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NOISE SUPPRESSION IN ELECTRIC POWER TRANSFORMERS

Filed June 13, 1960

2 Sheets-Sheet 1

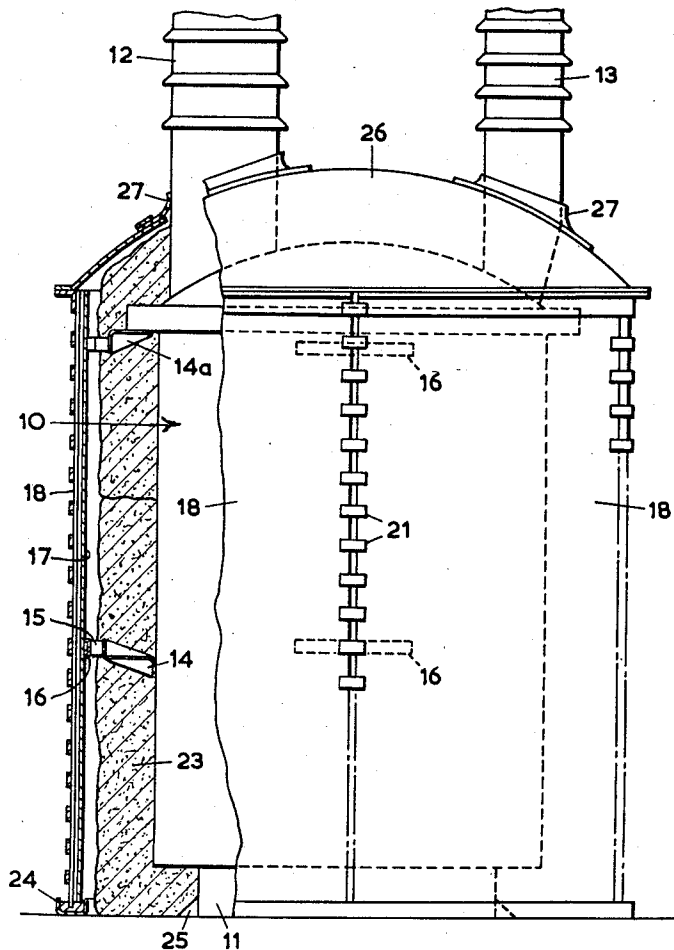


FIG.1

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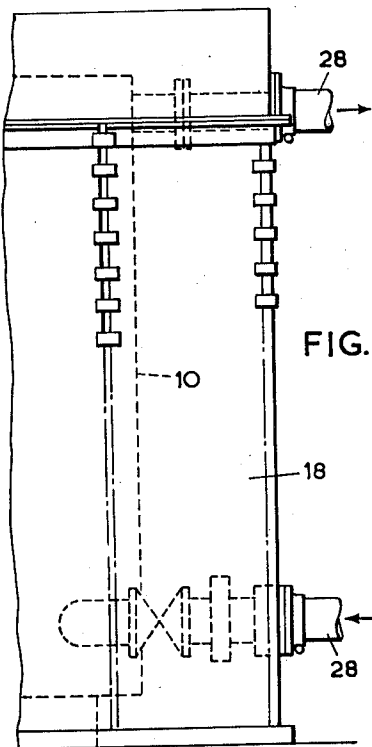


FIG. 2

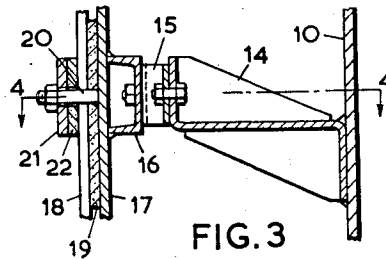


FIG. 3

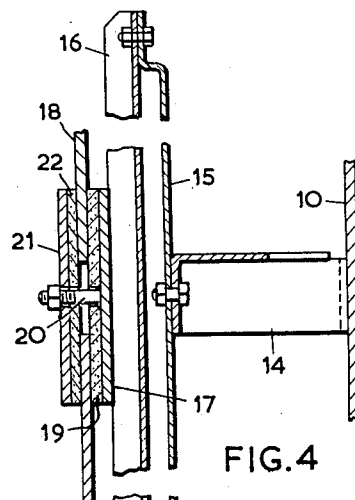


FIG. 4

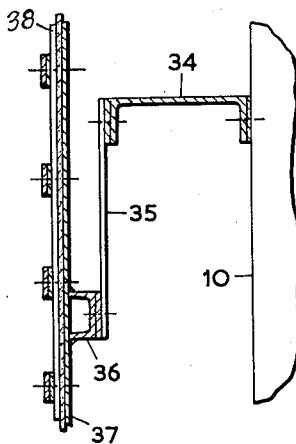


FIG. 6

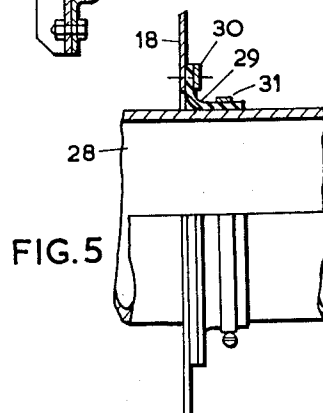


FIG. 5

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NOISE SUPPRESSION IN ELECTRIC POWER TRANSFORMERS

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8 Claims. (Cl. 181—33)

This invention relates to electric power transformers and the like, and is particularly concerned with means for reducing noise emitted by such transformers. These transformers, which are usually oil-filled, generate a certain amount of noise mainly, it is thought, as a result of magneto-strictive effects in the core, which are transmitted through the insulating and cooling medium and through the supports to the tank or container which can act as a sounding board.

According to this invention, an electric power transformer comprises a tank rigidly mounted on a base and containing a core, windings and an insulating and cooling medium, external cladding means comprising at least one plate acting as a sound-reflecting medium and spaced away from the tank, and flexible support means secured to said tank and to said external cladding means to support said cladding means from said tank, the mass of the cladding means and the resilience of the flexible support means being such that the flexibly-supported cladding has a natural resonant frequency substantially less than the operational frequency of the transformer.

According to a feature of the invention an energy-absorbing material is located in the space between the cladding means and the tank.

According to another feature of the invention, the external cladding means comprises a number of steel plates, the mass of the plates and the nature of the flexible supports being such that the natural resonant frequency of the cladding is substantially less than the operational frequency of the transformer.

According to another feature of the invention, the flexible supports are relatively stiff in the vertical plane and of relatively low stiffness in the transverse plane, so as to support the weight of the plates without substantial deflection and to allow deflection in the transverse plane.

According to yet another feature of the invention, the steel plates themselves are of low stiffness.

The invention will now be described with reference to the accompanying drawings of which,

FIG. 1 is an end elevation of a transformer to which the invention has been applied,

FIG. 2 is a side elevation of part of the transformer of FIG. 1,

FIG. 3 is a detail view of part of FIG. 1 partly in section,

FIG. 4 is a section on the line 4—4 of FIG. 3,

FIG. 5 is a detail view of part of FIG. 2 partly in section, and

FIG. 6 is a view corresponding to FIG. 3 of a modified arrangement.

Referring to FIGS. 1 and 2 the transformer tank 10, which contains the core and windings and oil as an insulating and cooling medium, is provided with high-tension and low-tension insulators 12 and 13 respectively. It is also equipped with cooling oil inlet and outlet pipes which will be described in greater detail hereafter.

A number of brackets 14, 14a is secured to the outside of the wall of the tank 10, for example by welding, and these brackets carry laterally-extending springs 15, the brackets and springs together forming flexible supports for the cladding. One of these supports is shown in

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greater detail in FIGS. 3 and 4. The springs 15 are secured at their centres to the brackets 14, 14a and have their extremities bolted to channel members 16. To these channel members are welded, adjacent the brackets 14, 14a, vertical support strips 17. The cladding, consisting of steel plate in a number of sections 18, is arranged around the tank 10 and is fastened to the support strips 17 by means of stubs 20 welded to the vertical strips 17 and fish plates 21. Felt strips 19 and 22 are interposed between the vertical strip 17 and the cladding plates 18 and between the latter and the fish plates 21 for damping purposes. The arrangement of the springs 15 gives a low stiffness in the horizontal direction and a high stiffness, suitable for supporting the weight of the steel plates, in the vertical direction. The steel plate sections 18 are so dimensioned and arranged as to be relatively flexible, thus ensuring that the sections are very poor radiators of noise at frequencies of, say, fifty cycles per second and upwards. The thickness of the steel plate sections in the case of a large power transformer measuring some twenty-four feet long and ten feet high may be of the order of a quarter of an inch and the plates are flat and do not incorporate stiffeners. The plates thus act as a reflecting surface for sound emitted from the tank at the operational frequency of the transformer, for example fifty cycles per second. The thickness of the steel plate sections, and consequently their effective mass, is also chosen in relation to the resilience of the springs so as to provide the system as a whole, including the plate section and spring, with a natural resonant frequency substantially less than the operational frequency of the transformer. For example, this natural resonant frequency may conveniently be arranged to be of the order of ten cycles per second, and may be as low as two cycles per second. These frequencies are below the normal audible range. The fundamental driving frequency is found to be twice the operational frequency of the transformer, since a pulse is transmitted both by the positive and by the negative wave of the operational-frequency vibration. Since the natural resonant frequency of the plate sections is below the fundamental driving frequency, it follows that higher-frequency harmonics will have still less exciting effect on the plate sections. Moreover, the attenuation will also be greater in the case of higher harmonics.

It will be understood that the plate sections will have a number of natural resonant frequencies, depending on the mode of vibration. The dimensions and arrangement of the plate sections is so chosen that the natural resonant frequency in the simple modes is substantially less than the driving frequency in the corresponding mode, and it is then found that there is little likelihood of the excitation of the more complex modes of vibration.

Additional masses may however be secured to the cladding at intervals, either to reduce the natural resonant frequency of the cladding as a whole or to modify local resonances.

In order to absorb the energy of the reflected sound, mats 23 of energy-absorbing material, such as glass wool, are inserted into the space between the cladding and the transformer tank.

The lower edges of the sections 18 are sealed by means of a channel 24 containing foam rubber or some other similar flexible material and secured to the base 11 of the tank 10 by means of brackets 25. The top of the cladding is provided with a domed cover 26 supported through intermediate flexible material on the top edges of the sections 18, so as to provide between it and the top of the transformer tank 10 a hollow space which is also filled with glass wool.

The cover 26 is provided with suitable apertures for the insulators 12 and 13 and a seal is made to each by

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means of rubber diaphragms 27 secured to the cover 26 by means of flanges. The oil cooling pipes 28 between the transformer tank 10 and the external oil cooler (not shown) are carried through holes in the cladding plates 18 in the following manner.

The holes are surrounded by rubber diaphragms 29 which are secured to the edges of the holes by flanges 30. The free edge of each of the rubber diaphragms 29 lies round the cooling pipe 28 and is secured to it by an annular clamp 31.

In the modified arrangement of supporting brackets and springs shown in FIG. 6 the tank 10 has welded to it channel-section members 34 to the free end of which are attached vertical springs 35 spaced at intervals along the length of the members 34. These springs 35 are welded at their free ends to channel-section members 36 which are welded in turn to vertical strips 37. Steel plate sections 38 are secured to the vertical strips 37 by means of studs and fish plates in the same manner as described with reference to FIGS. 3 and 4.

A high-power fifty cycle per second transformer constructed and insulated in this manner has been found to have a noise emission of the order of twenty decibels less than that of the same transformer not provided with noise-reducing means according to the invention.

What I claim as my invention and desire to secure by Letters Patent is:

1. An electric power transformer comprising a tank rigidly mounted on a base and containing a core, windings and an insulating and cooling medium, external cladding means comprising at least one plate constituting a sound-reflecting medium and spaced away from the tank, and flexible support means secured to said tank and to said external cladding means supporting said cladding means from said tank, the mass of the cladding means and the resilience of the flexible support means being such that the flexibly-supported cladding has a natural resonant frequency substantially less than the operational frequency of the transformer.

2. An electric power transformer as claimed in claim 1, comprising also an energy-absorbing material located in the space between the cladding means and the tank.

3. An electric power transformer as claimed in claim 2, wherein the external cladding means comprises a number of steel plates, the mass of the plates and the nature of the flexible support means being such that the natural resonant frequency of the cladding is substantially less than the operational frequency of the transformer.

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4. An electric power transformer comprising a tank containing a core, windings, and an insulating and cooling medium, external cladding means comprising a number of steel plates constituting a sound-reflecting medium and spaced away from the tank, flexible support means secured to said tank and to said external cladding means and supporting said cladding means from said tank, the flexible support means being relatively stiff in the vertical plane and of relatively low stiffness in the transverse plane so as to support the weight of the plates without substantial deflection and to allow deflection in the transverse plane, and an energy-absorbing material located in the space between the cladding means and the tank, the mass of the plates and the nature of the flexible support means being such that the natural resonant frequency of the cladding is substantially less than the operational frequency of the transformer.

5. An electric power transformer as claimed in claim 4, wherein the steel plates themselves are of low stiffness.

6. An electric power transformer comprising a tank containing a core, windings and an insulating and cooling medium, external cladding means comprising a number of steel plates acting as a sound-reflecting medium and spaced away from the tank, and flexible support means secured to said tank and to said external cladding means to support said cladding means from said tank, the mass of the plates and the nature of the flexible support means being such that the natural resonant frequency of the flexibly-supported cladding is substantially less than the operational frequency of the transformer.

7. An electric power transformer as claimed in claim 6, wherein the flexible support means are relatively stiff in the vertical plane and of relatively low stiffness in the transverse plane, so as to support the weight of the plates without substantial deflection and to allow deflection in the transverse plane.

8. An electric power transformer as claimed in claim 7, wherein the steel plates themselves are of low stiffness.

References Cited in the file of this patent

UNITED STATES PATENTS

2,734,096	Ennis	Feb. 7, 1956
2,776,020	Conover et al.	Jan. 1, 1957
2,830,780	Schloss	Apr. 15, 1958
2,870,858	Adams	Jan. 27, 1958
2,883,130	Rose	Apr. 21, 1959