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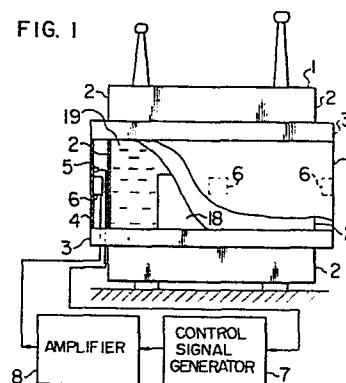
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54 Noise-reduction device for stationary induction apparatus.

57 A noise-reduction device for a stationary induction apparatus is disclosed in which sound insulation panels (4) for reducing the noises radiated from the side walls (2) of a tank (1) are mounted on the reinforcing channel (3) protruded outside of the tank (1) of the induction apparatus. Vibration sensors (5) detect the vibrations transmitted from the tank (1) to the sound insulation panels (4) through the reinforcing channels (3). Vibrators (6) apply vibrations of opposite phase to the vibrations detected by the vibration sensors (5). The vibration sensors (5) and vibrators (6) make up vibration cancelling devices.

FIG. 1



NOISE-REDUCTION DEVICE FOR STATIONARY
INDUCTION APPARATUS

1 The present invention relates to a noise-
reduction device for reducing the noises generated from
the tank of a stationary induction apparatus such as a
transformer or reactor.

5 With the recent expansion of urban areas and
the resultant construction of residential housings near
to a power station or substation, the demand has increas-
ingly be raised for reducing the noises generated from
stationary induction apparatuses such as the transformer.
10 The noises of the stationary induction apparatuses are
caused by the magnetostriction of the core which in turn
causes electromagnetic vibrations to be transmitted to the
tank through such a medium as oil and are radiated into
the atmosphere as a noise from the tank. Various measures
15 have so far been taken to prevent such noises.

In one method, the transformer is installed in a
sound-proof building of concrete or steel plates to shut
off or absorb the noises. This method has various
disadvantage including an increased installation space
20 of the stationary induction apparatus, an increased
production cost and a lengthened construction period.

A simple noise-reduction method for stationary
induction apparatuses overcoming the above-mentioned dis-
advantages in which the noises are cancelled by a sound
25 of the phase oposite to the noises of the stationary

1 induction apparatus involved has been suggested by
 Japanese Patent Publication No. 417/58 published on
 January 28, 1958, which is based on U.S. Patent Applica-
 tion filed on February 9, 1955 by William B. Conover
 5 and Willard F.M. Gray and assigned to General Electric
 Company. This method, however, is not yet practically
 used in view of the fact that the noises generated by
 an induction apparatus, which is complicated in const-
 ruction, include a multiplicity of frequency components,
 10 thereby making it necessary to provide separate loud
 speakers for different frequency components, with the
 result that an increased number of loud speakers are
 required on the one hand and the adjustment of the fre-
 quency and sound volume is complicated on the other hand.

15 A method to improve this disadvantage is
 disclosed in U.S. Patent Application Serial No. 279,814
 filed on July 2, 1981 by Yasuro Hori et al. and entitled
 "Vibration/Noise Reduction Device for Electrical
 Apparatus", in which the vibrations generated in an
 20 induction apparatus are detected and the frequency
 components of the vibrations are determined by Fourier
 transformation, so that additional vibrations are applied
 in a manner to cancel the vibrations of the respective
 frequency components by vibrators mounted on the induc-
 25 tion apparatus. This system also requires a number of
 vibrators as in the case of the above-mentioned Japanese
 Patent Publication. Further, vibrators of larger
 power is required to cancel the vibrations of the

1 induction apparatus.

U.S. Patent co-pending Application Serial No.
406,564 filed August 9, 1982 by Syuya Hagiwara and Yasuro
Hori and entitled "Method and Apparatus for Reducing
5 Vibrations of Stationary Induction Apparatus" also
discloses a system similar to the one disclosed in U.S.
Patent Application Serial No. 279,814, in which the phase
and amplitude of the vibrations caused by the vibrators
are adjusted advantageously. The above-mentioned
10 problems, however, are not solved even by this suggested
method.

Other conventional systems include U.S. Patent
Application Serial No. 217,772 filed December 18, 1980 and
entitled "Static Induction Apparatus" in which a sound-
15 insulating plate is mounted on the framework such as a
reinforcing channel on the outside surface of the tank
through an elastic member thereby to reduce the noises
produced from the tank, and Japanese Patent Publication
No. 87306/81 entitled "Static Induction Apparatus" in
20 which a similar sound-insulation panel is provided with
a weighty material thereby to reduce the vibrations trans-
mitted from the tank through the reinforcing channel to
the sound insulation panel. The former method has the
disadvantage that although the noises (primary noises)
25 radiated by way of the outer wall of the tank through
the oil from the winding and core are capable of being
reduced, it is impossible to reduce the noises (secondary
noises) caused by the vibrations of the sound insulation

1 panels in which the vibrations are transmitted from the
outer wall of the tank through the reinforcing channel.
In the latter method comprising a sound insulation panel
and a weighty material combined which is intended to
5 reduce the secondary noises, on the other hand, the
noise reduction level is limited by the physical limita-
tions of the strength or dimensions of the elastic member
for carrying the sound insulation panels or the size of
the weighty material.

10 An object of the present invention is to provide
a noise-reduction device for stationary induction appara-
tuses, which obviates the disadvantages of the prior art de-
vices and effectively reduces the noises caused by the tank.

In order to achieve this object, according to the
15 present invention, there is provided a noise-reduction
device, in which the primary noises radiated from the outer
wall of the tank are prevented by sound insulation panels
mounted on the outer wall of the tank through a framework
such as reinforcing channels, and vibration cancelling
20 means including vibration sensors and vibrators are mounted
on the sound insulation panels, so that the controlling
force of a phase opposite to the vibration transmitted
from the tank through the reinforcing channel to the
sound insulation panels causing the secondary noises is
25 applied thereto, thus making it possible to cancel the
vibrations by a smaller number of vibrators with a smaller
controlling force than when the controlling force is applied
directly to the tank.

1 The above and other objects, features and
advantages of the present invention will be apparent
from the following detailed description of the preferred
embodiments of the invention in conjunction with the
5 accompanying drawings, in which:

Fig. 1 is a partly cut-away side view showing the
general construction of a noise reduction device for a
transformer according to an embodiment of the present
invention;

10 Fig. 2 is a partly cut-away perspective view of
a noise reduction device on which sound insulation panels
and reinforcing channels are mounted;

Fig. 3 is a enlarged sectional view at left hand
portion of Fig. 1;

15 Fig. 4 is a perspective view of the essential
parts showing a configuration of a noise reduction device
for a transformer according to another embodiment of the
present invention; and

Fig. 5 is a central longitudinal sectional view
20 taken parallel to the tank plan view with the noise
reduction device of Fig. 4 mounted on the tank through
the reinforcing frames.

An embodiment of the present invention will be
described below with reference to Figs. 1, 2 and 3.

25 In these figures, reference numeral 1 designates
a transformer tank containing a winding and core 18 and
filled with an insulating oil 19. At least a pair of
reinforcing channels 3 of U-shaped steel surrounding the

1 tank 1 are securely welded to the side walls 2 of the
tank 1 thereby to reinforce the tank 1. A plurality of
sound-insulation panels 4 surrounding the whole periphery
of the tank including the main vibration section providing
5 a noise source are mounted in such a manner as to close
the part of the side walls 2 between the reinforcing
channels 3. At the part of the side walls 2 which is
covered by the sound insulation panels 4, as shown by
the arrow A in Fig. 3, the primary noises radiated by the
10 vibrations generated from the winding and core 18 and
transmitted to the side walls 2 through the insulating
oil 19 are blocked by the sound insulation panels 4.
The sound insulation panels 4 is preferably made of highly
damped plate with resin sandwiched between a pair of steel
15 plates which absorbs vibrations more than an ordinary
steel plate.

In this construction, however, although the
primary noises caused by the vibrations of the side walls
2 covered by the sound insulation panels 4 are attenuated
20 sufficiently, what is called the secondary noises
radiated by the vibrations of the sound insulation panels 4
in which the vibrations are transmitted from the side
walls 2 through the reinforcing channels 3 as shown by
the arrow B are hardly reduced.

25 According to the embodiment under considera-
tion, vibration sensors 5 and vibrators 6 are mounted
on the sound insulation panels 4, so that detection signals
from the vibration sensors 5 are applied to a control

1 signal generator 7, which in turn applies a control
signal to the vibrators 6 through an amplifier 8. The
vibration transmitted from the reinforcing channels 3
to the sound insulation panels 4 is thus detected by the
5 vibration sensors 5 and a control signal corresponding
to the detection signal is generated by the generator 7,
which signal, after being amplified by the amplifier
8, is applied to the vibrators 6 to generate vibrations of
the phase opposite to the vibrations transmitted to the
10 sound insulation panels 4, thereby cancelling the
vibrations of the sound insulation panels 4.

The circuit configuration and the operation of
the control signal generator, the amplifier and the
vibrators are essentially identical to those of similar
15 devices disclosed in aforesaid U.S. Patent Application
Serial No. 279,814, except that according to the present
invention, the vibrators are adapted to reduce the vibra-
tions transmitted to the sound insulation panels but
not the vibrations of the tank itself and therefore a
20 smaller number of vibrators with a smaller power are used
to achieve the object of the invention.

The vibration sensors 4 and the vibrators 5
are mounted on the sound insulation panels 4 in such a
manner of construction as shown in Fig. 3. Each of the
25 vibration sensors 5 and the vibrators 6 is held on a
mounting plate 9, which is bolted replaceably to the
sound insulation panel 4 so that the vibration sensor 5
and the vibrator 6 are situated in the space between the

1 sound insulation panel 4 and the side plate 2 through a
hole 10. Lead wires 11, 12 from the vibration sensor 5
and the vibrator 6 are led through a hole 13 into a
reinforcing channel 3 and after being wired therein,
5 are connected to the control signal generator 7 and the
amplifier 8 together with the lead wires of the other
vibration sensors and vibrators.

The advantages of the present invention are
described below.

10 (1) The sound insulation panel 4, which does not
participate in the strength of the tank, may be made of a
comparatively thin plate and is capable of reducing the
vibrations with a small control power as compared with
the conventional method in which the control power is
15 applied directly to the outer surface of the tank.

(2) Since the vibrations of the reinforcing channel
of comparatively simplified construction provide a
source of vibrations of the sound insulation panel, a
smaller number of frequency components are contained
20 than the vibrations of the induction apparatus, and
therefore a smaller number of vibrators are required
than when the vibrations of the induction apparatus are
cancelled directly.

(3) The vibration sensors 5 and the vibrators 6
25 are easily removable from the sound insulation panels 4
and therefore the maintenance and inspection thereof are
easy.

(4) The vibration cancelling devices including

1 the vibration sensors 5 and the vibrators 6 are contained
in the space surrounded by the tank side walls 2 and the
reinforcing channels 3, and therefore the tank dimension
is not substantially increased. Further, the vibration
5 cancelling devices, which are enclosed by the sound
insulation panels 4 and the mounting plates 9, are not
exposed to the elements and have a longer service life.
(5) The lead wires 11 and 12 of the vibration sensor
5 and the vibrator 6 are wired through the channel 3, thus
10 eliminating the need of an exclusive piping for the lead
wires.

Another embodiment of the present invention
will be described with reference to Figs. 4 and 5. In
this embodiment, the sound insulation panel 4 is mounted
15 on the reinforcing channels 3 through a frame 14 and a
flexible thin plate 15. The vibration sensor 5 and the
vibrator 6 are mounted on the frame 14 through mounting
frames 16. The vibration sensor 5 and the vibrator 6
alternatively may be mounted directly on the frame
20 14 without the mounting frame 16. Numeral 17 designates
an inspection cover.

In this construction, the frame 14 and the thin
plate 15 function as a weighty member and a spring res-
pectively thereby to reduce the transmission of the
25 vibrations from the reinforcing channel 3. The vibration
reduce effect may be increased by reducing the spring
constant of the thin plate 15 and increasing the weight
of the frame 14. The limitation of the strength and

1 dimensions, however, limit the vibration damping effect.

According to the present embodiment, the vibrators 6 are mounted on the frame 14 through the mounting frame 16 so that the force of the phase opposite to the vibrations applied through the reinforcing channels 3 is applied to the tank 1 thereby to cancel the vibrations thereof, thus cancelling the vibrations of the sound insulation panels 4 and the inspection cover 17 connected with the frame 14.

10 Each vibrator 6 is mounted on the frame 14 by reason of the fact that the frame 14 has a larger rigidity than the sound insulation panel 4, resulting in a smaller number of natural vibration frequencies in the frequency range to be reduced. Specifically, when
15 cancelling the vibrations of a structure by applying a control force thereto, vibrators as many as number of the natural vibration frequencies are theoretically required. When the vibrators 6 are mounted, not on the sound insulation panel 4, but on the frame 14 which is
20 larger in rigidity, a smaller number of natural vibration frequencies to be reduced are involved, thus making it possible to reduce the vibrations with a smaller number of vibrators 6. The embodiment under consideration, which uses a control signal generator, an amplifier
25 and vibrators similar to those of the first embodiment, has the advantages mentioned below.

(1) As in the first embodiment, only the power sufficient to cancel the vibrations of the sound

1 insulation panels are required and therefore the output
power of the vibrators is reduced.

(2) Since the vibrations of the sound insulation
panels 4 are controlled by the frame 14 larger in
5 rigidity and smaller in the number of natural vibration
frequencies to be reduced, the number of the frequency
components of the vibrations to be cancelled is further
decreased as compared with the first embodiment, thus
reducing the number of vibrators required.

10 (3) The sound insulation panel 4 is supported from
the reinforcing channel 3 by a spring of the thin plate
15, and therefore the vibration system of the sound
insulation panel 4 may be considered substantially
independently of the reinforcing channel 3, thereby
15 clarifying and making it easy to predict the vibration
characteristics of the sound insulation panel 4. This
facilitates the vibration control on the one hand and
improves the stability of vibration control on the other
hand.

20 (4) By removing the inspection covers 17, the
maintenance and inspection of the vibration sensors 5
and the vibrators 6 are easily carried out.

(5) In view of the fact that the vibration cancelling
devices including the vibration sensors 5, the vibrators
25 5 and the frame 14 are contained in the space surrounded
by the tank side plates 2 and the reinforcing channels 3,
the tank dimension is not generally increased. Further,
since the vibration cancelling devices are hermetically

1 enclosed by the sound insulation panels 4, the thin plates
15 and the inspection covers 17, the vibration cancelling
devices are not exposed to the elements, thus ensuring
the long service life thereof.

5 (6) The fact that the vibrators 6 are mounted
through the mounting frames 16 makes it possible to
control a plurality of points (four points in the case
of Fig. 4) by a single vibrator 6, thus increasing the
vibration reducing effect.

10 It will be understood from the foregoing description that according to the present invention, the
primary noises radiated from the surface of the tank are
reduced by sound insulation panels mounted on the outer
walls of the tank through framework such as reinforcing
15 channels on the one hand, the vibration cancelling devices
including vibration sensors and vibrators are mounted on
sound insulation panels or weighty members installed on
the sound insulation panels thereby to apply the controlling
force of opposite phase to the vibrations transmitted
20 to the sound insulation panels through the reinforcing
channels from the tank causing the secondary noises on
the other hand. As compared with the prior art devices
in which the controlling force is applied directly
to the tank, the noises generated from the tank are
25 effectively reduced by a small number of vibrators with
smaller power.

WHAT IS CLAIMED IS:

1. A noise-reduction device for a stationary induction apparatus comprising a tank (1) filled with the insulating oil (19) and an induction apparatus (18) mounted in said tank, said noise-reduction device comprising:

first means mounted on at least two reinforcing channels (3) arranged substantially parallelly to each other in spaced relationship therebetween on side walls (2) of said tank (1) in a manner to surround said tank (1), said first means including sound insulation panels (4) provided to surround the part of said tank side walls (2) between said reinforcing channels (3), thereby reducing the noises generated from said winding and core and radiating outside through said insulating oil (19) and said tank side walls (2); and

second means for cancelling the vibrations of said sound insulation panels, including a plurality of vibration sensors (5) for detecting the vibrations of said sound insulation panels (4), a plurality of vibrators (6) for applying to said sound insulation panels (4) such vibrations as to cancel the frequency components of the vibrations detected by said vibration sensors (6) respectively.

2. A noise reduction device for a stationary induction apparatus according to Claim 1, wherein said sound insulation panels (4) arranged substantially parallelly with said tank side walls (2) form a space

with said tank side walls (2).

3. A noise-reduction device for a stationary induction apparatus according to Claim 2, wherein said vibrators (6) are mounted with said sound insulation panels (4) in the space between said tank side walls (2) and said sound insulation panels (4).

4. A noise-reduction device for a stationary induction apparatus according to Claim 2, wherein each of said vibrators (6) is mounted on a plate member (16) mounted removably on said sound insulation panel (4) in a manner to enclose the opening formed in each of said sound insulation panels (4).

5. A noise-reduction device for a stationary induction apparatus according to Claim 1, comprising a flexible member (15) through which each of said sound insulation panels (4) is mounted on said reinforcing channel (3), and a weighty member (14) on which said vibrator (6) is mounted, said weighty member (14) being located at the junction of each of said sound insulation panels (4) and said flexible member (15).

6. A noise-reduction device for a stationary induction apparatus according to Claim 5, wherein each of said sound insulation panels (4) includes a peep hole (10) for said vibrators (6), said peep hole (10) being closed with a cover (17).

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FIG. 1

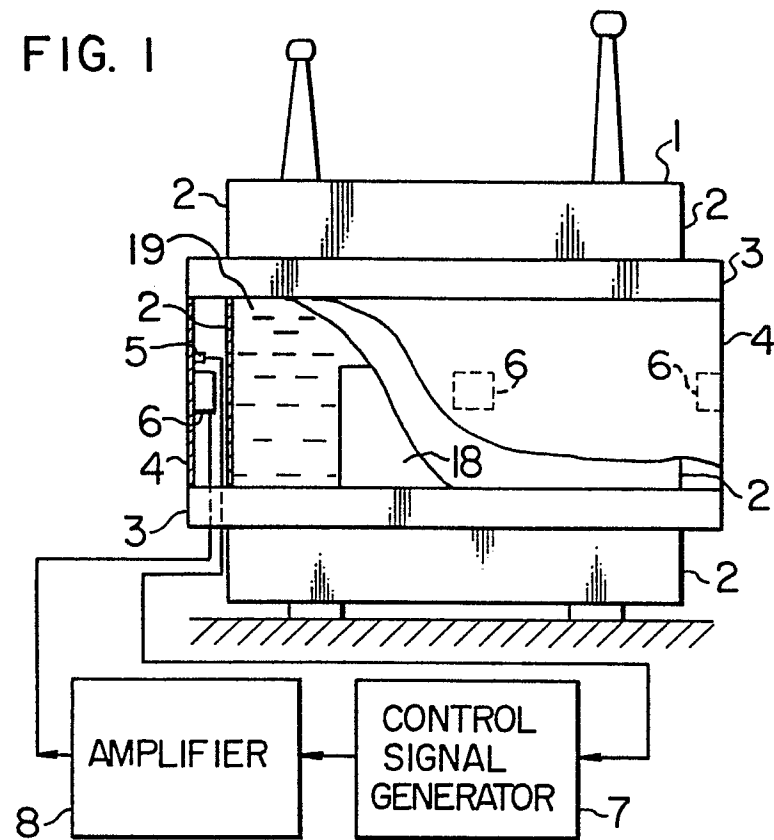


FIG. 2

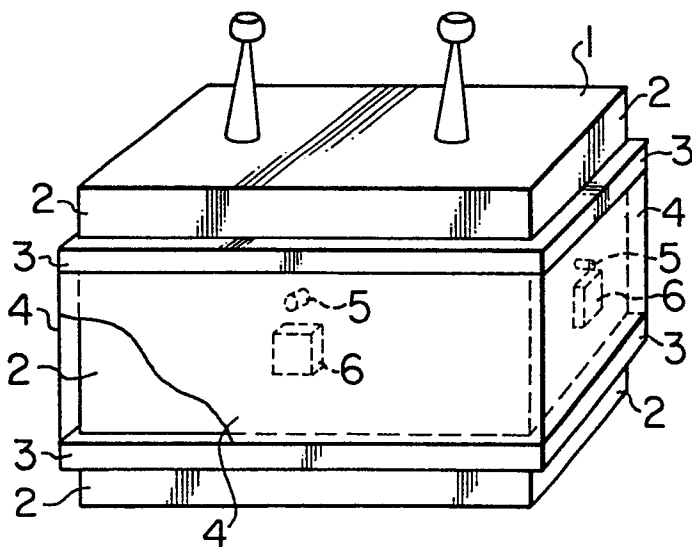


FIG. 3

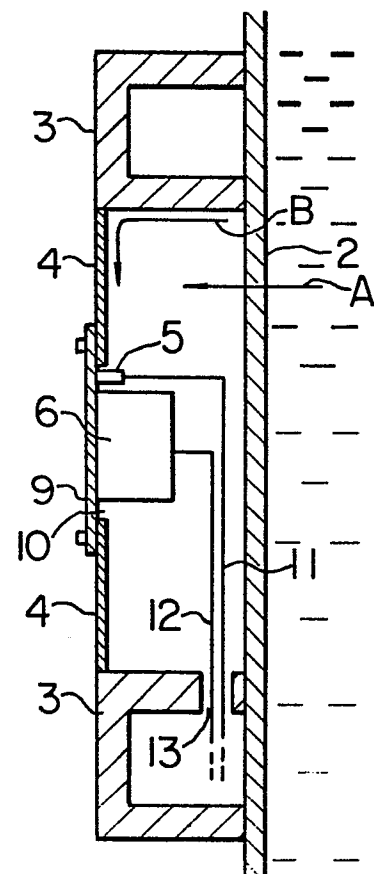


FIG. 4

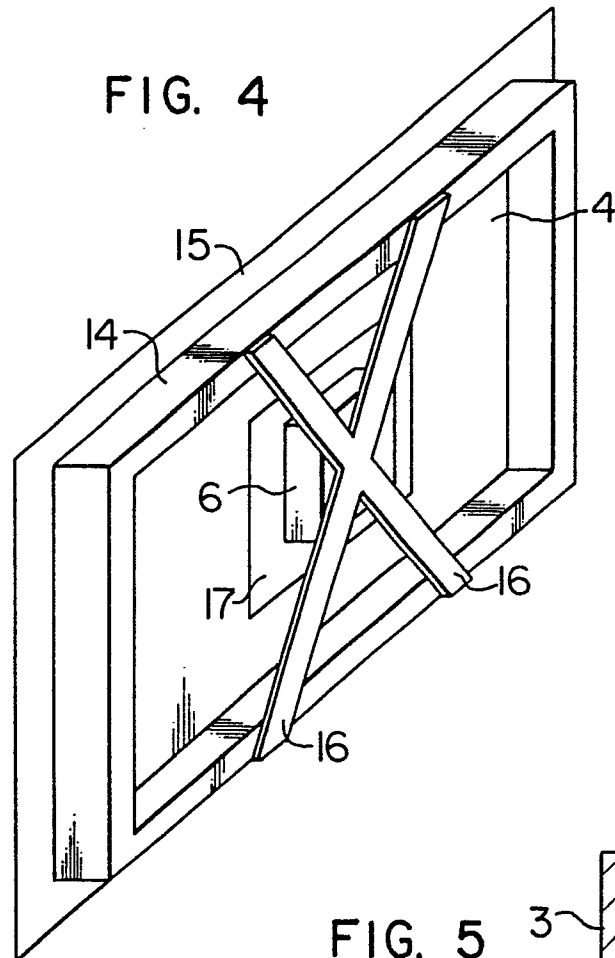
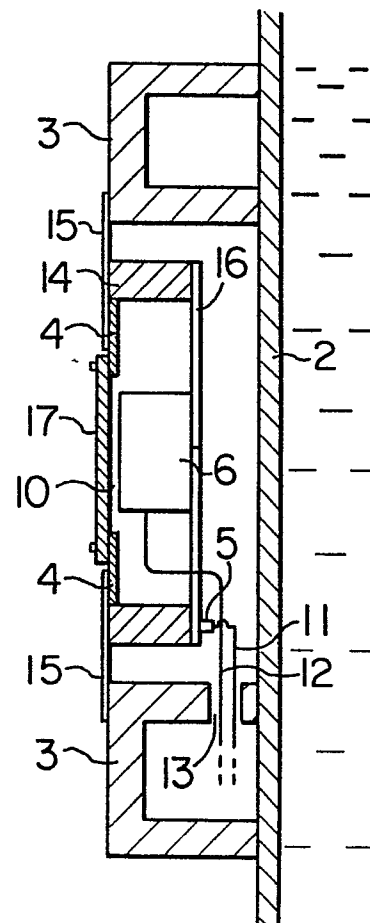


FIG. 5





European Patent
Office

EUROPEAN SEARCH REPORT

0083718

Application number

DOCUMENTS CONSIDERED TO BE RELEVANT			EP 82110831.3
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)
D,Y	<u>DE - A1 - 3 047 341</u> (HITACHI) * Totality * --	1-3	H 01 F 27/33 G 10 K 11/16
Y	SOVIET INVENTIONS ILLUSTRATED, Section El., week C 39, nov. 5, 1980 DERWENT PUBLICATIONS LTD.LONDON; T 06 * SU-714 471 (WORK SAFETY RES.) --	1-3	
A	<u>PCT - A1 - WO 81/01 479</u> (SOUND ATTENUATORS LIMITED) --		
A	<u>CH - A5 - 610 429</u> (WESTINGHOUSE ELECTRIC CORPORATION) --		
A	<u>DE - B - 1 227 142</u> (WILLEM SMIT & CO'S) --		
A	<u>GB - A - 782 794</u> (GENERAL ELECTRIC) ----		
The present search report has been drawn up for all claims			
Place of search VIENNA		Date of completion of the search 09-04-1983	Examiner TSILIDIS
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			