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NOISE REDUCTION IN TRANSFORMERS

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Fig. 1.

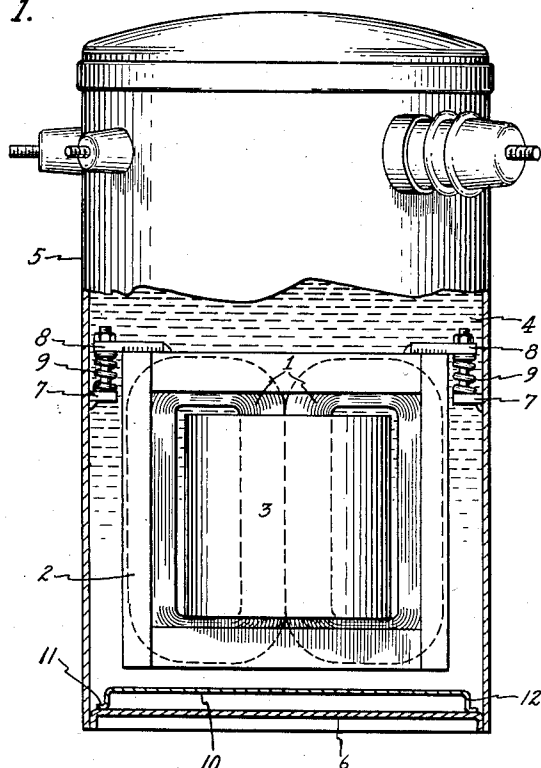
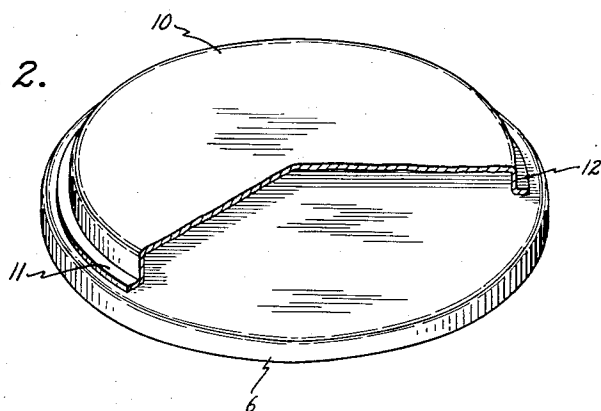


Fig. 2.



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NOISE REDUCTION IN TRANSFORMERS

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4 Claims. (Cl. 181—33)

This invention relates to reducing noise produced by transformers.

It is an object of this invention to provide an improved method and means for reducing noise produced by transformers.

A conventional form of transformer comprises a magnetic core structure linked with electrical windings immersed within an insulating liquid inside a tank. The core structure rests on the tank bottom and is laterally braced by struts or the like extending from the core structure to the side walls of the tank. Vibrations set up in the core structure are transmitted to the tank bottom inasmuch as they are in contact with each other, and vibrations are also transmitted to the tank side walls through the lateral braces or struts.

It has been suggested in the prior art that the noise transmitted to the ambient air could be reduced by surrounding the bottom and sides of the core structure with double walled gas filled isolators or by making the bottom and sides of the tank double walled. These prior art methods of reducing noise in transformers have been successful but are not entirely practicable since they are rather costly. It will be appreciated that inasmuch as the tank side walls as contrasted to the tank bottom constitute the major portion of available heat dissipating surface it may be necessary to provide special means for removing heat from the transformer in the event the isolators about the sides of the core structure impede the free dissipation of heat from the transformer to the tank side walls.

I have discovered that by the utilization of a properly designed bottom isolator the magnitude of noise reduction can be as great as in those cases where side isolators are used in combination with a bottom isolator. In my invention no side isolators are utilized, but only a bottom isolator. The bottom isolator may comprise a shallow and wide relatively resilient entirely hollow member. This member may be filled with a gas or vacuum, and the core structure may be suspended from the sides of the tank. The core structure suspension may be a resilient one, and pulsations set up in the insulating liquid by virtue of vibrations in the core structure are transmitted from the insulating liquid to the member. The member, since it is resilient, will vibrate in tune with these pulsations.

While the specification concludes with claims particularly pointing out and distinctly claiming the subject matter which I regard as my invention, it is believed the invention will be better understood from the following description taken in connection with the accompanying drawing in which:

Fig. 1 is a side elevation view of a transformer having one form of my invention incorporated therein; and

Fig. 2 is an enlarged perspective view of the bottom isolator of Fig. 1.

Referring now particularly to Fig. 1, shown therein

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is an electric transformer comprising a pair of magnetic core loops 1 which are held together by a core clamp assembly 2. An electrical winding cylinder 3 which has low and high voltage winding sections is linked with core loops 1. The core structure 1, 2 and linked windings 3 are immersed in an electrical insulating liquid 4 within a closed tank 5. A plurality of lugs or ledges 7 are welded or otherwise secured to the tank side walls. A plurality of other lugs or ledges 8 which may be secured to the core clamp assembly 2 such as by welding overlie the lugs 7 and have resilient mounting means 9 disposed therebetween. The resilient means 9 may comprise resilient members such as springs or blocks of rubber or other equivalent means. Only a minor portion of the total sound reduction obtained is by virtue of the resilient mounts 9, and therefore, it is not mandatory in the practice of my invention to utilize resilient mounts. However, inasmuch as the resilient mounts do contribute to the total amount of sound reduction obtained they are desirable. The core structure need not necessarily be suspended from the tank side walls. For instance, the core structure could be suspended from the tank cover as by resilient cables or the like.

An isolator 10 is positioned between the tank bottom 6 and the core structure, and by the statement that the core structure is isolated from the tank bottom 6 is meant that a resilient entirely hollow and gas or vacuum filled member such as isolator 10 or its equivalent is interposed between the bottom of the core structure and the tank bottom 6. Vibrations in the core structure will set up corresponding pulsations in the insulating liquid 4 which in turn will cause the top of member 10 to vibrate in tune with the core vibrations and insulating liquid pulsations. Preferably the core structure does not rest directly on the bottom 6 or on blocks placed on the bottom 6 so that there is no direct transmission path for the vibrations in the core structure to the bottom 6.

The member 10 is a shallow and wide relatively resilient entirely hollow member which is liquid tight sealed to the inside surface of bottom 6. The member 10 is shallow so that it will not occupy too much space, and is made sufficiently wide to cover all or a major portion of the bottom 6. The top of member 10 is made thin and flat so that it can vibrate freely in response to the pulsations of the insulating liquid 4. Also member 10 has no liquid therein but is gas filled with air or the like or may have a vacuum therein. The out-turned flange 11 on the skirt 12 of member 10 may be liquid tight sealed to the inner surface of bottom 6 by welding, brazing, or the like.

The top member 10 is relatively resilient, and by this is meant that the top of member 10 will resonate in tune with the pulsations of the insulating liquid 4 or roughly in tune therewith. Such a resilient member may be provided by a relatively thin cup-shaped inverted member whose bottom is specifically designed to vibrate at two times the frequency of the voltage applied to the transformer. For instance, assuming that the transformer is operated at 60 cycles power frequencies, then the member 10 should be designed to resonate at 120 vibrations per second. However, the member 10 need not necessarily be specifically designed to resonate exactly in tune with the transformer. For instance, the member 10 may be made from relatively thin copper and possibly non-metallic materials such as plastics which will inherently vibrate roughly in tune with an apparatus which has a wide range of frequencies. Since the top of member 10 vibrates and is not liquid filled corresponding vibrations will not be induced in the tank bottom 6.

The core structure is spaced from the member 10

but this is not absolutely necessary. That is, I have achieved good results even when the core structure rested directly on member 10. However, if the core structure makes direct contact with the member 10 in some cases there may be a tendency for vibrations in the core structure to be directly transmitted through the skirt portion 12 of member 10 to the tank bottom 6. The connection between the member 10 and bottom 6 is purposely made liquid tight so that no insulating liquid 4 will enter member 10. If member 10 should become filled with liquid then vibrations in the top of member 10 will be substantially transmitted to the tank bottom 6. The member 10 need not necessarily be directly connected to the bottom 6. For example, a member such as 10 could first be connected to a plate which in turn would be positioned over the tank bottom 6 and bolted thereto or even spaced therefrom due to its buoyancy.

I have discovered that when structure such as member 10 is utilized in the bottom of a transformer tank the overall magnitude of sound reduction obtained is, as a practical matter, as great as the overall magnitude of sound reduction obtained when lateral isolators are used in conjunction with a bottom isolator. That is, in view of the additional cost of providing side isolators and the problem of insuring adequate transfer of heat to the tank side walls as well as other considerations, side isolators are not justifiable in light of the small margin of additional improvement, if any, which would be obtained thereby.

For example, the following decibels of bottom and lateral sound reduction were obtained in tests conducted on three modified 10 kva. pole type transformers (designated A, B, and C) over a standard 10 kva. pole type transformer. Bottom figures indicate the decibels sound reduction when measured adjacent the bottom of the transformer tank, and lateral figures were obtained by taking readings about the sides of the tank. The standard transformer was conventional in that the core structure rested directly on the tank bottom. In transformer A the core structure was suspended and my bottom isolator was used but not side isolators. In transformer B the core structure was not suspended and side isolators were used but not a bottom isolator, and in transformer C the core structure was suspended and both side and bottom isolators were used.

Transformer	Decibels Sound Reduction Over Standard Transformer	
	Bottom	Lateral
A.....	10.5	6.4
B.....	0-2.2	1.6-4.2
C.....	11.0-13.0	2.7-6.5

It will be noted that transformer A had better sound reductions than transformer B in all respects. Transformer A had better or as good lateral sound reductions as transformer C and the bottom sound reductions of transformer A were only slightly less than for transformer C. However, this does not mean that transformer C with its side and bottom isolators is better than transformer A with a bottom isolator but no side isolators. In the art lateral sound readings are generally accepted as being the standard method of comparison. A three decibel sound reduction is a sound energy reduction of about 50% and 8 to 9 decibels reduction represents a sound energy reduction of almost 90%. Also, side isolators are costly and tend to interfere with the free dissipation of heat to and from the tank side walls unless special precautions are taken. In view of these various considerations, as a practical matter, a transformer which has only a bottom isolator is better designed than one which uses both side and bottom iso-

lators, and is substantially as good in sound reduction as one which has both side and bottom isolators.

I have a theoretical explanation for why my bottom isolator alone is substantially as good as bottom and side isolators together. When no bottom sound isolator is used the pulsations set up in the liquid may cause the bottom of the tank to vibrate in an up and down direction. These vibrations cause noise in the tank bottom and may also cause the tank side walls to vibrate towards and away from each other since the tank side walls and tank bottom are rigidly connected together. However, if the top of member 10 is free to vibrate then only it and not the tank bottom will vibrate. Another consideration is that even though the tank bottom may be made rigid enough in a conventional transformer so as to not vibrate, the pulsations in the liquid act equally in all directions so it may be the tank side walls which are directly vibrated by these pulsations. In this situation since the top of the member 10 is resilient, the pulsations will be relieved at member 10 instead of at the tank side walls.

While there has been shown and described a particular embodiment of the invention, it will be obvious to those skilled in the art that changes and modifications may be made without departing from the invention, and therefore, it is intended by the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. In the combination of a tank, a liquid in said tank, a vibrating structure which is immersed in said liquid, means for reducing noise generated by said structure comprising a shallow and wide relatively resilient entirely hollow liquid-empty member disposed between the bottom of said structure and the bottom of said tank and spaced from said structure, and there being only one such hollow liquid-empty member in said tank whereby the sides of said structure and tank have primarily only said liquid therebetween.

2. In the combination of a tank, a liquid in said tank, and a vibrating structure which is immersed in said liquid, means for reducing audible noise generated by said structure comprising means for spacing said structure from the bottom of said tank, and a shallow and wide relatively resilient entirely hollow liquid-empty member disposed between the bottom of said structure and said tank bottom and spaced from said structure, and there being only one such hollow liquid-empty member in said tank whereby the sides of said structure and tank have primarily only said liquid therebetween.

3. In the combination of a tank, a liquid in said tank, and a vibrating structure which is immersed in said liquid, means for reducing audible noise generated by said structure comprising means for resiliently suspending said structure from the side walls of said tank whereby said structure is spaced from the bottom of said tank, and a shallow and wide relatively resilient entirely hollow liquid-empty member disposed between the bottom of said structure and said tank bottom and spaced from said structure, and there being only one such hollow liquid-empty member in said tank whereby the sides of said structure and tank have primarily only said liquid therebetween.

4. In the combination of a tank, a liquid in said tank, and a vibrating structure which is immersed in said liquid, means for reducing audible noise generated by said structure comprising means for resiliently suspending said structure from the side walls of said tank whereby said structure is spaced from the bottom of said tank, and an isolator which is adapted to vibrate generally in tune with vibrations in said structure and corresponding pulsations in said liquid, said isolator comprising a shallow and wide relatively resilient entirely hollow liquid-empty member which is disposed between

the bottom of said structure and said tank bottom, said structure bottom being spaced from said isolator, and there being only one such hollow liquid-empty member in said tank whereby the sides of said structure and tank have primarily only said liquid therebetween.

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