(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 331 008 B1**

(12) # EUROPEAN PATENT SPECIFICATION

(45) Date of publication of patent specification: **21.10.92** (51) Int. Cl.5: **H01F 27/33**

(21) Application number: **89103172.6**

(22) Date of filing: **23.02.89**

(54) **Electromagnetic induction apparatus with a sound suppressing arrangement.**

(30) Priority: **29.02.88 JP 48231/88**

(43) Date of publication of application:
06.09.89 Bulletin 89/36

(45) Publication of the grant of the patent:
21.10.92 Bulletin 92/43

(84) Designated Contracting States:
CH DE FR LI SE

(56) References cited:
EP-A- 0 087 121

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Description

BACKGROUND OF THE INVENTION

This invention relates to an electromagnetic induction apparatus with a sound suppressing arrangement and, more particularly, to a sound suppressing arrangement for reducing the noise generated by an electromagnetic induction apparatus such as an electrical transformer as known from EP-A-87 121.

Fig. 1 is a sectional view showing the conventional electromagnetic induction apparatus of this kind, in which reference numeral 1 designates an electrical coil assembly of an electromagnetic induction apparatus; 2 is an electrically insulating oil; 3 is a tank main body in which the coil assembly 1 is housed together with the insulating oil 2; 31 is a tank side plate constituting one portion of the tank main body 3; 32 is a tank bottom plate constituting one portion of the tank main body 3; 4 are reinforcing members for the tank side plate 31; 5 are sound shield members mounted to the reinforcing members 4; 6 are heavy objects attached to the sound shield members 5; 7 are reinforcing members for the tank bottom plate 32; 8 are electrical bushings connected to the coil assembly 1 mounted on a tank top plate 33; 9 is a floor surface on which the electromagnetic induction apparatus is installed, and 10 are spaces defined between the reinforcing members 7, the tank bottom plate 32 and the floor surface 9.

In this conventional design, the coil assembly 1 of the electromagnetic induction apparatus vibrates in all vertical and horizontal directions due to electromagnetic forces during normal operational conditions of the induction apparatus. Such vibrations are transmitted through the electrical insulating oil 2 to vibrate the tank main body 3, causing noises.

Therefore, in order to reduce noises generated by the vibration of the tank side plates 31, the sound absorbing members 5 are mounted to the reinforcing member 4 attached to the side plates 31 of the tank main body 3, and heavy objects 6 are additionally attached to the sound absorbing members 5 to improve the sound absorbing function of the sound absorbing members 5.

If a conventional electromagnetic induction apparatus with a sound suppressing arrangement is designed as described above, noises generated due to the vibration of the tank side plate 3 can be effectively reduced by the sound absorbing members 5 attached to the tank side plates 3, but noises generated by the tank bottom plate 32 and radiated from the space 10 defined between the reinforcing members 7, the bottom plate 32 and the floor surface 9 cannot be effectively reduced. Therefore, it has been necessary to provide a large scale sound insulating arrangement such as a sound shield wall or the like around the induction apparatus in order to effectively reduce the noise of the conventional electromagnetic induction apparatus.

SUMMARY OF THE INVENTION

This invention has been made in order to solve the above-mentioned problems of the conventional electromagnetic induction apparatus, and accordingly one object of the present invention is to provide an electromagnetic induction apparatus in which any noise generated by the vibrating induction device is effectively suppressed.

Another object of the present invention is to provide an electromagnetic induction apparatus with a sound suppressing arrangement in which any noise generated by the vibration of the tank bottom plate and radiated from the spaces formed between the reinforcing members, the bottom plate and the floor surface is significantly suppressed, too.

Still another object of the present invention is to provide an electromagnetic induction apparatus with a sound suppressing arrangement in which any noise generated by the vibration of the tank bottom plate is insulated.

A further object of the present invention is to provide an electromagnetic induction apparatus with a sound suppressing arrangement in which any noise generated by the vibration of the tank bottom plate is absorbed.

With the above objects in view, the electromagnetic induction apparatus with a sound suppressing arrangement of the present invention comprises a tank main body having a bottom plate and capable of being placed on a floor surface and containing therein an electrical device which vibrates during operation. The tank main body is supported by supporting members inserted between the tank bottom plate and the floor surface to define spaces therebetween, and a sound suppressing member is disposed in association with the spaces defined between the support members and between the tank bottom plate and the floor surface. The sound suppressing member may be a sound barrier member closing the space defined between the tank bottom plate and the floor surface or a sound absorbing or suppressing element disposed within the spaces.

By the sound shielding member or the sound suppressing element of the present invention, any noise generated in the spaces defined between the reinforcing members and the floor surface is directly insulated or suppressed.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will become more readily apparent from the following detailed description of the preferred embodiments of the present invention taken in conjunction with the accompanying drawings, in which:

Fig. 1 is a sectional view showing the conventional electromagnetic induction apparatus to which the present invention can be applied;

Fig. 2 is an exploded fragmental perspective view of the electromagnetic induction apparatus with the sound shield of one embodiment of the present invention;

Fig. 3 is a fragmental perspective view of the sound shield shown in Fig. 2 attached to the electromagnetic induction apparatus;

Fig. 4 is a schematic sectional view taken along line IV-IV of Fig. 3 useful for explaining the operation of this invention;

Fig. 5 is an exploded fragmental perspective view showing the electromagnetic induction apparatus with the sound shield of another embodiment of the present invention;

Fig. 6 is a fragmental perspective view of the sound shield shown in Fig. 5 attached to the electromagnetic induction apparatus;

Fig. 7 is a schematic sectional view taken along line VII-VII of Fig. 6 useful for explaining the operation of this invention;

Fig. 8 is an acoustic circuit diagram useful for explaining the operation of this invention;

Fig. 9 is an exploded fragmental perspective view showing the electromagnetic induction apparatus with the sound absorbing elements of an embodiment of the present invention;

Fig. 10 is a fragmental perspective view of the sound absorbing elements shown in Fig. 9 assembled into the electromagnetic induction apparatus;

Fig. 11 is an exploded fragmental perspective view showing the electromagnetic induction apparatus with the sound absorbing elements of another embodiment of the present invention; and

Fig. 12 is a fragmental perspective view of the electromagnetic induction apparatus with sound absorbing elements shown in Fig. 11 assembled into the electromagnetic induction apparatus.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Figs. 2 to 4 illustrate an electromagnetic induction apparatus with a sound suppressing arrangement according to the present invention. It is seen that only a lower portion of the electromagnetic induction apparatus is illustrated for the simplisity of explanation. The other portion of the electromagnetic induction apparatus not illustrated in Figs. 2 to 4 is the same as that shown in Fig. 1 and accordingly, the illustrated electrical induction apparatus is an electrical transformer having an electrical coil assembly similar to the coil assembly 1 shown in Fig. 1.

The electromagnetic induction apparatus comprises a tank main body 3 having side walls 31, a bottom wall 32 and a top wall 33 (Fig. 1). The tank main body 3 contains therein an electrically insulating oil 2 and an electrical device such as an electrical coil assembly 1 immersed in the insulating oil 2 and vibrating during operation.

In order to support the tank main body 3 from the floor surface 9, three supporting members 7 are inserted between the tank bottom wall 32 and the floor surface 9 to provide spaces 10 defined between the support members 7 and between the tank bottom wall 32 and the floor surface 9. In a preferred embodiment, the support members 7 are box-like or block-like members attached to the outer (lower) surface of the tank bottom wall 32.

According to the present invention, the electromagnetic induction apparatus comprises a sound barrier member 11 disposed in association with the spaces 10 defined between the support members 7 and between the tank bottom wall 32 and the floor surface 9. In the illustrated embodiemnt, the sound barrier member 11 is an elongated plate which is secured by welding for example at its upper side edge to the tank side wall 31 to close the spaces 10 against the exterior as best shown in Figs. 3 and 4.

With the sound suppressing arrangement as above described, any noise generated by the vibration of the tank bottom plate 32 due to the vibration of the coil assembly 1 within the tank propagates in the space 10 as shown by arrows and is shielded and confined by the sound barrier member 11 within the spaces 10, so that the leakage of the noise to the exterior from the spaces 10 formed between the tank bottom plate 32 and the floor surface 9 is significantly reduced.

While this embodiment shown in Figs. 2 to 4 employs the sound barrier members 11 by which the noise generated by the tank bottom wall 32 is shielded and confined by the sound shielding members 11 mounted to the tank bottom plate 32 or the tank side plate 31 in the vicinity of the tank bottom plate 32 to close the spaces 10 below the tank bottom wall 32, a similar sound suppressing effect can also be obtained by inserting a sound absorbing element into the spaces 10 defined between the support members 7 and between the tank bottom wall 32 and the floor surface 9.

Figs. 5 to 8 illustrate one of such embodiments in which a sound absorbing material 12 in the form of a block of asbestos is inserted into each space 10 defined between the tank bottom wall 32 and

the floor surface 9.

Referring to Figs. 7 and 8, it is now assumed that the cross-sectional area of the outlet of the space 10 to the outside of the electromagnetic induction apparatus is S_1 and that the area of the surface of the tank bottom wall 32 exposed to the space 10 is S_2 as shown in Fig. 7. If an acoustic circuit is considered, then a constant flow sound source circuit as shown in Fig. 8 is obtained since the tank bottom wall has a very large impedance. More particularly, in an equivalent circuit as shown in Fig. 8, a radiation impedance r_1 of the outlet cross-sectional area S_1 of the space 10 and a radiation impedance r_2 of surface area S_2 of the tank bottom wall 32 are connected in series with an acoustic source U, and an acoustic capacitance C of the space 10 and a resistance r_3 of the sound absorbing material 12 are connected in parallel to the impedance r_1.

With the structure of the above arrangement, since the resistance r_3 is connected in parallel with the radiation impedance r_1, the resultant impedance of r_1 and r_2 and the acoustic capacitance C is smaller than that when there is no resistance r_3, whereby the sound level at the point X or the noise radiated from the space outlet of the area S_1 is decreased.

Also, depending upon the frequency of the sound generated by the vibrating bottom wall 32, when the distance between the bottom surface of the tank bottom wall 32 and the floor surface 9 exceeds a certain value, the space 10 can resonate with the vibration of the tank bottom plate 32, causing the generated noise to become much larger than that when no resonance occurs. Under such circumstances, the noise can be reduced by inserting a structural member 13 such as shown in Figs. 9 and 10 into each of the spaces 10 formed between the support members 7 and under the tank bottom wall 32. The structural element 13 has three vertical rectangular plates 13a and one horizontal rectangular plate 13b supported at the center of the vertical plates 13a to provide a cross-sectional shape of a monogram composed of an "H" and an "I" crossing the horizontal leg of "H". The distance of the horizontal plate 13b relative to the tank bottom wall 32 is selected so that no resonace occurs when it is inserted into the space 10. The structural element 13 may preferably be attached to the tank bottom wall 32.

The configuration of the structural member 13 is not limited to the illustrated configuration and many modifications can be resorted to as long as the space 10 can be changed to have dimensions and configuration with which no resonance phenomenon occurs. Figs. 11 and 12 illustrate one of such modifications in which a structural member 14 comprises a plurality of rectangular plates 14a arranged in a plane perpendicular to the longitudinal direction of the structural member 14 and a horizontal plate 14b supported by the plates 14a. The horizontal plate 14b is positioned to prevent any resonance within the space 10. It is seen that the vertical plates 14a close the space 10.

As has been described, the sound absorbing arrangement for an electromagnetic induction apparatus according to the present invention can suppress any noise generated in the space formed between the tank bottom plate reinforcing members and the floor surface with a simple structure without employing a large scale sound insulating facility such as a sound insulating wall by shielding the above space with a sound shielding member or by disposing a sound supressing element into the space.

Claims

1. An electromagnetic induction apparatus with a sound suppressing arrangement comprising:
a tank main body (3) having a tank bottom plate (32) and capable of being placed on a floor surface (9) and containing an electrical device (1) which vibrates during operation;
supporting members (7) attached to the outer surface of the tank bottom plate (32) with spaces (10) defined between the support members (7) and between the tank bottom plate (32) and the floor surface (9); characterised by
sound suppressing means (11, 12, 13, 14) disposed in association with the spaces (10) defined between the support members (7) and between the tank bottom plate (32) and the floor surface (9).

2. The electromagnetic induction apparatus as claimed in claim 1, wherein the sound suppressing means (11, 12, 13, 14) comprises a sound barrier member (11) closing the spaces (10) defined between the tank bottom plate (32) and the floor surface (9).

3. The electromagnetic induction apparatus as claimed in claim 2, wherein the sound barrier member (11) comprises a shield plate attached to the tank main body (3).

4. The electromagnetic induction apparatus as claimed in any of claims 1 to 3, wherein the sound suppressing means (11, 12, 13, 14) comprises a sound absorbing element (12, 13, 14) disposed within each of the spaces (10).

5. The electromagnetic induction apparatus as claimed in any of claims 1 to 4, wherein the

sound suppressing means (11, 12, 13, 14) comprises sound suppressing means (12, 13, 14) for changing the dimension of the spaces so that no resonance occurs within the spaces (10).

6. The electromagnetic induction apparatus as claimed in any of claims 1 to 5, wherein the dimension changing means (12, 13, 14) comprise a horizontal plate (12, 13b, 14b) positioned in each of the spaces (10) to prevent any resonance of sound within the spaces (10).

7. The electromagnetic induction apparatus according to any of claims 1 to 6, wherein the sound suppressing means (11, 12, 13, 14) comprise grid-like or ladder-shaped elements (13, 14) having a horizontal plate (13b, 14b) essentially parallel to the floor surface (9) and a plurality of vertical plates (13a, 14a) attached to the horizontal plate (13b, 14b), wherein the grid-like or ladder-shaped elements (13, 14) are inserted into the respective spaces (10).

Patentansprüche

1. Elektromagnetische Induktionsvorrichtung mit einer Schalldämpfungsanordnung, die folgendes aufweist:
einen Behälterhauptkörper (3), der eine Behälterbodenplatte (32) hat und auf einer Bodenfläche (9) plazierbar ist und eine elektrische Einrichtung (1) enthält, die im Betrieb schwingt;
Stützelemente (7), die an der Außenfläche der Behälterbodenplatte (32) befestigt sind, wobei Zwischenräume (10) zwischen den Stützelementen (7) und zwischen der Behälterbodenplatte (32) und der Bodenfläche (9) definiert sind, gekennzeichnet durch
Schalldämpfungseinrichtungen (11, 12, 13, 14), die in Zuordnung zu den Zwischenräumen (10), die zwischen den Stützelementen (7) und zwischen der Behälterbodenplatte (32) und der Bodenfläche (9) definiert sind, angeordnet sind.

2. Elektromagnetische Induktionsvorrichtung nach Anspruch 1, wobei die Schalldämpfungseinrichtungen (11, 12, 13, 14) eine Schallbarriere (11) aufweisen, die die Zwischenräume (10), die zwischen der Behälterbodenplatte (32) und der Bodenfläche (9) definiert sind, schließt.

3. Elektromagnetische Induktionsvorrichtung nach Anspruch 2, wobei die Schallbarriere (11) eine Abschirmplatte aufweist, die an dem Behälterhauptkörper (3) befestigt ist.

4. Elektromagnetische Induktionsvorrichtung nach einem der Ansprüche 1 bis 3, wobei die Schalldämpfungseinrichtungen (11, 12, 13, 14) ein Schallabsorptionselement (12, 13, 14) aufweisen, das in jedem der Zwischenräume (10) angeordnet ist.

5. Elektromagnetische Induktionsvorrichtung nach einem der Ansprüche 1 bis 4, wobei die Schalldämpfungseinrichtungen (11, 12, 13, 14) eine Schalldämpfungseinrichtung (12, 13, 14) aufweisen, um die Dimensionen der Zwischenräumen zu verändern, so daß keine Resonanz in den Zwischenräumen (10) auftritt.

6. Elektromagnetische Induktionsvorrichtung nach einem der Ansprüche 1 bis 5, wobei die Dimensionsänderungseinrichtungen (12, 13, 14) eine horizontale Platte (12, 13b, 14b) aufweisen, die in jedem der Zwischenräume (10) positioniert ist, um jede Resonanz von Schall in den Zwischenräumen (10) zu verhindern.

7. Elektromagnetische Induktionsvorrichtung nach einem der Ansprüche 1 bis 6, wobei die Schalldämpfungseinrichtungen (11, 12, 13, 14) gitterartige oder leiterförmige Elemente (13, 14) aufweisen, die eine horizontale Platte (13b, 14b), die im wesentlichen parallel zu der Bodenfläche (9) verläuft, und eine Vielzahl von vertikalen Platten (13a, 14a) haben, die an der horizontalen Platte (13b, 14b) befestigt sind, wobei die gitterartigen oder leiterförmigen Elemente (13, 14) in die jeweiligen Zwischenräume (10) eingesetzt sind.

Revendications

1. Appareil d'induction électromagnétique avec un dispositif supprimant le son, comprenant :
un corps principal (3) de réservoir ayant une plaque (32) de fond de réservoir et pouvant être placé sur une surface de plancher (9) et contenant un dispositif électrique (1) qui vibre pendant son fonctionnement ;
des organes de support (7) attachés à la surface externe de la plaque (32) de fond du réservoir avec des espaces (10) définis entre les organes de support (7) et entre la plaque (32) de fond du réservoir et la surface (9) du plancher ; caractérisé par des moyens de suppression du son (11, 12, 13, 14) disposés en association avec les espaces (10) définis entre les organes de support (7) et entre la plaque (32) de fond du réservoir et la surface (9) du plancher.

2. Appareil d'induction électromagnétique selon

la revendication 1, où le moyen de suppression du son (11, 12, 13, 14) comprend un organe formant barrière contre le son (11) qui ferme les espaces (10) définis entre la plaque (32) du fond du réservoir et la surface (9) du plancher.

3. Appareil d' induction électromagnétique selon la revendication 2, où l'organe formant barrière du son (11) comprend une plaque de blindage attachée au corps principal (3) du réservoir.

4. Appareil d'induction électromagnétique selon l'une quelconque des revendications 1 à 3, où le moyen de suppression du son (11, 12, 13, 14) comprend un élément absorbant le son (12, 13, 14) disposé dans chacun des espaces (10).

5. Appareil d'induction électromagnétique selon l'une quelconque des revendications 1 à 4, où le moyen de suppression du son (11, 12, 13, 14) comprend un moyen de suppression du son (12, 13, 14) pour changer la dimension des espaces de manière qu'aucune résonance ne se produise dans les espaces (10).

6. Appareil d'induction électromagnétique selon l'une quelconque des revendications 1 à 5, où les moyens de changement de dimension (12, 13, 14) comprennent une plaque horizontale (12, 13b, 14b) qui est placée dans chacun des espaces (10) pour empêcher une résonance du son dans les espaces (10).

7. Appareil d'induction électromagnétique selon l'une quelconque des revendications 1 à 6, où les moyens de suppression du son (11, 12, 13, 14) comprennent des éléments en forme de grille ou en forme d'échelle (13, 14) ayant une plaque horizontale (13b, 14b) essentiellement parallèle à la surface (9) du plancher et un certain nombre de plaques verticales (13a, 14a) attachées à la plaque horizontale (13b, 14b) où les éléments en forme de grille ou en forme d'échelle (13, 14) sont insérés dans les espaces respectifs (10).

FIG. 1
PRIOR ART

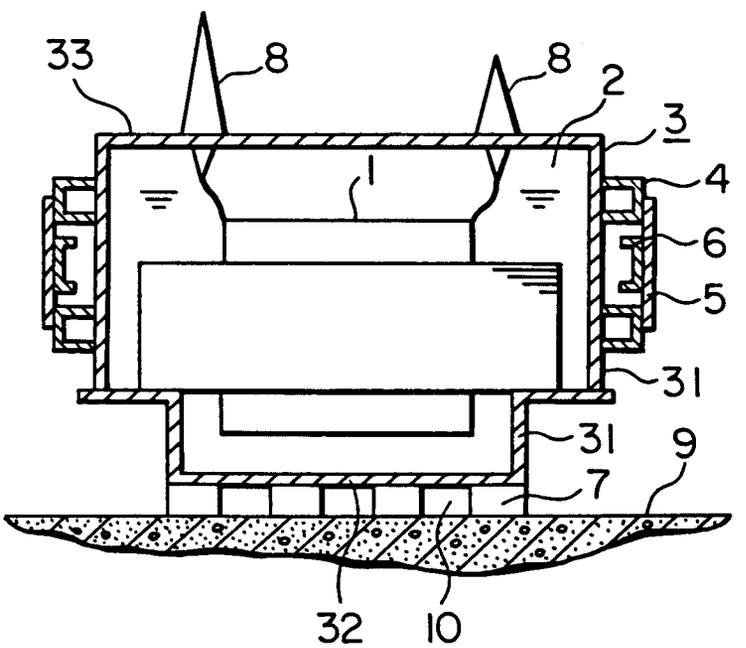

FIG. 2

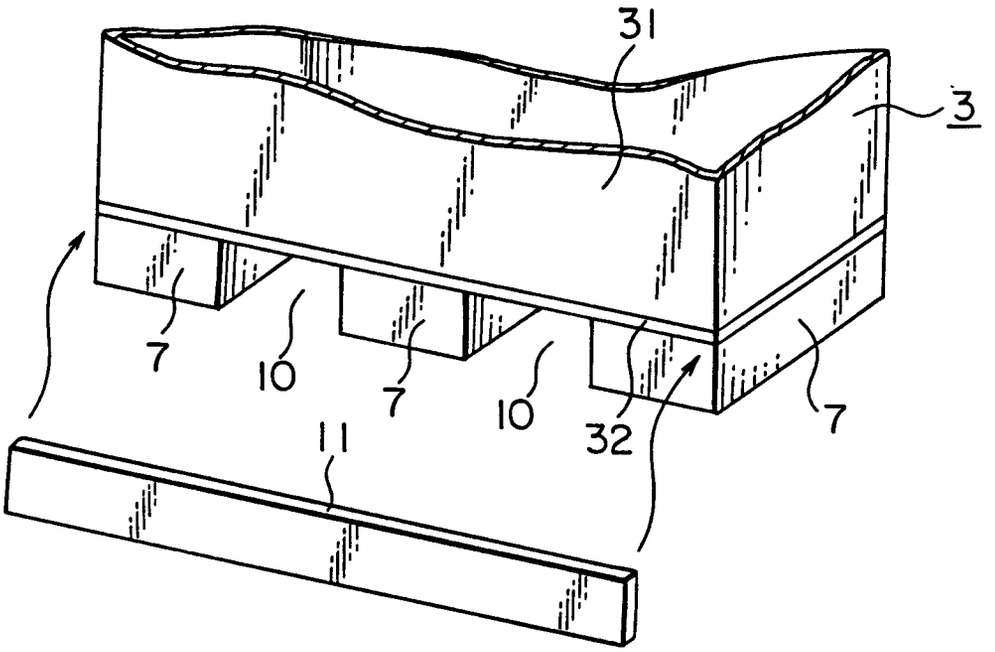

FIG. 3

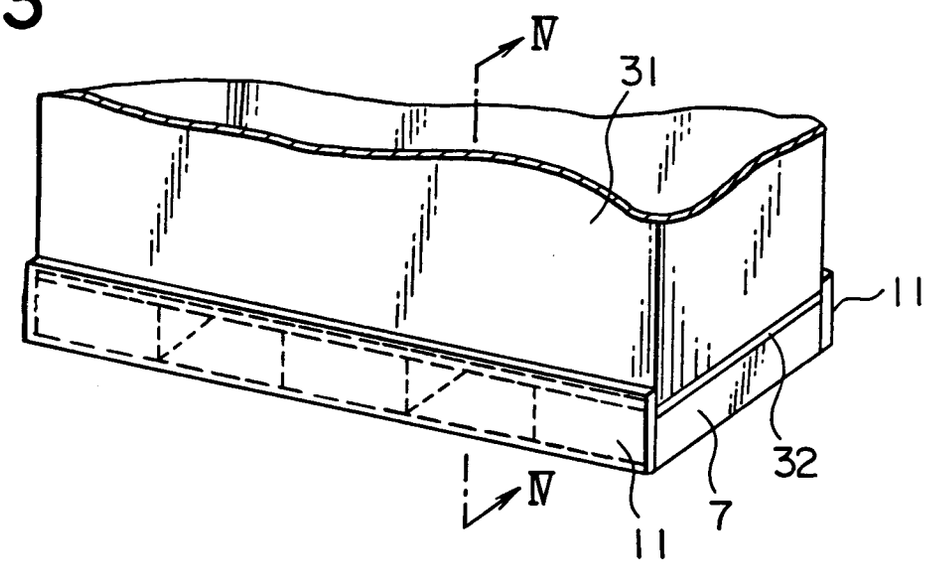

FIG. 4

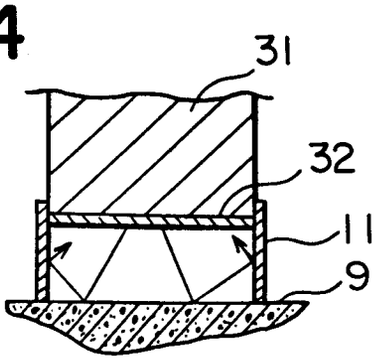

FIG. 5

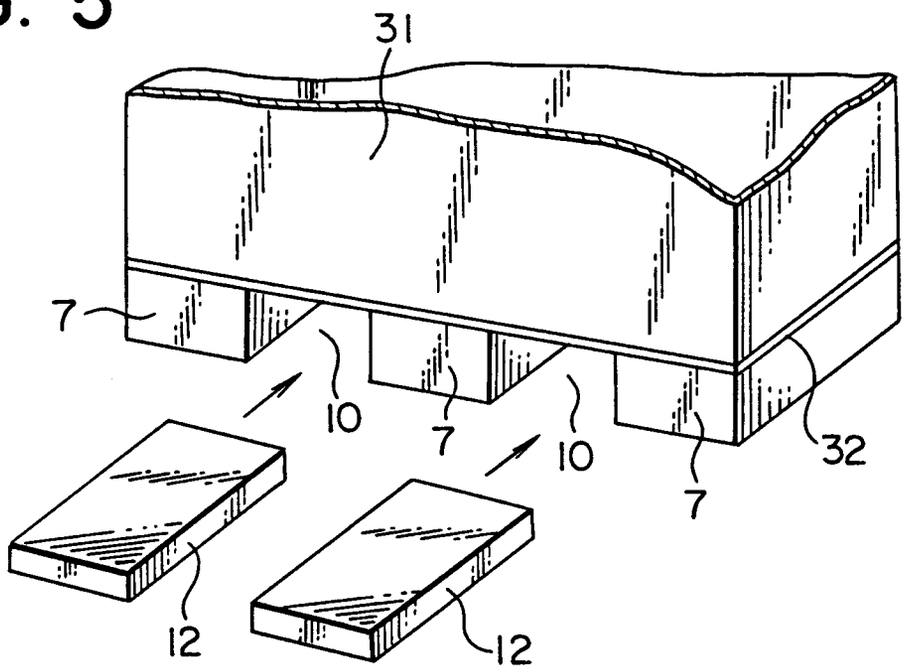

FIG. 6

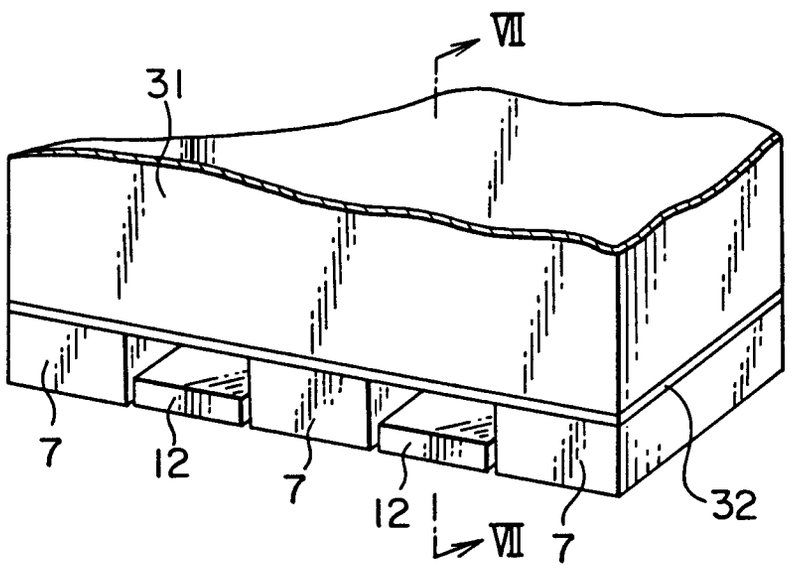

FIG. 7

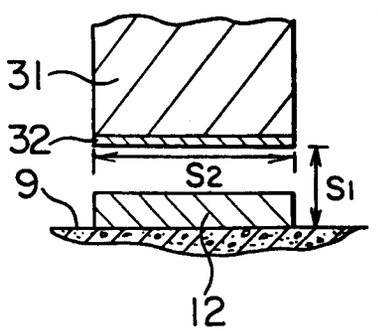

FIG. 8

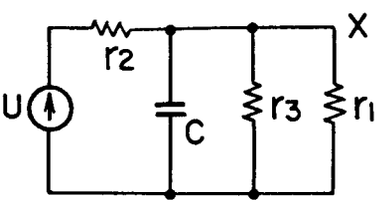

FIG. 9

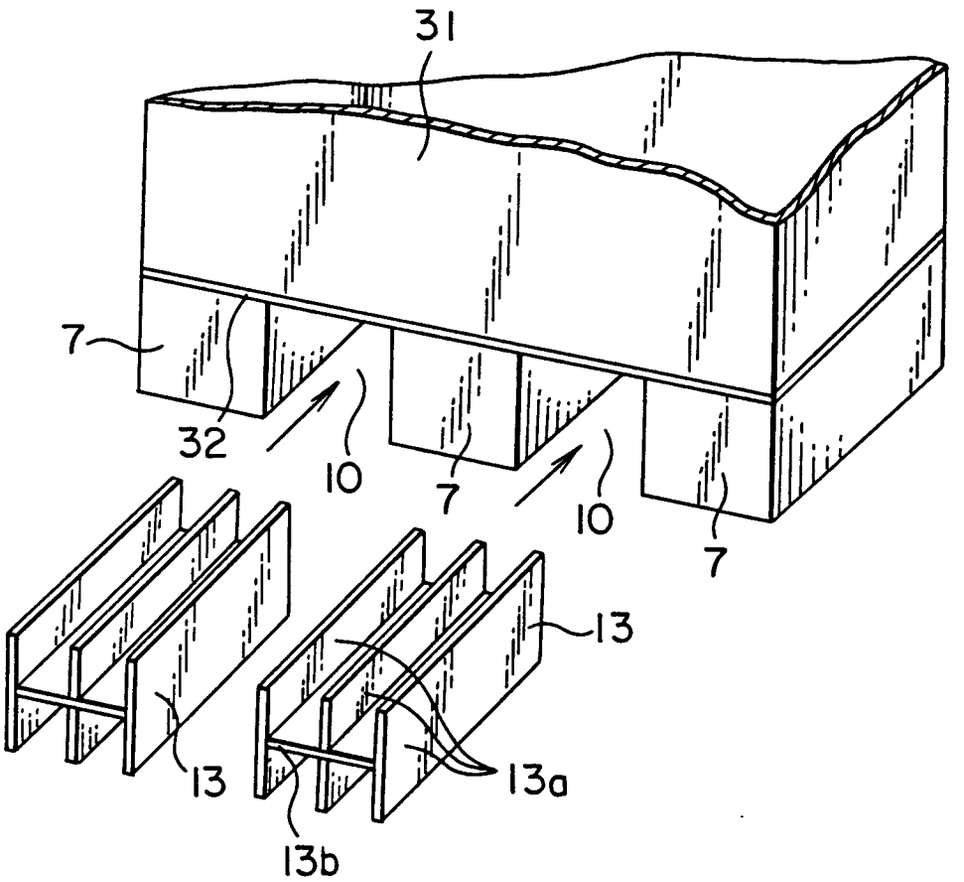

FIG. 10

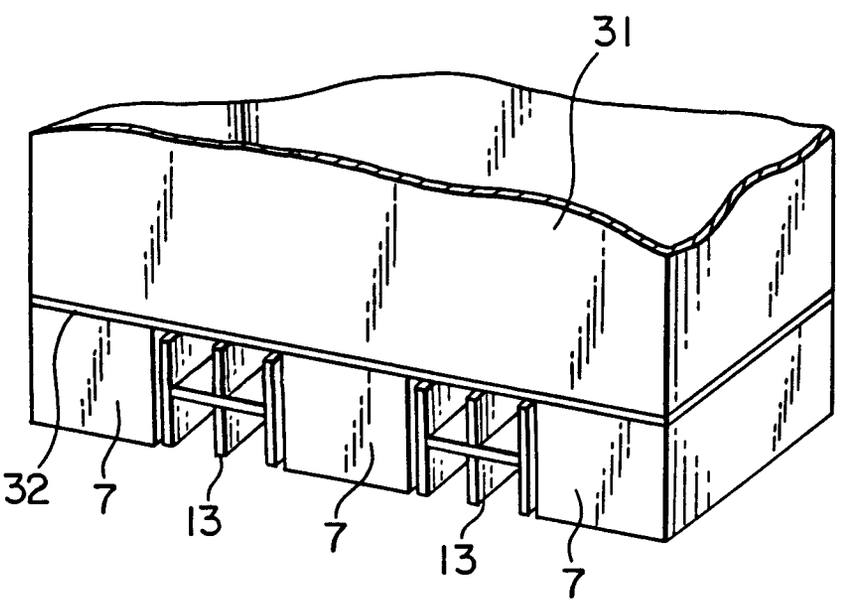

FIG. 11

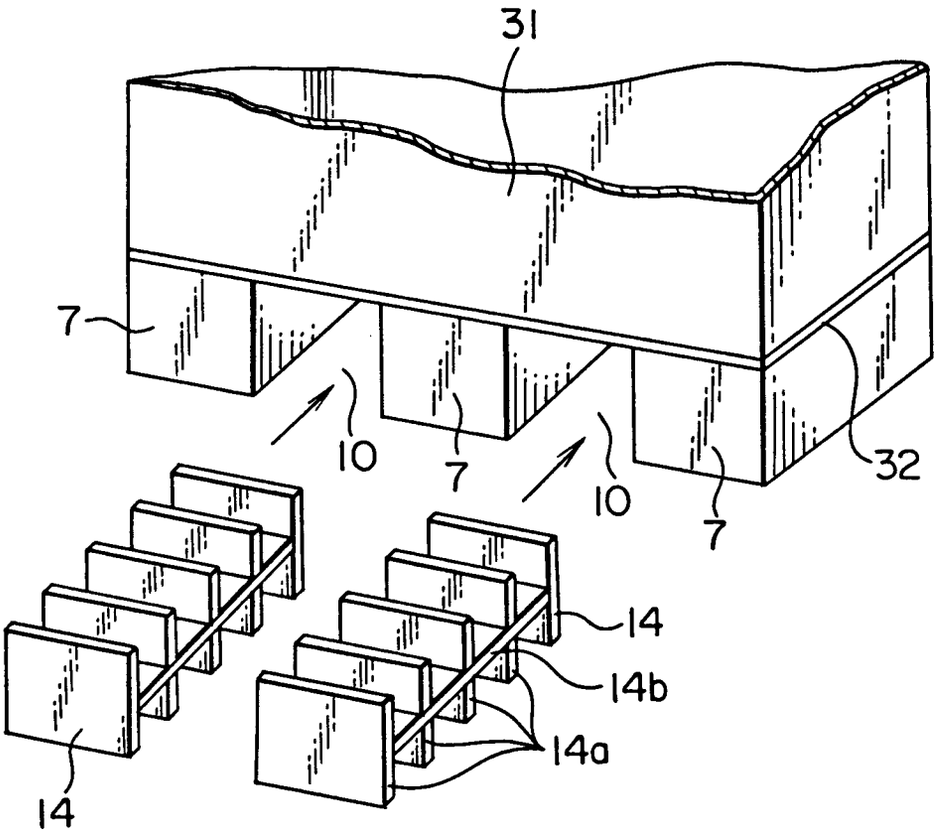

FIG. 12