United States Patent

[11] 3,628,626

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[54] **QUIET WALL**
5 Claims, 3 Drawing Figs.

[52] **U.S. Cl.** ..... **181/33 GB,** 160/40, 160/84 R
[51] **Int. Cl.** **E04b 1/99,** G10k 11/04
[50] **Field of Search** ..... 181/33 GB, 33 GA; 160/40, 84 R, 84 H; 52/144, 145

[56] **References Cited**

UNITED STATES PATENTS

3,062,277	11/1962	Merrill	160/84
3,234,996	2/1966	King et al.	181/33 GB X
3,223,147	12/1965	Holloway	160/84
1,810,847	6/1931	Nordell et al.	181/33 GB
2,903,055	9/1959	Merrill	160/84
2,915,115	12/1959	Reynolds	160/84

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ABSTRACT: A folding partition consisting of a pair of acoustical assemblies or sides which combine the acoustical properties of sound absorption and sound transmission loss, and include a flexible blanket of sound absorbent fiberglass sandwiched between an inner vinyl lining and an outer fabric and a plurality of metal panels are attached to the inner side of the vinyl lining. The outer fabric is provided with a multiplicity of perforations for admitting sound into the fiberglass blanket where it is absorbed, while the metal panels further reduce the sound which passes through the fiberglass and further prevent it from passing through the closure.

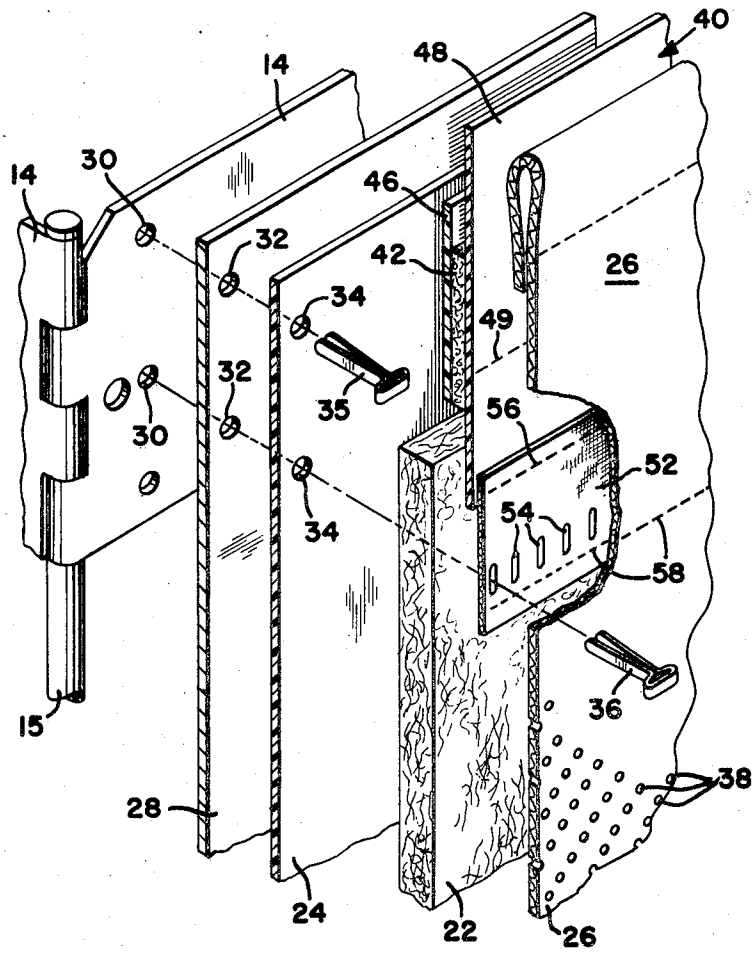


FIG-1

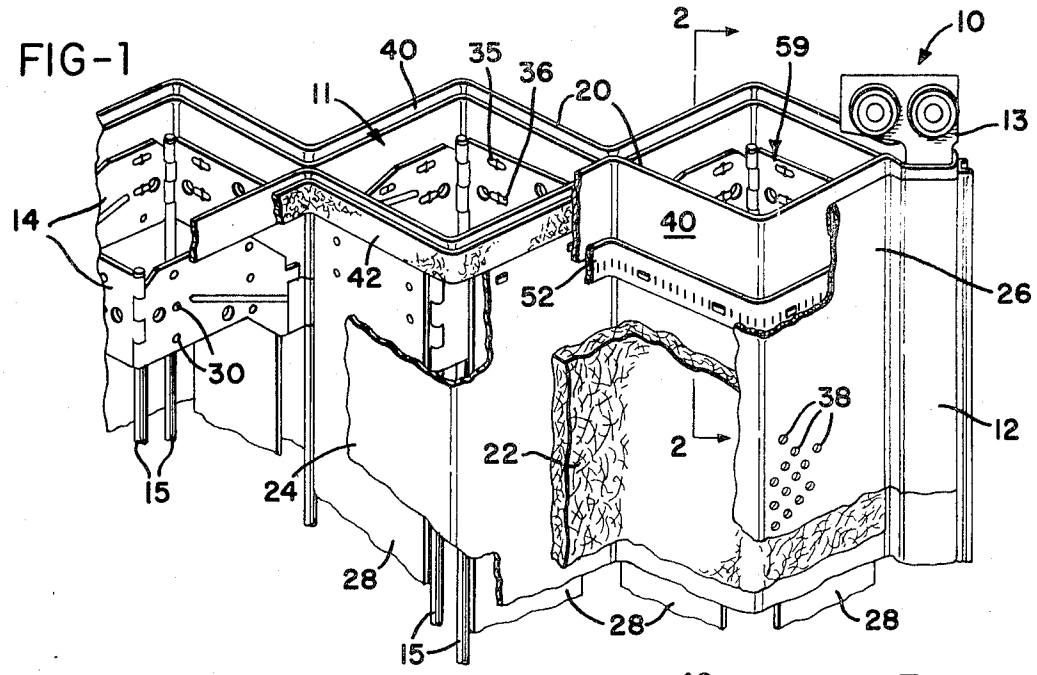


FIG-2

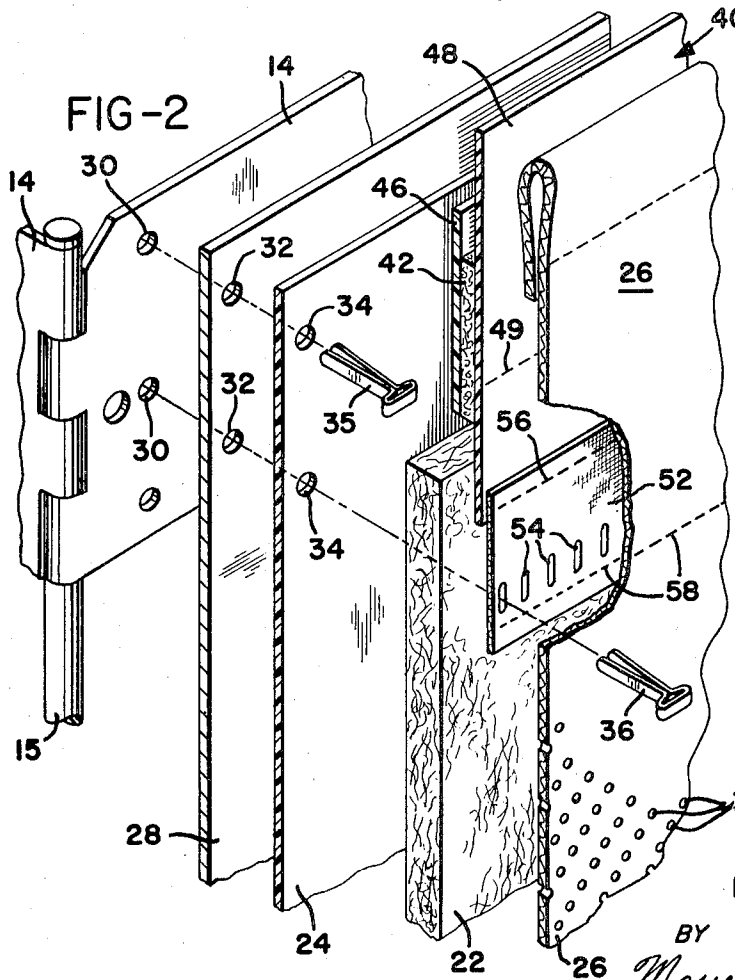
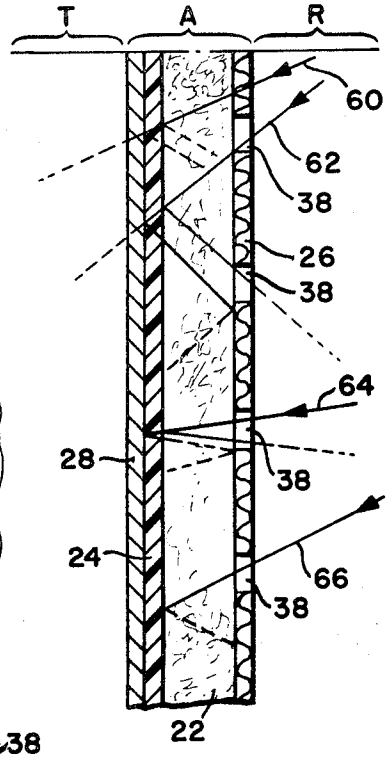


FIG-3



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QUIET WALL

BACKGROUND OF THE INVENTION

In folding doors or partitions such as disclosed in U.S. Pat. Nos. 2,903,055, and 3,062,277, which are assigned to the assignee of the present invention, usually some form of sound insulation lining is employed to block the passage of sound from one side of the partition to the other. Commonly, the sound lining is designed to have a relatively high sound transmission loss, and therefore consists of materials which will block the passage of sound through the partition. Such materials usually have a high capability of reducing the sound passing through the partition, thereby maintaining a relatively low level of sound on the receiving side (quiet side) and a relatively constant level of sound on the source side (loud side). On the source side, the level of sound is influenced by the source itself, and also by the sound originated by the source and which is reflected by the partition back into the source area.

Partition constructions which have a relatively high sound transmission loss properties also have surfaces which are low in sound absorption properties, and therefore reflect a considerable amount of sound energy back into the source room. Constructions of this type have certain disadvantages. To illustrate, in a school in which this type of folding closure is used to separate a classroom or auditorium from a study hall, a high percentage of the noise from the classroom will be reflected back into the classroom, and its noise level will not be substantially diminished. Also, if there is a constant background noise in the study hall, such as an air duct or outside noise passing through the window, the sound reflected back into the classroom by the partition may keep the noise level high enough to pass through the partition and overcome the background noise in the study hall, so that the sounds from the classroom will be audible in the study hall.

Moreover, when highly reflective partitions are used to divide auditoriums or large meeting rooms or ballrooms, they create unwanted echoes which are disturbing to the occupants of these areas. And if they are used in the rear of auditoriums, for example, they will reflect the sound back to the stage area and significantly detract from the clarity of the presentation or performance.

Partitions which have these disadvantages contribute little to an overall sound conditioning plan. They do not effectively control environmental noise in areas such as auditoriums, classrooms, meeting rooms, computer rooms, etc. because the critical acoustical requirement, noninterference with speech communication, is not effectively controlled. In short, the high percentage of noise reflected by such partitions causes needless distractions which should not occur with modern acoustical materials.

SUMMARY OF THE INVENTION

The present invention is directed to an improved partition which utilizes the acoustical power of sound absorption as well as the acoustical property of sound transmission loss. The invention provides a partition having a construction which effectively balances all of the properties which an ideal acoustical partition should have: high sound absorption, low sound reflection, and low sound transmission.

In accordance with the preferred embodiment of the invention, a folding partition has an acoustical construction which includes a flexible blanket of sound absorbent fiberglass sandwiched between an inner vinyl lining and an outer fabric. A plurality of spaced metal panels are attached to the inner side of the lining adjacent the skeletal frame of the partition. The outer fabric has a multiplicity of small perforations for admitting a portion of the sound emanating from the source into the fiberglass blanket, so that it may be absorbed or muffled, while the flexible lining and spaced panels serve to reduce the sound which passes through the fiberglass blanket and prevent it from passing through the closure. Ideally, the wall assemblies of the present invention absorb more sound than before, so that less sound is reflected.

The basic construction of the present invention may be advantageously altered to suit different acoustical requirements. For example, the metal panels may be used on one side of the closure, or both, depending upon the expected relative noise levels on each side. Similarly, the perforated fabric and sound absorbing blanket combination may be used on only one side of the closure, although it is preferred that they be used on both sides. The present invention enables the architect to achieve many different acoustical environments and make better use of space, simply by varying the constituents of the acoustical construction.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a perspective view of a folding partition, partly broken-away and partly in fragmentary section, showing the acoustical construction of the present invention mounted thereon:

FIG. 2 is an exploded view of the construction of the invention taken generally along line 2—2 of FIG. 1; and

FIG. 3 is an enlarged sectional view of the assembled parts shown in FIG. 2 and diagrammatically showing the treatment of sound waves by the construction.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1, a foldable closure or partition **10** is shown in fragmentary section and includes a skeletal frame **11** which extends between a stationary end post (not shown) and a movable end or lead post **12** and is adapted to move along a rail or track (not shown) by means of ball bearing trolley wheels **13**. The frame **11** includes a plurality of crisscrossing top hinge plates **14**, which may be constructed according to U.S. Pat. No. 3,133,589, assigned to the assignee of the present invention, and a corresponding plurality of crisscrossing bottom hinge plates (not shown) which are pivotally connected to the top hinge plates **14** by a plurality of vertical rods or pins **15** extending substantially the full height of the structure. The pins **15** may be constructed according to the disclosure of U.S. Pat. No. 3,062,277, also assigned to the assignee of the present invention. The skeletal frame **11** folds like an accordion at pivot pins **15**, and one of the acoustical assemblies **20** of the present invention is secured to each side of the frame **11** and is adapted to fold with it.

The basic construction of the acoustical assembly of the present invention, as shown in FIGS. **1–3**, includes a flexible blanket **22** of sound muffling or sound absorbent material, preferably loosely woven fiberglass or other material which deadens sound, and the flexible blanket **22** is sandwiched between a flexible inner web or lining **24** and a flexible outer web or cover **26**. The web **24** is preferably a strong sheet of vinyl lining material and the web **26** is preferably a vinyl-coated fabric, and both webs extend substantially the full height and width of the skeletal frame.

A plurality of vertically elongated metal sound deadening panels **28** are laminated and spaced in parallel relation on the inner side of the lining **24**, preferably by gluing or heat sealing, and extend continuously the height of the lining **24**. A spring is provided between the panels in the vicinity of the pins **15** for permitting the flexible components of the assembly to fold with the frame. The panels **28** are preferably **22**, **24** or **26** gauge steel and add mass to the structure for sound transmission loss and internal reflecting purposes.

As shown in FIGS. **1** and **2**, the hinge plates **14** are provided with a series of holes **30**. The metal panels **28** and the inner lining **24** are also provided with holes **32** and **34**, respectively, which are aligned with the holes **30** in the hinge plate **14**. This arrangement is identical for the bottom portion of the assembly. The holes **32** and **34** may be formed after the panels **28** are laminated on the lining **24**, if desired, and are adapted to receive steel fasteners **35** and **36** which secure the assembly to the hinge plates **14**.

In the preferred form of the present invention, the other fabric or cover 26 is formed with a multiplicity of small perforations 38 defining an open area of at least about 15 percent of the cover 26. The flexible blanket 22 is preferably about ½-inch thick and does not span the vertical length of the assembly but rather, as shown in FIG. 2, stops slightly short of the vertical extremities. This provides room at the top and bottom extremities of the assembly for sweep strips 40 which abut the vertical extremities of the blanket 22 and are essentially interposed between the inner lining 24 and the outer fabric 26.

Each sweep strip 40 seals off opposite sides of the room and includes a narrow strip of felt 42 sandwiched between a narrow vinyl strip 46 and a wide vinyl strip 48, and the three parts are sewn together along line 49. As shown in FIG. 2, the wide strip 48 has a lower end which may be inserted inwardly between the blanket 22 and the outer fabric 26. It also has an upper end which extends upwardly above the extremity of the outer fabric 26 and is intended to seal against the ceiling or floor.

A narrow strip of webbing 52 with a plurality of elongated slots 54 is sewn to the lower end of the vinyl strip 48 along a line 56. The webbing 52 is then sewn to the outer fabric 26 along a line 58.

In assembling the present invention, the metal panels 28 are laminated to the inner side of the lining 24 and the lining 24 is secured to the hinge plate 14 of the skeletal frame 11 by means of the fasteners 35. The blanket of fiberglass 22 is then spot glued centrally on the lining 24 to leave room on each end for the sweep strips 40. The outer fabric 26 with the sweep strips 40 attached through the webbing 52 is then placed over the blanket 22 so that the felt strips 42 will abut adjacent the ends of the blanket 22. The webbing 52 will accordingly lie over the upper and lower extremities of the blanket 22. The outer fabric 26 is then folded back at line 58, and the fasteners 36 are inserted through the slots 54 and the blanket 22, and are secured to the hinge plate 14 through the holes in the inner web and metal panels.

In the preferred form of the invention, an acoustical assembly 20 is secured to each side of the skeletal frame 11. The acoustical assemblies 20 will accordingly define a central airspace 59 (FIG. 3) within the frame 11 which isolates the acoustical assemblies from each other so that, aside from the hinge plates, there is no direct mechanical connection between them. This isolation of the respective sound reducing panels 28 on each assembly 20 contributes to the effective sound transmission loss of the entire closure.

The treatment of sound waves by the basic construction of the present invention is diagrammatically illustrated in FIG. 3, which shows the parts in FIG. 2 assembled in overlying relation adjacent the dead airspace 59. Sound waves which emanate from a sound source will strike the partition and will be separated into essentially three components—reflected sound, absorbed sound, and transmitted sound. Reflected sound is indicated by lines confined to the right of the partition, marked R; absorbed sound is indicated by lines confined within the partition, marked A; and transmitted sound is indicated by lines within the airspace 59, marked T.

To illustrate the effect of the acoustical partition 10, some sound waves, such as illustrated by the line 60, will strike the wall and a portion R will be reflected, and a portion T will have sufficient intensity to penetrate through the entire assembly and into the dead airspace 59. But a portion A which is essentially energy will be internally absorbed by the flexible blanket 22 between the vinyl lining 24 and the metal panel 28, and will lower the intensity of the reflected portion R as well as the intensity of the transmitted portion T. Other sound waves, such as the ones represented by lines 62 and 64, will pass through a perforation 38, be partially absorbed by the blanket 22, and have diminished portions reflected from the vinyl lining 24 and the metal panel 28 which may either pass back out through another perforation as a reflected portion R or be absorbed when it is internally reflected back into the blanket by the inner surface of the fabric 26. A small portion of these sound waves may be retransmitted from the back side of the metal panels into the dead airspace 59, depending upon their original intensity, Still other sound waves passing through a perforation, represented by line 66, will not have sufficient intensity to produce either a reflected portion or a transmitted portion, and will be completely absorbed in the blanket 22. The foregoing description is intended merely to illustrate the effect of the present construction in balancing the transmitted and reflected sound and maximizing the absorption of sound.

Sound waves are essentially compression waves which will work or move the individual fibers in the fiberglass blanket, and their energy and noise level are thereby dissipated in the form of heat and movement. Unlike the metal panels which reflect the sound, the fiberglass essentially averages the resonance of the sound by reducing peak wavelengths to a more inaudible form. Thus, the more fiberglass the sound waves are exposed to, the more inaudible they will become.

Accordingly, when a second acoustical assembly is used on the other side of the partition, it should be apparent that the sound transmitted through the first assembly, which has been substantially attenuated by the time it reaches the dead airspace 59, will be further reduced, if not completely muffled, by the second assembly. In order to pass through the partition, such an attenuated sound wave must then pass in the reverse direction through the second assembly. The second blanket of fiberglass will therefore absorb a substantial portion of the energy of the already deadened sound wave.

There is yet another dampening effect, inherent in the present construction, which further complements the internal reflecting and trapping effects of the metal panels and lining materials and the muffling effect of the fiberglass blanket. Since the inner lining 24 and the outer fabric 26 are flexible webs, they will absorb some of the sound energy in the form of heat and will convert it into mechanical energy by moving or vibrating. Although the metal panels are structurally stiff, they also vibrate to some extent when they absorb sound energy. These materials further serve to deaden the transmitted portion of the sound and to provide a more acoustically effective partition.

An assembly according to the basic construction of the present invention was installed on both sides of a foldable partition and the partition was tested according to the American Society of Testing Materials test procedure C423-66 to determine the sound absorption characteristics. According to this procedure, ratings are determined at six different frequencies from 125 c.p.s. through 4,000 c.p.s. The noise reduction coefficient (NRC) is the numerical average of the four middle frequencies from 200 c.p.s. through 2,000 c.p.s., and it is the accepted single number rating for an acoustical material. A good grade of acoustical ceiling tile wall has a NRC of approximately 0.70 to 0.75, while a smooth plaster wall will have a NRC of about 0.02 to 0.03. The foldable closure tested with the wall assemblies of the present invention was found to have NRC of approximately 0.60. Stated differently, of the noise contacting the wall assemblies and ranging in intensity between 200 c.p.s. and 2,000 c.p.s., an average of 60 percent was absorbed per square foot and an average of 40 percent was reflected per square foot.

From the drawings and the above description, it is apparent that the basic construction of the present invention may be varied to alter the absorption and transmission properties of the partition to suit different acoustical environments. For example, the outer fabric may be perforated on one side of the partition and not on the other. Or, the fiberglass blanket may be used on one side of the partition with or without the perforations, or not at all. In places where it is desired to have a movable wall with acoustical properties, such as in the rear of auditoriums and the like, it is preferred that the highly sound absorbent perforated cover and fiberglass combination be used on both sides of the partition. Such a partition substantially eliminates echoes and prevents unwanted sound from being reflected back to the stage. It provides properties akin to

acoustical title, but in the new and more useful form of a movable structure.

Similarly, the metal panels may be eliminated on one or both sides of the partition where it is desirable to increase absorption, and where transmission of sound through the partition is not altogether distracting. For example in open schools where transmission loss is relatively unimportant, such partitions can be used to form study areas and absorb a high percentage of sound. In this construction the sound will pass through the partition without being substantially reflected, and the acoustics in the area will be improved by the absorption of energy as the sound is transmitted through the partition.

While the form of apparatus herein described constitutes a preferred embodiment of the invention, it is to be understood that the invention is not limited to this precise form of apparatus, and that changes may be made therein without departing from the scope of the invention, which is defined in the appended claims.

What is claimed is:

1. In a foldable closure of the type having an accordionlike skeletal frame extending between vertical end posts or the like, an acoustical wall assembly adapted to be mounted on at least one side of said skeletal frame comprising, an outer web of flexible material, a flexible blanket of sound absorbing material adjacent the inner side of said outer web, means defining a multiplicity of perforations in said outer web for permitting said flexible blanket to absorb sound waves passing through the outer web, an inner web of flexible lining material adjacent the inner side of said flexible blanket, a plurality of sound deadening panels arranged in spaced relation along said skeletal frame between said frame and said inner web, and means for securing said assembly to said skeletal frame, said assembly providing a significant increase in the absorption of sound by said closure and a high degree of sound transmission loss properties of said closure.

2. In a foldable closure of the type having an accordionlike skeletal frame extending between vertical end posts or the like, an acoustical wall assembly adapted to be mounted on at least one side of said skeletal frame, comprising an inner web of flexible lining material, an outer web of flexible fabric material, a flexible blanket of sound absorbent material sandwiched between said inner and outer webs, a plurality of metal panels laminated in spaced relation along said skeletal frame on the side of said inner web facing said frame, means for securing said assembly to said frame, and means defining a multiplicity of small perforations in said outer web opposite said blanket for admitting sound waves into said blanket for absorption thereby to significantly increase the absorption of sound and the transmission loss properties of said closure.

3. A foldable closure comprising a skeletal frame, at least one acoustical wall assembly, means securing said assembly to at least one side of said frame, said wall assembly being particularly adapted to dissipate the energy and decrease the intensity of sound waves striking said closure, including means defining spaced-apart and inner and outer webs for converting a portion of the sound energy of said waves into mechanical vibration energy, means defining sound absorbent material between said webs for reducing the intensity of another portion of the sound energy of said waves to a more inaudible form, means in said outer web defining a multiplicity of perforations for admitting sound waves into said sound absorbent material and for reducing the number of sound waves reflected by said closure, and means defining a plurality of sound deadening rigid panels adjacent said inner web and positioned along said skeletal frame inwardly of said absorbent material for internally reflecting the sound waves passing through said perforations and said material back into said material and for cooperating with said webs to trap internally reflected waves within said assembly to attenuate further the intensity of said waves and provide a significant increase in the sound absorption and the sound transmission loss properties of said closure.

4. The foldable closure of claim 3 wherein one of said acoustical wall assemblies is secured to each side of said frame.

5. The closure of claim 3 in which said sound absorbent material comprises a blanket of fiberglass.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,628,626 Dated December 21, 1971

Inventor(s) Bennett W. Merrill

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Col. 1, line 56, "power" should be --property--.

Col. 4, line 6, "in" should be --by--.

Col. 6, line 17, delete "and" following --spaced apart--.

Signed and sealed this 29th day of August 1972.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents

PO-1050
(5/69)

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,628,626 Dated December 21, 1971

Inventor(s) Bennett W. Merrill

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

In the Title:

Cancel "QUIET WALL" and insert --ACOUSTICAL WALL FOR FOLDABLE CLOSURE--

Signed and sealed this 6th day of March 1973.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents