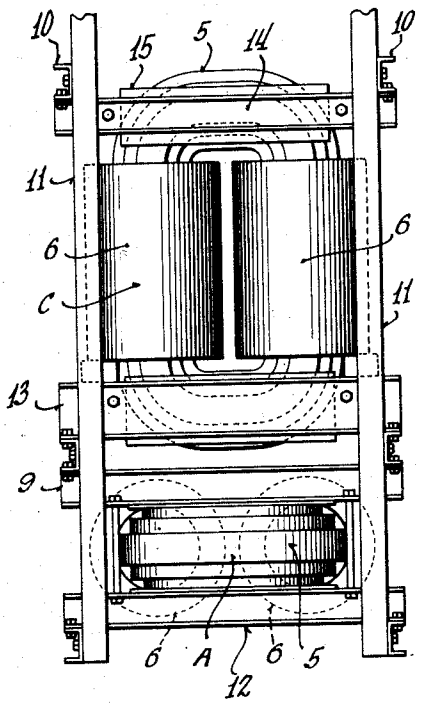
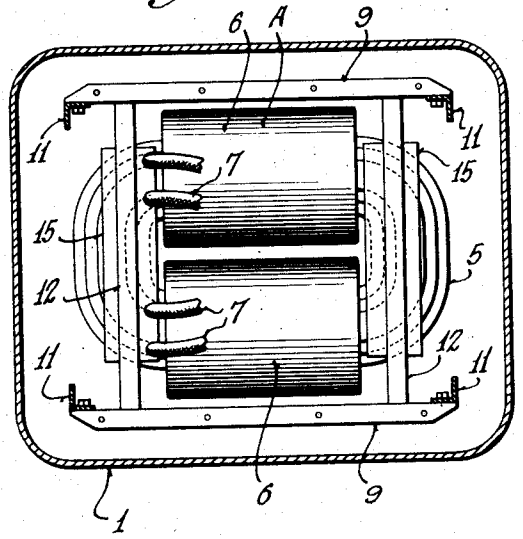


Fig. 3



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THREE-PHASE TRANSFORMER CONSTRUCTION

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Application September 16, 1943, Serial No. 502,562

8 Claims. (Cl. 175—361)

In three phase transformer constructions where the three transformer units are mounted in the same tank and are submerged in oil or other cooling fluid, difficulty has been encountered in obtaining proper cooling of the transformer units while still maintaining proper proportions of the tank and a suitably compact arrangement of the transformer units.

When three transformer units were mounted horizontally one above the other, it was found that the uppermost unit became too hot as it received heated oil from both of the other units and, in addition, the tank was necessarily quite tall to accommodate all of the units. When the three units were mounted vertically one above the other, the uppermost unit still received the heated oil from both of the other units, but in this case the tank was very tall.

This invention is designed to overcome the above noted difficulties and objects of this invention are to provide a three phase transformer construction which provides adequate cooling of all three of the transformer units while still securing an economical and practical proportion of the tank, and particularly to provide a construction which, though compact, is so constructed that a rapid circulation of oil is obtained and no transformer unit receives heated oil from both of the other two units.

In greater detail, further objects of this invention are to provide a three phase transformer construction in which one unit is mounted horizontally in the bottom portion of the tank thus fully utilizing the cooler oil at such point, and in which the other two units are mounted above the lower unit and are vertically mounted and are spaced upwardly from the lower unit and are spaced laterally from each other, the floor space required by the lower horizontal unit being approximately the same as the floor space or horizontal area required by the two upper vertically mounted units.

Further objects are to provide a transformer construction, as set forth above, in which the two upper vertically mounted spaced units provide a vertical passageway between them for the rising heated oil, such passageway allowing free and rapid rise of such heated oil which in turn entrains oil passing laterally of the upper units, and to provide return passageways for the cooler oil either between the transformer units and the vertical walls of the tank or by means of cooling tubes externally of the tank or by both such means.

Further objects are to provide a three phase transformer construction in which there are two vertically mounted spaced transformer units located above a horizontally mounted unit, as set forth above, and in which the conducting leads from the units extend upwardly in the space between the vertically mounted upper units thus protecting such leads from mechanical injury during insertion or removal of the transformer assembly from the tank and at the same time securing adequate spacing of the leads from the side walls of the tank, and in which an open framework supports the three transformer units and has vertically extending uprights which are positioned outside of the outline of the entire assembly and thus act as guards for the transformer assembly.

Further objects are to provide a construction which is practical and lends itself readily to ordinary manufacturing methods as it is easy to produce and assemble and as it is cheap to make although it provides at one and the same time a well cooled and compact three phase transformer construction.

Embodiments of the invention are shown in the accompanying drawings, in which:

Figure 1 is a side elevation, partly broken away and partly in section, showing the three phase transformer.

Figure 2 is a sectional view on the line 2—2 of Figure 1.

Figure 3 is a sectional view on the line 3—3 of Figure 1.

Figure 4 is a side elevation with the tank removed and with parts broken away, such view being taken at right angles to that shown in Figure 1.

Figure 5 is a side elevation of a further form that the invention may take.

Referring to the drawings, it will be seen that the transformer is mounted as a unitary structure and is positioned within the tank 1. The tank is provided with the usual terminal members and with a removable cover 2 secured in any suitable manner, not shown, and with a permanent bottom 3. The tank is filled with a suitable cooling liquid such, for instance, as oil, up to approximately the level indicated by the reference character 4.

The three phase transformer comprises three units indicated generally by the reference characters A, B and C. These transformer units are each formed of a closed wound magnetic core indicated generally by the reference character 5. This core is formed of magnetic ribbons of different widths which are wound to provide a core

having a cruciform cross-section. The conducting coil assemblies, including the primaries and secondaries, are preferably round wound and are wound on each of the two straight legs of the core as shown and as indicated by the reference character 6. A few of the leads of the transformer units have been indicated but all of the leads have not been shown. For instance, the connecting leads between the conducting coil assemblies have not been shown. The leads extending to the terminals of the transformer are indicated generally by the reference character 7. These leads are all located approximately in the central zone of the transformer assembly so that they will be protected from mechanical damage.

Referring particularly to Figures 1 and 4, it will be seen that the lowest unit A is mounted horizontally and that the upper units B and C are mounted vertically above and spaced from the lower unit A. This provides a very compact arrangement for the floor space required by the horizontal unit is approximately the same as the floor space required for the vertically mounted units B and C.

The units are carried by an open work frame structure which may comprise lower channel members 8, intermediate channel members 9, and upper channel members 10. These members are joined by uprights 11 which may be L-shaped in cross-section as indicated. The lower unit has its protruding portions of its core section clamped between channel irons 12 which in turn are attached to the channel members 8 and 9. The upper units have the protruding portions of their core sections clamped between channel irons 13 at their lower portions and 14 at their upper portions. The channel irons 13 are secured to the transverse channel members 9 and the channel irons 14 are secured to the transverse channel members 10. Suitable insulating sheets are positioned between the clamping channel irons and the end portions of the cores of the several transformer units so as not to short-circuit the laminations of the core sections. If desired certain of these insulating sheet members indicated by the reference character 15 may be extended and may be positioned between certain of the conducting leads 7 and the adjacent frame structure.

It is to be noted particularly that the upper transformer units B and C are spaced apart and provide a chimney like zone or passageway between them which is substantially unobstructed. The conducting leads 7 occupy only a very small portion of this space and do not offer any material obstruction to the rising heated liquid.

It is also to be noted that the transformer units are spaced from the vertical side walls of the transformer housing or tank 1 so as to provide downwardly extending, substantially unobstructed passageways for the free downward flow of the cooler liquid. If desired, these downward passageways may take the form of cooling tubes or hollow cooling fins indicated at 16 in Figure 5. These cooling tubes may either furnish the downwardly extending passageways for the descending cooled liquid or they may supplement the downwardly extending passageways shown in Figure 1 between the vertical side walls and the transformer assembly or the transformer may be built without any cooling tubes whatsoever, the downwardly extending passageways being solely provided by the structure shown in Figure 1. It is also to be noted that the various supporting and clamping channel members may be apertured to further increase the freedom of circulation of the oil, though this has not been found necessary in the actual device.

It will be seen that the rising heated liquid from the lowest unit A flows upwardly into the central channel or chimney like zone where its upward flow is substantially unobstructed. This upward flow of heated liquid will entrain liquid from adjacent the units B and C and the heated liquid from these units B and C will thus augment the upward flow through the central zone. The heated liquid in the upper portion of the tank 1 will divide and pass outwardly towards the side walls of the tank 1 and will be cooled by these side walls and will, therefore, descend in the downwardly extending, laterally located zones between the vertical walls of the tank and the transformer assembly. The descent of this cooler liquid is substantially unobstructed and therefore a very rapid flow of cooling liquid will take place. The descending cooled liquid divides, part of it passing above the unit A and below the units B and C and part of it passing downwardly to the lowest part of the tank and thereafter around the unit A. Some of the cooler liquid will also pass in between the conducting assemblies 6 of the units B and C and will be heated and will be entrained by the rapidly rising central heated stream of liquid.

By this arrangement no transformer unit is subjected to the heated liquid from two of the other units. The heated liquid from the transformer unit A does not substantially contact the units B and C at all as its heated liquid rises centrally between the units B and C and entrains liquid from around the units B and C. In actual tests with the three phase transformer constructed in accordance with the disclosure of this invention it has been found that a great improvement in cooling is obtained by this construction while still maintaining a compact arrangement of the transformer assembly. Also the height and size of the enclosing tanks do not become excessive but instead are well within the practical range or practical proportion.

In addition to this it is to be noted that the conducting leads 7 are very adequately protected from damage when the transformer is either placed in the tank or removed from the tank. Also it is to be noted, for instance from reference to Figures 2 and 3, that the corner angle irons 11 are at the corner edges of the frame like structure and are outside of the outline of the transformer assembly and consequently these uprights act as guards for the transformer units and protect them from mechanical damage when the transformer assembly is being placed within the tank or being removed from the tank.

As stated, all of the conducting leads have not been shown, and in Figure 4 all of the leads have been omitted for the sake of clearness.

It will be seen that a very simple and practical arrangement of three phase transformer units has been provided by this invention which greatly improves the cooling of the transformer units and prevents any unit from receiving heated liquid from the other two units.

Also it will be seen that this invention provides a cooling means having gravity flow which insures a very rapid circulation of the cooling liquid, it being noted that the horizontal unit is placed in the bottom of the tank in the coolest portion of the liquid and that the vertical units are so mounted that cool liquid is constantly

drawn across and upwardly of the units by the entraining action of the rapidly rising central stream of heated liquid.

It will be seen further that the arrangement provide a very compact and easily produced three phase transformer structure.

Although this invention has been described in considerable detail, it is to be understood that such description is intended as illustrative rather than limiting, as the invention may be variously embodied and is to be interpreted as claimed.

We claim:

1. A three phase transformer construction comprising a tank adapted to contain a cooling liquid, three transformer units mounted within said tank and submerged in the liquid, two of said units being mounted above the third unit and being spaced apart to provide a centrally located passageway to promote the upward rapid flow of heated liquid through said passageway, whereby no unit receives heated liquid from the other two units.

2. A three phase transformer construction comprising a tank adapted to contain a cooling liquid, three transformer units mounted within said tank and submerged in the liquid, two of said units being mounted above the third unit and being spaced apart to provide a centrally located passageway to promote the upward rapid flow of heated liquid through said passageway, whereby no unit receives heated liquid from the other two units, said construction being provided with passageways laterally of said units for downward flow of cooler liquid.

3. A three phase transformer construction comprising a tank adapted to contain a cooling liquid, three transformer units mounted within said tank and submerged in the liquid, two of said units being mounted above the third unit and being spaced apart to provide a centrally located passageway to promote the upward rapid flow of heated liquid through said passageway, whereby no unit receives heated liquid from the other two units, said units being spaced from the side walls of said tank to provide passageways laterally of said units for downward flow of cooler liquid.

4. A three phase transformer construction comprising a tank adapted to contain a cooling liquid, three transformer units mounted within said tank and submerged in the liquid, two of said units being mounted above the third unit and being spaced apart to provide a centrally located passageway to promote the upward rapid flow of heated liquid through said passageway, whereby no unit receives heated liquid from the other two units, and cooling tubes located externally of the tank and leading from the upper portion of said tank to the lower portion of said tank to provide passageways for downward flow of cooler liquid.

5. A three phase transformer construction comprising a tank adapted to contain a cooling liquid, three transformer units mounted within said tank and submerged in the liquid, said units having longitudinal core portions and conducting winding assemblies surrounding said longitudinal core portions, one of said units being a lower unit and being positioned in the lower part of said tank with the longitudinal core portion extending horizontally and the other two units being upper units and being positioned above said lower unit and having their longitudinal core portions extending vertically, said upper units being spaced apart to provide a centrally located passageway for upwardly flowing heated liquid, said construction having passageways located laterally of said units for downwardly flowing cooler liquid.

6. A three phase transformer construction comprising a tank adapted to contain a cooling liquid, three transformer units mounted as a unitary assembly and positioned within said tank and submerged in the liquid, one of said units being a lower unit and positioned in the lower portion of said tank and the other two units being upper units and being positioned above said lower unit and being laterally spaced apart to provide an upwardly extending passageway therebetween for upwardly flowing heated liquid, and conducting leads extending from said units and positioned within said upwardly extending passageway, said construction being provided with passageways positioned laterally of said units for downwardly flowing cooler liquid.

7. A three phase transformer construction comprising a tank adapted to contain a cooling liquid, a unitary construction mounted within said tank and consisting of an open framework and three transformer units supported from said open framework and submerged in the liquid, one of said transformer units being a lower unit and being located adjacent the lower portion of said tank and spaced from the bottom and side wall of said tank, the other of said units being upper units and being positioned above said lower unit, said lower unit being mounted horizontally and said upper units being mounted vertically, said upper units being spaced apart and spaced upwardly from said lower unit to provide a passageway for the upwardly flowing heated liquid, whereby no unit receives heated liquid from the other two units and whereby the free upward flow of heated liquid in a predetermined zone is enhanced, said upper units being spaced from the side walls of said tank, said construction providing downwardly extending passageways for downwardly flowing cooler liquid, said units having conducting leads extending upwardly therefrom and positioned between said upper units.

8. A three phase transformer construction comprising a tank adapted to contain a cooling liquid, a unitary construction mounted within said tank and consisting of an open framework and three transformer units supported from said open framework and submerged in the liquid, one of said transformer units being a lower unit and being positioned in the lower part of said tank, the other two units being upper units and being positioned above said lower unit, said upper units being spaced apart to provide a passageway for upwardly flowing heated liquid, said construction having passageways laterally of said units for downwardly flowing cooler liquid, said units having conducting leads extending upwardly in the space between said upper units, said framework including uprights positioned laterally of said units and acting as guards for said units.

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