A noise abatement kit for reducing noise emissions emanating from beneath a machine through a gap between the bottom of the machine and a floor, includes a sound barrier (10) adapted to be attached around a lower portion of the machine to form a barrier across the gap and a sound absorber (20) adapted to be placed under the machine within the area circumscribed by the sound barrier (10). The sound barrier (10) and absorber (20) may be used individually, although a synergistic noise abatement system is achieved when they are used in combination.
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NOISE ABATEMENT KIT

TECHNICAL FIELD AND INDUSTRIAL APPLICABILITY OF THE INVENTION

The invention herein disclosed relates to a noise abatement system for use with machines. In particular, the invention is directed to a noise abatement system for home appliances to thus reduce noise emissions while the appliance is in operation.

BACKGROUND OF THE INVENTION

Today's homes contain numerous machines and appliances, and they are in frequent use. Moreover, the machines and appliances are being used in the home more and more in the early morning or at night when working parents or family members are at home. Washing machines, for example, because they consist of a motor, a pump, and a rotating or oscillating tub, are particularly noisy. The noise is readily transferred from the machine to the surrounding area because there is generally little noise insulation built into washing machines intended for home use. Moreover, they are frequently located in the home on a hard surface floor which serves to readily reflect the sounds from the machine to the surrounding areas. For example, it is not uncommon to locate a family laundry facility in the basement of the house where the machine would be situated on a concrete floor. Even in situations where the laundry facilities are located above the basement level of a home, for example, in or near the kitchen or bathroom, they are generally placed in an area that has a hard sound reflecting floor, such as tile or linoleum. Moreover, it is not uncommon in today's newer homes to locate laundry facilities on the bedroom level of the home. Locating laundry machines near living and sleeping areas only exacerbates the problem of noise from the laundry machines causing a disturbance to those nearby.

Washing machines, and other laundry and general household appliances, have little in the way of sound proofing or damping. Occasionally, a thin fiber blanket may be attached to the walls of an appliance housing, but this in and of itself does not address the problem of noise emanating from the bottom of the machine. See, for example, U.S. Patent No. 5,044,705.

Some attempts have been made to reduce sound emissions emanating from the bottom of home washing machines, which attempts have centered on a sound reduction system that is an integral part of the machine. For example, U.S. Patent Nos.
5,515,702 and 5,056,341 show washing machines in combination with sound reduction systems offered as a single unit. However, the noise reduction systems therein shown are designed to be an integral part of the particular washing machine, and they are not designed to be added, or retro-fitted, to an existing machine already in the home.

Similarly, U.S. Patent Nos. 4,007,388 and 3,773,140 disclose integral noise reduction systems for large industrial machinery. However, as with the home washing machines mentioned above, these noise reduction systems are designed for the particular unit for which the sound proof equipment is made and are not adaptable to a wide range of machines. Moreover, the sound proofing materials are added during manufacture of the machine, and are not intended as a "retro-fit" to existing machines in use in the field.

**SUMMARY OF THE INVENTION**

The present invention provides an apparatus useful to contain and absorb, or otherwise attenuate, the noise emanating from a machine. In particular, the invention provides a noise attenuation system that may be easily installed on machines already in use, for example, in the home.

A noise abatement kit for reducing noise emissions emanating from beneath a machine through a gap between the bottom of the machine and a floor, includes a sound barrier adapted to be attached around a lower portion of the machine to form a barrier across the gap; and a sound absorber adapted to be placed under the machine within the area circumscribed by the sound barrier. The barrier and the absorber may be used alone or in combination to reduce noise emissions from the machine.

The noise abatement kit of invention is particularly useful for the abatement of acoustic energy emanating from the bottom of a washing machine, and can be made impervious to water and other products used in and around such machines.

**BRIEF DESCRIPTION OF THE DRAWINGS**

Fig. 1 is an oblique view of the invention applied to a washing machine.

Fig. 2 is an enlarged view of a portion of Fig. 1.
DETAILED DESCRIPTION AND
PREFERRED EMBODIMENTS OF THE INVENTION

The present invention provides a noise barrier system suitable for household or commercially operated machines and appliances. The invention includes a sound absorptive panel for placement beneath the machine, and a skirt-type noise barrier for placement around the sides and front of the machine to close off the space between the bottom of the machine's cabinet and the floor. Installation of the noise barrier system of the invention can significantly reduce the noise emanating from common household appliances such as laundry washing machines.

Although the noise barrier system of the invention may be used with any common household or commercial machine or appliance, including automatic dishwashers, clothes dryers, trash compactors, etc., it is particularly well suited for home laundry washing machines. Washing machines currently in use, as well as those readily available today, have little in the way of sound insulation. Typically, the pump and motor are located below the tub of the washer and are enclosed within a relatively thin metal cabinet which is open at the bottom. Consequently, acoustic energy generated from the machine's operation is directed downwardly and emanates from the lower portion of the machine into the surroundings in the form of noise. However, such noise can be easily abated by installation of the noise barrier system of the invention.

The sound barrier system of the invention is illustrated in Figures 1 and 2, as applied to a washing machine. Specifically, a washing machine 2 having a cabinet 4 is shown. The cabinet is open at the bottom and elevated above the floor by legs 6. It is to be understood, however, that the washing machine is shown as an example only, and that the noise attenuation system of the invention is adaptable to other machines in addition to a washing machine and is in no way limited thereto. Furthermore, the noise attenuation system is usable with virtually all washing machines for use in the home.

The noise attenuation system of the invention is composed of two subassemblies, which can be used alone or in combination. The first subassembly comprises a sound barrier or skirt 10, shown around the bottom of the washer 2, which is attached to the cabinet 4 at a lower portion thereof. The skirt 2 extends around all sides of the machine, although the skirt portion may be omitted from the rear panel to allow for
cooling of the machine. Since the rear of the machine generally faces a wall in use, there is minimal effect on the noise level as a result of leaving the rear open. Alternatively, the rear skirt section may be provided with holes (not shown) or other ventilation openings. The skirt attaches the lower portion of the machine such that the lower edge of the skirt rests on the floor and thus the skirt extends across and thereby forms a barrier across a gap between the bottom of the machine and the floor.

The noise barrier 10 can be made to virtually any dimensions sufficient to enclose the machine as discussed above. Typically, a skirt height of about three to five inches (about 76 to 127 mm) and thickness of from about 0.1 to 0.4 inches (about 2.5 to 10.2 mm) is adequate for most household appliances. For example, laundry appliances are generally manufactured such that the bottoms or lower edges of the cabinets are about \( \frac{1}{4} \) inch (about 19.1 mm) from the floor. Although such machines are usually supplied with legs 6 to allow movement of the cabinet for leveling purposes when necessary, a 3-1/2 inch (89 mm) skirt height is normally sufficient to allow for this.

The noise barrier skirt may be composed of any resilient material including urethanes, rubber, and polymeric materials. Preferably, the skirt is formed of an extruded polyvinyl chloride or dense, expandable polymer foam material such as polyether, polyethylene and urethane. Preferably, at least one longitudinal edge is provided with an adhesive 12, or other attaching means such as permanent magnets 11, to enable the skirt to be mounted onto the vertical sides of the cabinet 4 as shown in the figures.

Alternatively, the skirt can be mounted on the cabinet with hardware fasteners such as sheet metal screws or nuts and bolts 13. Because the height of the sound barrier is usually greater than the space between the appliance cabinet bottom and the floor, mounting the skirt so that it flares slightly outward as shown in the drawing will generally insure that a good seal is made with the floor.

Tests have shown that when using the sound barrier alone, acoustic energy is reduced by 1.5 dB to 4.4 dB during the wash cycle of a clothes washer. During all cycles on the washing machine, a reduction of 1.3 dB to 4.4 dB was observed.

In an optional embodiment, a strip of sound absorptive material may be attached to the skirt along and immediately above its bottom edge. The portion of the skirt to be fastened to the cabinet via adhesive, magnets, or other means extends above the
sound absorptive strip. When the skirt is fastened to the machine's cabinet, the sound absorptive strip is thus positioned so that it fills the gap between the cabinet and the floor. Preferably, the sound absorptive strip may extend from \( \frac{1}{2} \) to \( \frac{3}{4} \) inch (12.7 to 19.1 mm) above the bottom edge of the skirt, and is made of a compressible material such as an open or closed cell polyethylene, urethane or polyether foam, or a fibrous material, so that varying gap heights may be accommodated. The sound absorptive strip is preferably from \( \frac{1}{2} \) to 2 inches (12.7 to 51 mm) in thickness to provide good noise attenuation. Optimally, when the skirt with the attached sound absorptive strip is fastened to the machine's cabinet, the gap between the cabinet and the floor will be completely filled by the sound absorptive strip and firmly sealed by the skirt's contact with the floor. The sound absorptive material is preferably compressible so that one size would be appropriate for most common installation situations and can be easily trimmed with scissors or a knife.

The second subassembly is a sound absorbing pad 20 which may be placed on the floor, directly below the appliance unit 2 and within the area circumscribed by the walls 4 thereof. The sound absorbing pad 20 is generally from about \( \frac{1}{2} \) to 1 inch (about 12.7 to 25 mm) thick, preferably 0.75 inches (19.1 mm) thick, and has preferred lateral dimensions of about 25-32 inches by 23-28 inches (about 635-813 mm by 584-711 mm) to fit under virtually all standard size home laundry appliances. The sound absorbing pad is preferably composed of a glass fiber mat encased in a polyethylene bag. Preferably, the mat is a nonwoven mat formed of glass fibers of a mean diameter of from about 6 to 7 microns. The manufacture of such mats is well known in the glass fiber art. The bag should be thin enough to permit penetration of acoustic energy to the mat and is preferably sealed to exclude debris such as laundry detergent, bleach, and other items from adversely affecting the glass fiber mat.

In its optimal form, the sound barrier is used in combination with the pad and is provided as a kit. While the two parts of the kit do not generally contact each other after installation, there is a synergistic effect when used together. For example, when the sound barrier 10 is used alone, the acoustic energy emitting from the machine is constrained below the machine, but it is not absorbed or otherwise dispersed. When the pad is used alone, some of the acoustic energy is absorbed thereby, but much of it escapes out the open bottom of the machine without being absorbed by the pad. On the other
hand, when the sound barrier and the pad are used together, the pad is placed within the
area circumscribed by the sound barrier and the acoustic energy constrained by the barrier
is generally absorbed in the pad, thus achieving a synergism in sound abatement of the
washing machine.

In a preferred embodiment, a kit was provided which includes a sound
barrier and a sound absorber. The sound barrier was a strip of polyvinyl chloride material
3-1/2 inches wide (89 mm), about 1/8 inch (about 3.2 mm) thick, and approximately 90
inches (2286 mm) in length. Along one edge of the strip, a layer of adhesive was applied.
Also, the kit included a sound absorbing pad comprised of a glass fiber pad,
approximately 0.75 inches (19.1 mm) thick and having lateral dimensions of 24 x 27
inches (610 x 686 mm), encased in a polyethylene bag 0.002 inches (0.051 mm) thick.

In use, the sound absorbing pad was slid beneath a washing machine and
oriented to be completely under the washing machine. Next, the sound reflecting strip
was attached to the lower portion of the washing machine cabinet by exposing the
adhesive along one edge of the strip and pressing it against the cabinet. Since the strip
was 3.5 inches (89 mm) wide (or high), it was placed on the front and both sides of the
machine approximately 2.5 inches (64 mm) from the floor. This placement permitted a
slight flaring of the strip at the floor and facilitated a complete seal between the cabinet
bottom and the floor. The strip, because it was a thin PVC material about 1/8 inch thick
(3.2 mm), was easily trimmed with ordinary household scissors. The back of the cabinet
was not enclosed, as described above, to allow for proper air circulation and cooling of the
machine's internal parts.

After installation of the kit as described above, a reduction of the sound
power and thus energy levels of the machine were observed as shown in Table 1.

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<td>with kit</td>
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<td>% reduction in energy level with kit</td>
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<td>63.7%</td>
<td>36.90%</td>
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* Mean A - weighted sound power level
Accordingly, the use of the inventive sound barrier and sound absorber in combination provided an effective means to reduce noise levels around the washing machine, and, in general, is believed to be useful to reduce noise levels in other machinery of this type while they are in operation.

The principles, a preferred embodiment and the mode of operation of the present invention have been described in the foregoing specification. However, the invention which is intended to be protected is not to be construed as limited to the particular embodiment disclosed. The embodiment is therefore to be regarded as illustrative rather than restrictive. Variations and changes may be made by others without departing from the spirit of the present invention. Accordingly, it is expressly intended that all such equivalents, variations and changes which fall within the spirit and scope of the present invention as defined in the claims be embraced thereby.
CLAIMS

1. A noise abatement kit for reducing noise emissions emanating from beneath a machine through a gap between the bottom of the machine and a floor, comprising:

5 a sound barrier adapted to be attached around a lower portion of the machine to form a barrier across the gap; and

a sound absorber adapted to be placed under said machine within the area circumscribed by said sound barrier.

2. The noise abatement kit of claim 1, wherein said sound barrier is an elongated strip of sound reflective material having attachment means along one edge thereof to secure said sound barrier to the machine.

3. The noise abatement kit of claim 2, wherein said attachment means are selected from the group consisting of adhesives, magnets and hardware fasteners.

4. The noise abatement kit of claim 2, wherein said sound reflective material is selected from the group consisting of polyvinyl chloride, urethane, vinyl, polyethylene, polyether, natural rubber, synthetic rubber, and corrugated paper products.

5. The noise abatement kit of claim 2, wherein said sound reflective material is a dense, expandable polymer foam selected from the group consisting of polyethylene, polyether, and urethane.

6. The noise abatement kit of claim 2, wherein said sound barrier further comprises a sound absorbing material attached to the same side of the sound barrier as the attachment means, but spaced therefrom.

7. The noise abatement kit of claim 1, wherein said sound absorber comprises a mat of sound absorbing material.

8. The noise abatement kit of claim 7, wherein said mat is comprised of glass fibers.

9. The noise abatement kit of claim 7, wherein said mat is encased in a bag that permits penetration of acoustic energy to said mat.

10. The noise abatement kit of claim 9, wherein said bag is made of polyethylene and has walls approximately 0.002 inches (0.051 mm) thick.
11. A method for reducing sound emissions emanating from beneath a machine through a gap between the bottom of the machine and a floor, comprising: placing a sound absorbing mat on the floor beneath the machine, and placing a sound barrier around at least three sides of a lower portion of the machine to form a barrier across the gap.

12. The method of claim 11, wherein said sound barrier is an elongated strip of sound reflective material having attachment means along one edge thereof to secure said sound barrier to said machine, and said sound barrier placing step includes attaching said attachment means to the lower portion of the machine.

13. The method of claim 12, wherein said sound reflective material is selected from the group consisting of polyvinyl chloride, urethane, vinyl, polyethylene, polyether, natural rubber, synthetic rubber, and corrugated paper products.

14. The method of claim 12, wherein said sound reflective material is a dense, expandable polymer foam selected from the group consisting of polyethylene, polyether, and urethane.

15. The method of claim 12, wherein said sound barrier further comprises a sound absorbing material attached to the same side of the sound barrier as the attachment means, but spaced therefrom.

16. The method of claim 11, wherein said mat is comprised of glass fibers.

17. The method of claim 11, wherein said mat is encased in a bag that permits penetration of acoustic energy to said mat.

18. The method of claim 17, wherein said bag is made of polyethylene and has walls approximately 0.002 inches (0.051 mm) thick.

19. An apparatus comprising, in combination:

   a machine elevated above a floor thus forming a gap between a bottom of said machine and the floor; and

   a sound abatement system, including

   a sound barrier attached around a lower portion of said machine and extending across said gap to form a barrier across said gap, and
a sound absorbing mat located under said machine and
within the area circumscribed by said sound barrier.

20. The apparatus of claim 19, wherein said sound barrier is an
elongated strip of sound reflective material having attachment means along one edge
thereof to secure said sound barrier to said machine.

21. The apparatus of claim 20, wherein said attachment means are
selected from the group consisting of adhesives, magnets and hardware fasteners.

22. The apparatus of claim 20, wherein said sound reflective material is
selected from the group consisting of polyvinyl chloride, urethane, vinyl, polyethylene,
polyether, natural rubber, synthetic rubber, and corrugated paper products.

23. The apparatus of claim 20, wherein said sound reflective material is
a dense, expandable polymer foam selected from the group consisting of polyethylene,
polyether, and urethane.

24. The apparatus of claim 20, wherein said sound barrier further
comprises a sound absorbing material attached to the same side of the sound barrier as the
attachment means, but spaced therefrom.

25. The apparatus of claim 19, wherein said mat is comprised of glass
fibers.

26. The apparatus of claim 19, wherein said mat is encased in a bag
that permits penetration of acoustic energy to said mat.

27. The apparatus of claim 26, wherein said bag is made of
polyethylene and has walls approximately 0.002 inches (0.051 mm) thick.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
IPC(6) : F16 M 13/00
US CL : Please See Extra Sheet.
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED
Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<td>US 2,922,202 A (KODARAS) 26 January 1960 (26/01/60), see entire document.</td>
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Further documents are listed in the continuation of Box C. See patent family annex.

Date of the actual completion of the international search: 23 MARCH 1998
Date of mailing of the international search report: 10 APR 1998

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Authorized officer

Telephone No. (703) 305-8244

Form PCT/ISA/210 (second sheet)(July 1992)*
A. CLASSIFICATION OF SUBJECT MATTER:
US CL: