

[54] **LOUDSPEAKER ENCLOSURE**

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[51] Int. Cl. **G10k 13/00, H04r 1/28**

[58] Field of Search **181/31 B; 229/14 C**

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[57]

ABSTRACT

A loudspeaker enclosure comprises four discrete side wall units and an end wall unit each including a plurality of rectangular sheets of corrugated material arranged in a laminated stack with the corrugations of each sheet extending perpendicular to the corrugations of adjacent sheets, opposite ends of each side wall unit being constructed complementary to each other and the side wall units being assembled end-to-end with complementary ends glued and taped together to form a tubular wall structure rectangular in transverse cross-section defining an opening at one end thereof and being closed at the other end thereof by the end wall unit. The outer sheet of each side wall unit extends laterally beyond the other sheets thereof and is partially severed to form a flap which is folded back toward the other sheets and spaced therefrom to define a channel adjacent to the one end of the tubular wall structure for receiving a mounting frame therein. A loudspeaker mounting board with a loudspeaker mounted thereon is secured to the mounting frame and a grille cloth frame covered by a grille cloth is secured to the loudspeaker mounting board. Suitable strips of sealing and cushioning material are provided between the mounting frame and the mounting board.

13 Claims, 17 Drawing Figures

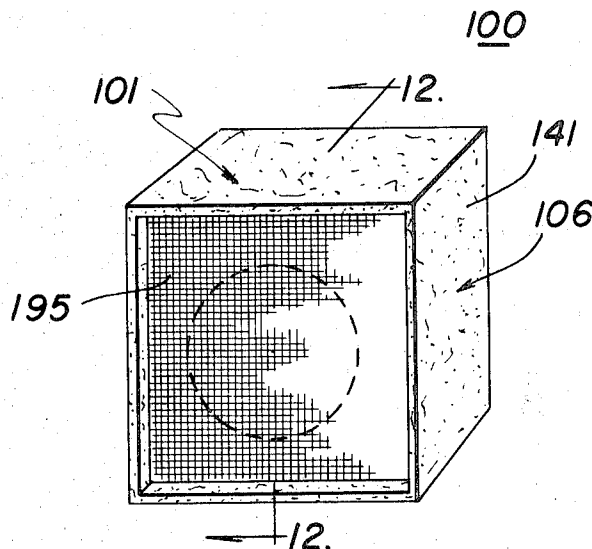


FIG. 1

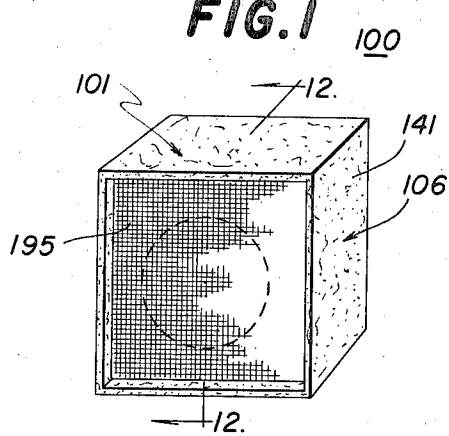


FIG. 2

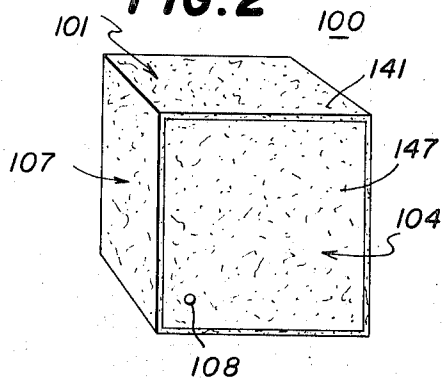


FIG. 5

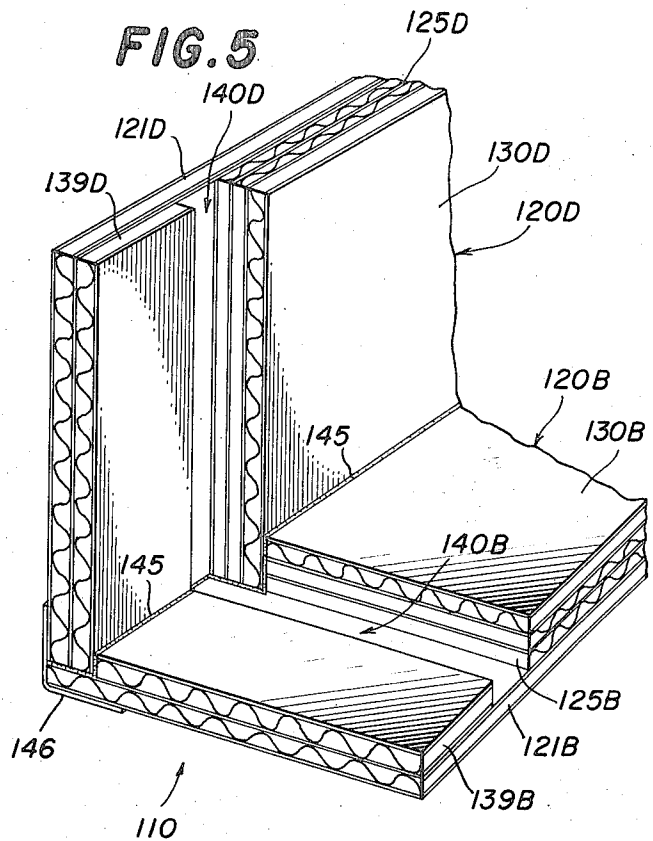


FIG. 4

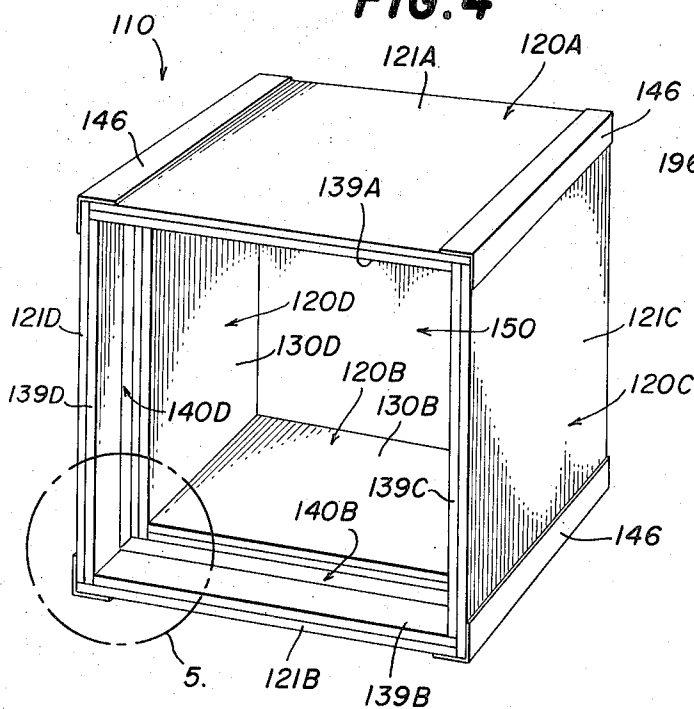
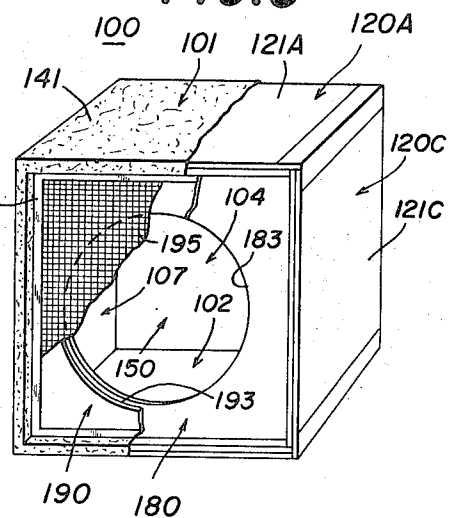


FIG. 3



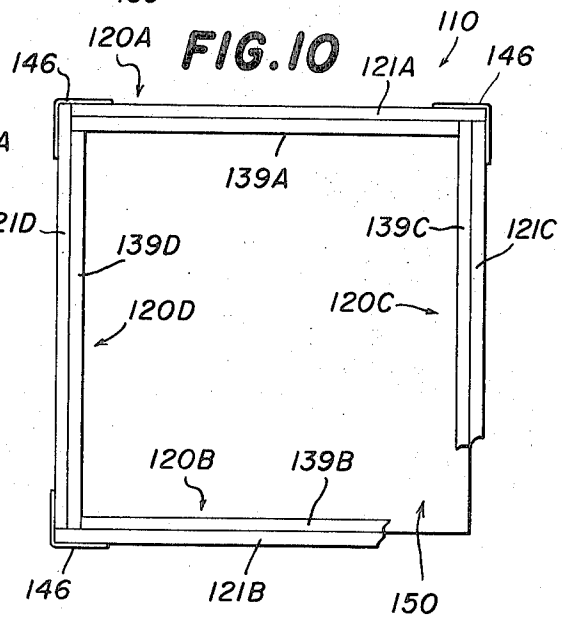
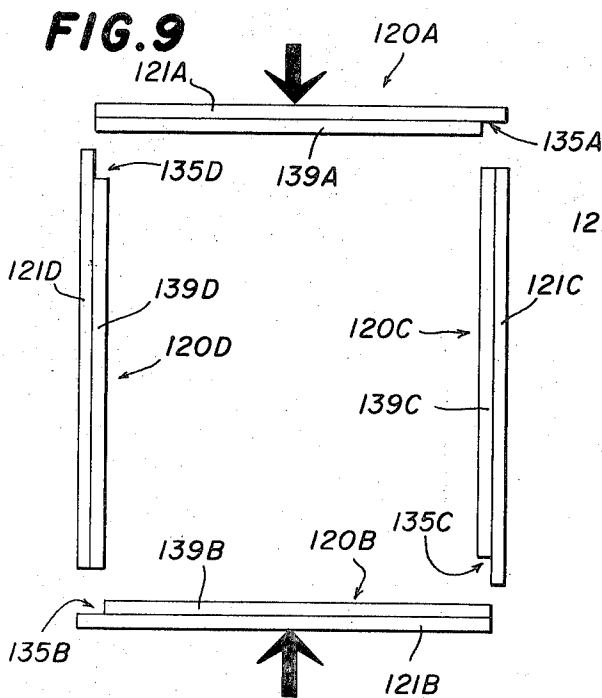
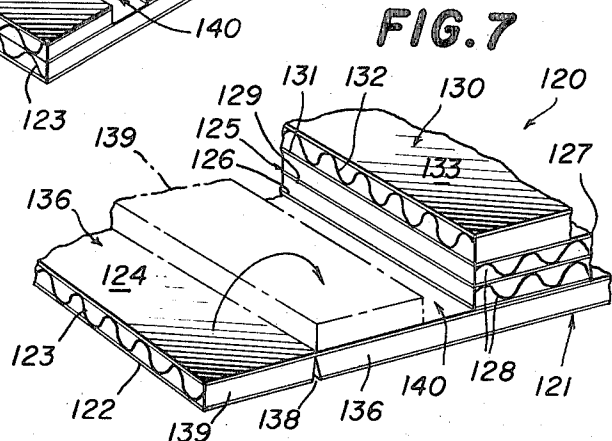
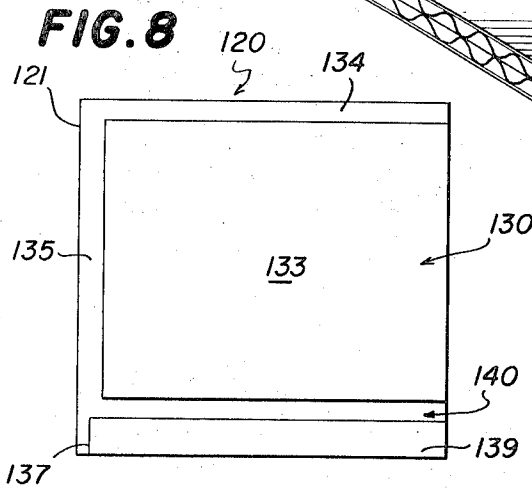
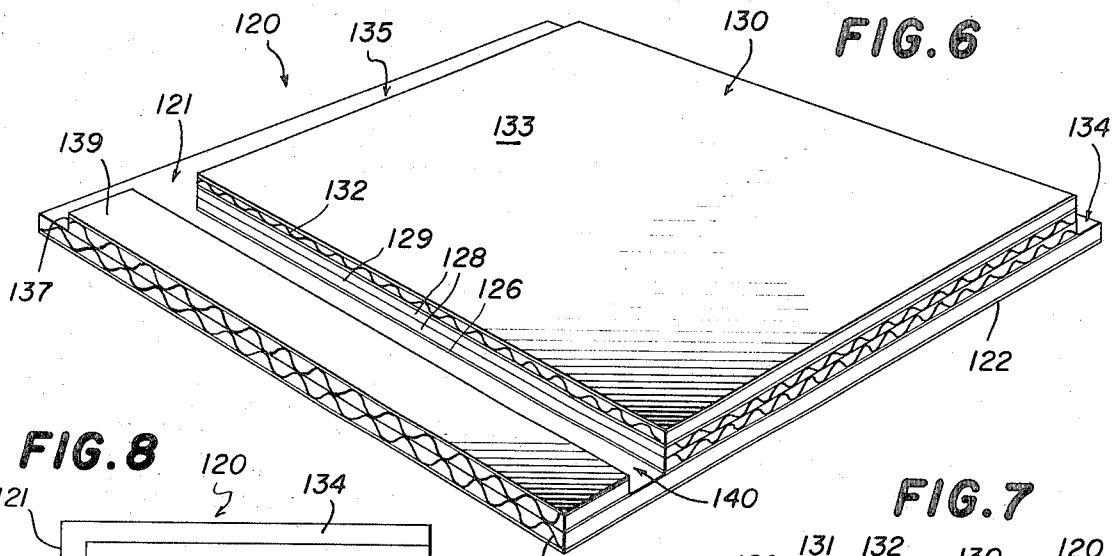


FIG. 11

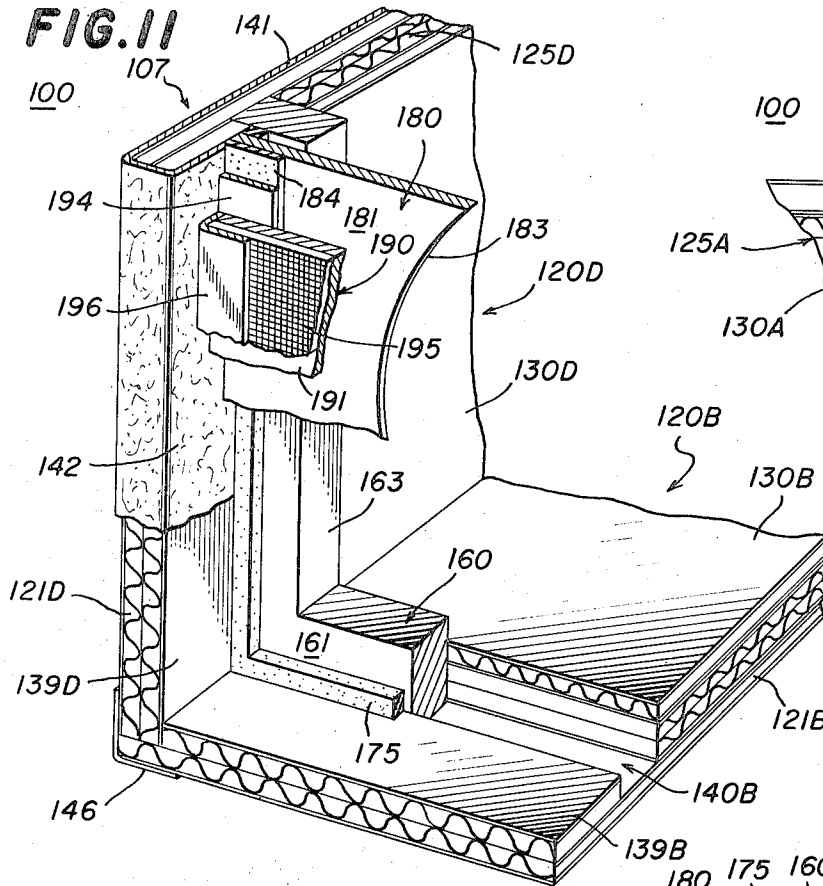


FIG. 14

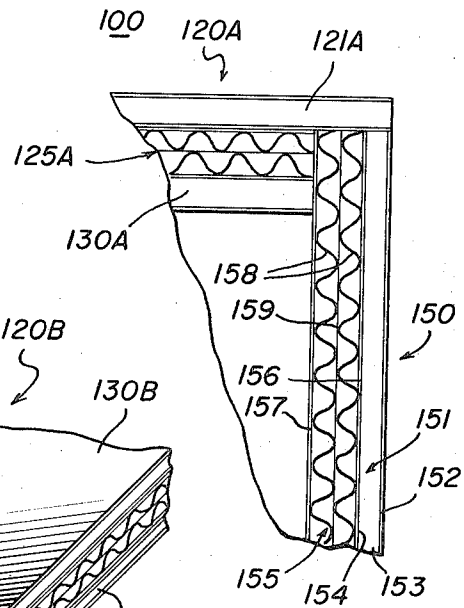


FIG. 13

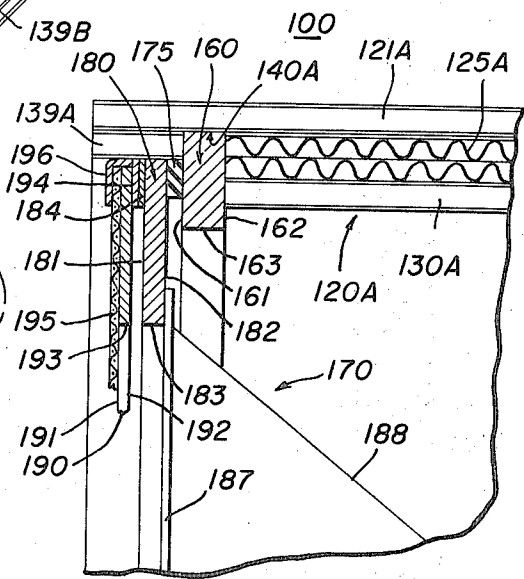


FIG. 12

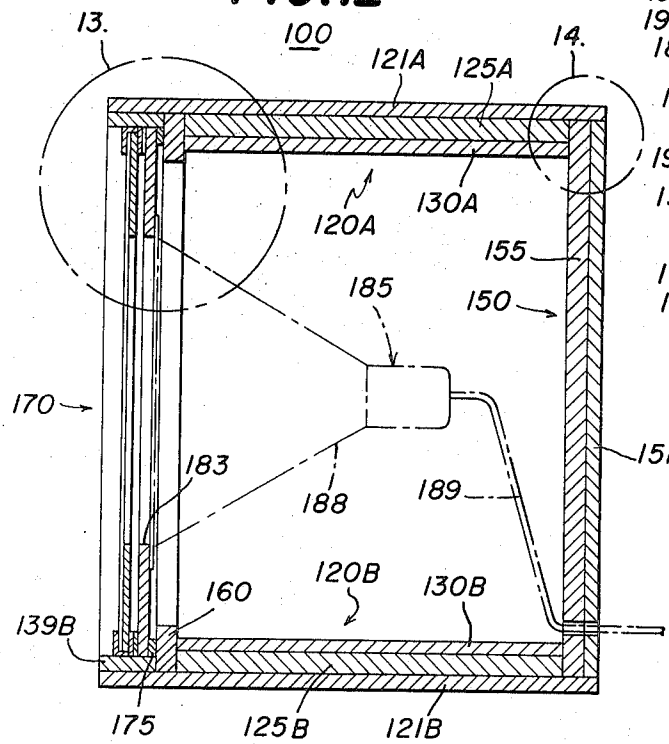


FIG. 15

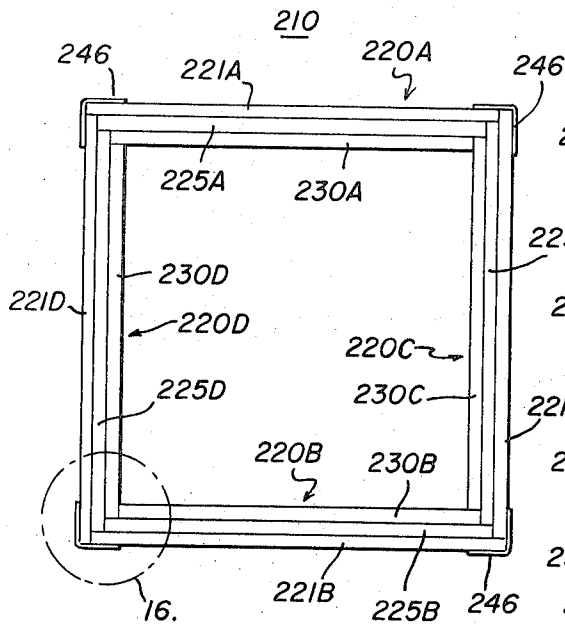


FIG. 16

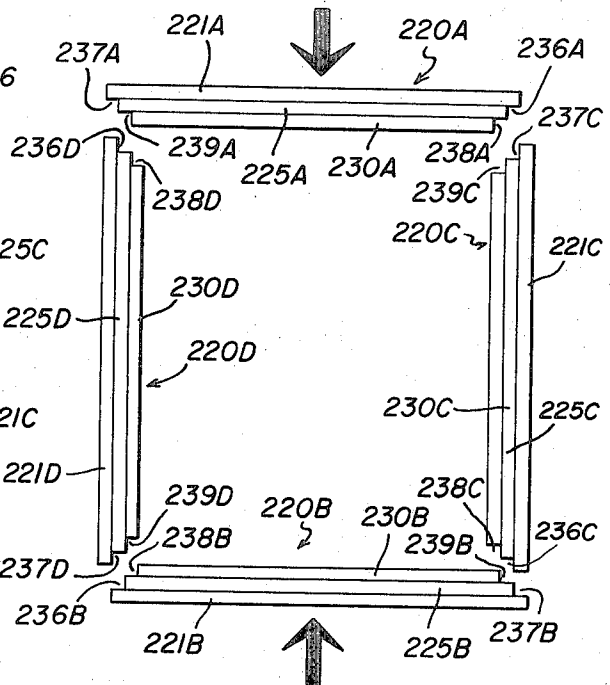
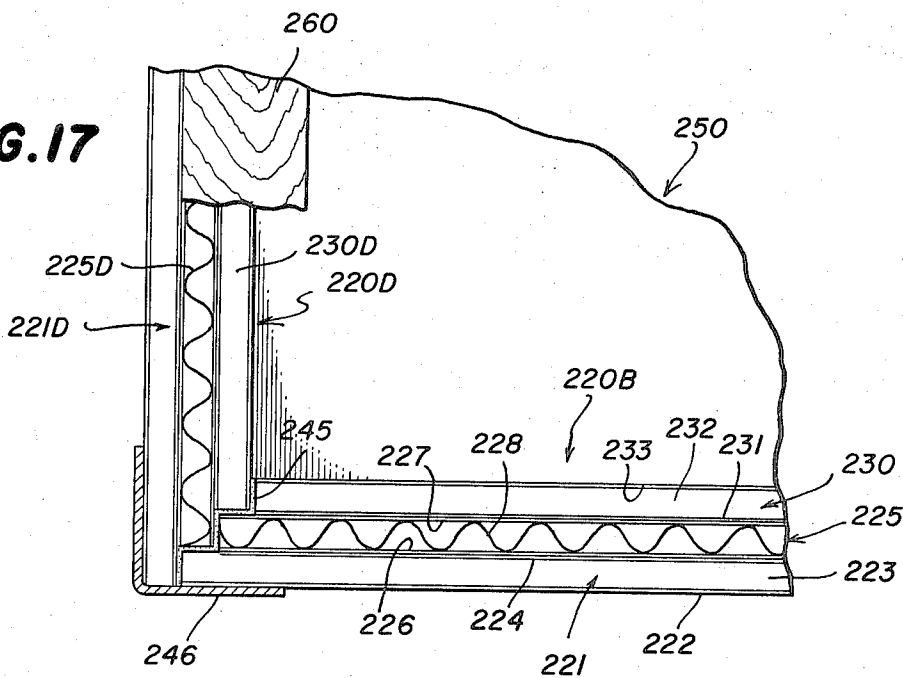


FIG. 17



LOUDSPEAKER ENCLOSURE

This application relates to a loudspeaker enclosure and the method of making the same. More particularly, this invention relates to a loudspeaker enclosure formed of sheets of corrugated material such as corrugated fiberboard.

It is a general object of the present invention to provide a loudspeaker enclosure constructed of a plurality of discrete wall units interconnected to form a closed housing for mounting a loudspeaker assembly therein.

It is another general object of the invention to provide a method of assembling such a loudspeaker enclosure from a plurality of sheets of corrugated material.

It is an important object of this invention to provide a loudspeaker enclosure comprising a plurality of discrete wall units interconnected to form a housing, the housing having an opening therein to facilitate the emission of sound waves therefrom, each of the wall units being formed of a plurality of sheets of corrugated material arranged in a laminated stack, the corrugations of each of the sheets of each said wall unit extending in a direction substantially perpendicular to the direction of the corrugations of adjacent sheets of the wall unit, predetermined ones of the wall units being disposed in use in continuous end-to-end engagement with each other to define the opening with the ends of each wall unit being respectively constructed and arranged complementary to the adjacent end of an adjacent wall unit and being secured thereto, whereby the perpendicular corrugations of adjacent sheets of the wall units cooperate to facilitate the suppression of the wall units of undesirable sound waves emitted from the housing.

In connection with the foregoing object, it is another object of this invention to provide a loudspeaker enclosure of the type set forth, which includes an end wall unit and a plurality of discrete side wall units interconnected to form a housing, the side wall units being disposed in continuous end-to-end engagement with each other to form a generally tubular side wall structure defining the opening at one end thereof, the end wall unit being disposed in use in engagement with the tubular side wall structure for closing the opposite end thereof, sheets of each side wall unit being constructed and arranged with the corresponding edges of the sheets being substantially coplanar at one end of the side wall units and with the edges of the inner sheets being recessed with respect to the corresponding edge of the outermost sheet a distance substantially equal to the thickness of the side wall unit and the opposite end thereof, the one end of each side wall unit being disposed in use snugly in the recess in the opposite end of the adjacent wall unit and secured thereto to form a tight rigid side wall structure.

It is another object of this invention to provide a loudspeaker enclosure of the type set forth, wherein the sheets of each of the side wall units is constructed and arranged with the edge of each inner sheet being recessed with respect to the corresponding edge of the next outermost sheet a distance substantially equal to the thickness of the inner sheet at one end of the side wall unit and with the edge of each inner sheet being recessed with respect to the corresponding edge of the next outermost sheet a distance substantially equal to

the thickness of the next outermost sheet at the opposite end of the side wall unit, each of the side wall units being disposed in use with the edges of the inner sheets at said other end of the side wall unit being respectively received in the recesses at the one end of an adjacent side wall unit and secured thereto to form a tight rigid side wall structure.

Still another object of this invention is to provide a loudspeaker enclosure of the type set forth, wherein each of the predetermined ones of the side wall units has a groove formed in the inner surface thereof extending from one end of the wall unit to the opposite end thereof, said grooves being disposed in use adjacent to the opening and in alignment with one another and cooperating to form a continuous channel extending entirely around the wall structure, and a rigid mounting frame snugly received in the channel and extending the entire length thereof for facilitating the mounting of an associated loudspeaker assembly in the housing.

Yet another object of the present invention is to provide a loudspeaker enclosure of the type set forth, wherein the outermost sheet of each of the predetermined ones of the wall units includes an inner facing layer and an outer facing layer and a corrugated layer disposed therebetween and extending beyond the inner sheets of the wall units in the direction of the openings, the outermost sheet being partially severed along the incision extending through only the outer facing layer and the corrugated layer adjacent to the opening and parallel to the adjacent edge of the outermost sheet to form a flap, the flap being disposed in use in a folded configuration with the portion of the inner facing layer thereon disposed flat against a portion of the inner facing layer on the other side of the incision, the flap in the folded configuration thereof being spaced a predetermined distance from the adjacent edges of the inner sheets substantially parallel thereto and cooperating therewith to form the elongated groove.

It is another object of this invention to provide a sound reproduction system corresponding a loudspeaker enclosure of the type set forth and further including a loudspeaker mounting board disposed in the opening within the wall structure and secured to the outer surface of the mounting frame and having an aperture therein, the loudspeaker having a cone-shaped diaphragm secured to the inner surface of the loudspeaker mounting board and extending inwardly therefrom in axial alignment with the aperture therein for transmitting therethrough to the exterior of the housing sound waves generated at the front surface of the diaphragm and for transmitting into the housing sound waves generated to the rear surface of the diaphragm.

In connection with the foregoing object, it is another object of this invention to provide a sound reproduction system of the type set forth, which further includes a grille cloth frame disposed in the opening within the wall structure and connected to the outer surface of the loudspeaker mounting board and having an aperture therein substantially congruent with the aperture in the loudspeaker mounting board, and a grille cloth secured to the grille cloth frame and covering the outer surface thereof for concealing the loudspeaker and the loudspeaker mounting board.

Yet another object of the present invention is to provide a method of making a loudspeaker enclosure com-

prising the steps of providing a plurality of discrete wall units each formed of a plurality of sheets of corrugated material arranged in a laminated stack with the corrugations of each of the sheets of each wall unit extending in a direction substantially perpendicular to the direction of the corrugations of adjacent sheets of the wall unit and with the opposite ends of each wall unit constructed and arranged complementary to each other, applying adhesive material to opposite ends of each of the wall units, and assembling the wall units in continuous end-to-end engagement with each other with each of the opposite ends of each wall unit adhesively secured to a complementary end of an adjacent wall unit to form a rigid encompassing wall structure defining an opening to facilitate the emission of sound waves therefrom, the perpendicular corrugations of adjacent sheets of the wall units cooperating to facilitate the suppression by the wall units of undesirable sound waves emitted from the wall structure.

In connection with the foregoing object, it is another object of this invention to provide a method of the type set forth including the steps of providing a plurality of different sized generally rectangular sheets of corrugated material each including two facing layers with a corrugated layer therebetween, applying adhesive material to one surface of each of the sheets, arranging the sheets in a plurality of stacks each including a relatively large bottom sheet and at least one relatively small sheet on top of the bottom sheet with corresponding edges of the sheets substantially parallel to form a plurality of discrete laminated wall units each having two opposite side edges and two opposite end edges, the bottom sheet of each wall unit extending laterally well beyond the corresponding edges of the top sheets along one side of the wall unit and the opposite ends of the wall unit being constructed and arranged complementary to each other, forming an incision through only the bottom facing layer and the corrugated layer of the bottom sheet of each wall unit adjacent to the one side edge thereof and extending substantially parallel thereto the entire length thereof to form a flap, applying adhesive material to the portion of the inner facing layer covering the flap, folding the flap along the incision through 180° to a position flat against the portion of the upper facing layer on the other side of the incision so that the free edge of the flap is spaced a predetermined distance from the adjacent edges of said upper sheets for cooperation therewith to form a groove extending therealong, applying adhesive material to the opposite ends of each of the wall units, and assembling the wall units in continuous end-to-end engagement with each other with each end of each wall unit adhesively secured to a complementary end of an adjacent wall unit to form a rigid encompassing wall structure defining an opening to facilitate the emission of sound waves therefrom, the grooves of the assembled wall units being aligned with one another and cooperating to define a continuous channel extending entirely around the inner surface of the wall structure, the perpendicular corrugations of adjacent sheets of the wall units cooperating to facilitate the suppression by the wall units of undesirable sound waves emitted from the wall structure.

In connection with the foregoing object, it is another object of this invention to provide a method of the type set forth, which further includes the steps of providing a rigid mounting frame having a plurality of sides equal

in number to the wall units and each shaped complementary to the groove in a corresponding one of the wall units, and assembling the wall units in continuous end-to-end engagement with each other about the mounting frame with each wall mounting frame being snugly received in a corresponding one of the grooves, the grooves of the assembled wall units being aligned with one another and cooperating to define a continuous channel accommodating the mounting frame therein with each end of the wall unit secured to a corresponding end of an adjacent wall unit to form a rigid encompassing wall structure defining an opening adjacent to the mounting frame to facilitate the emission of sound waves from the wall structure.

In connection with the foregoing object, yet another object of this invention is to provide a method of the type set forth, which further includes the steps of mounting on the mounting frame a loudspeaker assembly including a loudspeaker mounting board having an aperture therein and a loudspeaker mounted thereon in alignment with the aperture, the mounting board being connected to the outer surface of the mounting frame with the loudspeaker disclosed within the wall structure in alignment with the opening for transmitting sound waves therethrough to the exterior of the wall structure.

Further features of the invention pertain to the particular arrangement of the parts of the loudspeaker enclosure and the steps of the method of making the same whereby the above-outlined and additional operating features thereof are attained.

The invention, both as to its organization and method of operation, together with further objects and advantages thereof, will best be understood by reference to the following specification taken in connection with the accompanying drawings, in which:

FIG. 1 is a front perspective view of a sound reproduction system and loudspeaker enclosure constructed in accordance with and embodying the features of the present invention;

FIG. 2 is a rear perspective view of the sound reproduction system and loudspeaker enclosure of FIG. 1;

FIG. 3 is an enlarged perspective view of the loudspeaker enclosure of FIG. 1, with portions thereof broken away to more clearly show the interior structure of the enclosure;

FIG. 4 is a further enlarged front perspective view of the interior housing or wall structure of the loudspeaker enclosure of FIG. 1 with the loudspeaker mounting fixtures removed therefrom;

FIG. 5 is a still further enlarged front perspective fragmentary view of the lower left-hand corner of the housing as illustrated in FIG. 4;

FIG. 6 is a front perspective view of one of the laminated side wall units forming the wall structure of FIG. 4;

FIG. 7 is an enlarged fragmentary front perspective view of the wall unit of FIG. 6, illustrating the manner of forming the mounting frame channel therein;

FIG. 8 is a reduced top plan view of the wall unit of FIG. 6;

FIG. 9 is a front elevational view illustrating the manner in which the side wall units are assembled to form the wall structure of FIG. 4;

FIG. 10 is a front elevational view of the wall structure of FIG. 4 after the wall units have been assembled in the manner illustrated in FIG. 9, one corner of the

wall structure being broken away to more clearly show the rear wall units;

FIG. 11 is an enlarged fragmentary front perspective view in partial section of the lower left-hand corner of the loudspeaker enclosure of FIG. 1, with portions of the loudspeaker removed and portions of the loudspeaker mounting assembly broken away to more clearly show the details thereof;

FIG. 12 is an enlarged view in vertical section taken along the line 12-12 in FIG. 1;

FIG. 13 is a further enlarged fragmentary view in vertical section of the upper left-hand corner of the sound reproduction system as illustrated in FIG. 12;

FIG. 14 is a further enlarged fragmentary view in vertical section of the upper right-hand corner of the sound reproduction system, as illustrated in FIG. 12;

FIG. 15 is a front elevational view, similar to FIG. 10, of an assembled wall structure according to a second embodiment of the present invention;

FIG. 16 is a view similar to FIG. 9, illustrating the manner of assembling the wall units of the wall structure of FIG. 15; and

FIG. 17 is an enlarged fragmentary view of the lower left-hand corner of the wall structure of FIG. 15, illustrating a portion of the loudspeaker mounting frame.

Referring now in particular to FIGS. 1 through 3 of the drawings, there is illustrated a sound reproduction system including a loudspeaker enclosure, generally designated by the numeral 100, constructed in accordance with and embodying the features of the present invention. The loudspeaker enclosure 100 is preferably in the form of a rectangular parallelepiped, the illustrated embodiment being substantially cubical in shape and including a top wall 101, a bottom wall 102, a rear wall 104, and a pair of opposed side walls 106 and 107. Formed in the rear wall 104 is a smaller circular opening 108 for accommodating a jack coupling fixture for connecting the loudspeaker to an associated source of signal power. Each of the top and bottom and side walls 101, 102, 106 and 107 comprises a wall unit, generally designated by the numeral 120, and best illustrated in FIG. 6, there wall units being interconnected to form a generally tubular wall structure housing, generally designated by the numeral 110, and best shown in FIG. 4 and being substantially rectangular in transverse cross-section. Preferably, the outer surfaces of the wall structure 110 are covered by a suitable decorative facing sheet 141, a similar decorative facing sheet 147 also covering the outer surface of the rear wall 104.

Referring now also to FIGS. 4 through 7 of the drawings, the tubular wall structure of housing 110 will be described in detail. In the embodiment illustrated, the tubular wall structure 110 comprises four identically constructed wall units 120, the top and bottom and right and left-hand side ones of the wall units, as viewed in FIG. 4, being respectively designated by postscripts A, B, C, and D. It will, of course, be appreciated that the wall structure 110 need not have the substantially square transverse cross-section illustrated and that, therefore, the wall units 120 need not all be identical in size and shape. But since the wall units in the illustrated embodiment are all identically constructed, only a typical one of the wall units 120, as illustrated in FIG. 6, will be described in detail.

The wall unit 120 comprises a plurality of flat rectangular sheets of corrugated material, preferably corrugated fiberboard, arranged in a stack. While any num-

ber of sheets of corrugated material may be utilized, in the preferred embodiment three such sheets are used, including a relatively large outer sheet 121, an intermediate sheet 125, and an inner sheet 130. The intermediate and inner sheets 125 and 130 are identical in shape and size and are substantially smaller than the outer sheet 121. Each of the inner and outer sheets 121 and 130 is constructed of single-wall corrugated fiberboard, while the intermediate sheet 125 is preferably of double-walled corrugated fiberboard.

More particularly, the outer sheet 121 includes an outer facing layer 122 and an inner facing layer 124 having a corrugated layer 123 sandwiched therebetween. In like manner, the inner sheet 130 has outer facing layer 131 and an inner facing layer 133 with a corrugated layer 132 sandwiched therebetween. The intermediate sheet 125 includes an outer facing layer 126 and an inner facing layer 127 and an intermediate or middle facing layer 129, with two corrugated layers 128 respectively sandwiched between the outer and middle layers 126 and 129 and between the inner and middle layers 127 and 129. The outer sheet 121 is provided with a small rectangular notch 137 cut in what will ultimately be the front edge thereof at one end thereof.

In constructing the wall unit 120 from the corrugated sheets 121, 125, and 130, a suitable adhesive is first applied to two selected surfaces of the sheets as, for example, by applying adhesive to both sides of the intermediate sheet 125. The sheet 125 is then placed on top of the outer sheet 121 with the corrugations of the intermediate sheet 125 extending in directions substantially perpendicular to the directions of the corrugations of the outer sheet 121, and with one end edge of the intermediate sheet 125 aligned substantially flush with a corresponding end edge of the outer sheet 121 opposite from the notch 137, the other edges of the intermediate sheet 125 being respectively set back from the corresponding edges of the outer sheet 121 to form a rear recess or apron 134, an end recess or apron 135 and a front recess or apron 136. The inner sheet 130 is then placed on top of the intermediate sheet 125 substantially congruent therewith, and with the corrugations of the inner sheet 130 extending in directions substantially normal to the direction of the corrugations of the intermediate sheet 125 and parallel to the corrugations of the outer sheet 121. With the sheets 121, 125 and 130 thus adhesively secured together, the sheets may be compressed together, as by a suitable platen press, to insure a firm bond between adjacent sheets and produce a rigid laminated structure.

An incision 138 is made in the outer surface of the outer sheet 121, the incision 138 extending from the base of the notch 137 to the opposite end of the outer sheet 121 substantially parallel to the front edge thereof to a depth sufficient to sever the outer facing layer 122 and the corrugated layer 123 but not the inner facing layer 124. There is thereby formed a rectangular flap 139 which may be folded back through 180° along the line of the incision 138, as indicated by the arrow in FIG. 7. A suitable adhesive such as glue is applied to the portion of the inner facing layer 124 of the outer sheet 121 which covers the flap 139, after which the flap 139 is folded back through 180° to a position indicated in broken lines in FIG. 7, lying flat against and adhesively secured to the inner facing layer 124 of the outer sheet 121 on the other side of the line

of the incision 138 to form a double thickness of corrugation along the front end of the wall unit 120. The flap 139 is of such a width that the free end thereof in the folded-back condition thereof indicated in FIG. 7 is spaced a predetermined distance from the front edges of the intermediate and inner sheets 125 and 130 for cooperation therewith to define a channel or groove 140 therebetween.

As can best be seen in FIG. 8, the end of the flap 139 at the notch 137 is spaced inwardly from the adjacent end edge of the outer sheet 121 a predetermined distance less than the width of the end recess or apron 135. More particularly, that end of the flap 139 is spaced from the adjacent edge of the outer sheet 121 a distance substantially equal to the combined thicknesses of the sheet 121 and the flap 139, i.e., twice the thickness of the sheet 121. The end recess or apron 135 has a width substantially equal to the combined thicknesses of the sheets 121, 125 and 130. The rear recess or apron 134 has a width substantially equal to the thickness of the rear wall 104, to be described in greater detail hereinafter, and the channel or groove 140 has a width substantially equal to the thickness of a rectangular loudspeaker mounting frame, generally designated by the numeral 160, and best illustrated in FIG. 11. The frame 160 is preferably made of wood or other solid material and has a rectangular shape complementary to that of the wall structure 110. More particularly, the frame 160 has a front surface 161, a rear surface 162 and an inner surface 163 which defines a rectangular opening.

Referring now to FIGS. 9 and 10 of the drawing, the assembly of the wall units 120 to form the wall structure 110 will be described. As indicated in FIG. 9, the wall units 120A through 120D are arranged in end-to-end relationship with the flush end of one wall unit being positioned adjacent to the recessed end of the adjacent wall unit. Preferably, the wall units 120 will be erected around the loudspeaker mounting frame 160. More particularly, the frame 160 may be inserted in the groove 140 of a selected one of the wall units 120, such as the bottom wall unit 120B, the frame 160 being so dimensioned as to snugly fit into the groove 140B with one end thereof flush against the flush end of the wall unit 120B and with the other end thereof spaced from the edge of the outer sheet 121B at the recessed end of the wall unit 120B by a distance substantially equal to the thickness of the outer sheet 121B. Next, a coating 145 of suitable adhesive such as glue is applied to the ends of each of the wall units 120A through 120D, this adhesive coating best being illustrated in FIG. 5. More particularly, the adhesive coating covers the flush ends of each of the wall units and also covers the end recess or apron 135 and the adjacent end edges of the intermediate and inner sheets 125 and 130 of each of the wall units.

Then the side wall units 121C and 121D are moved into position at the opposite ends of the bottom wall unit 121B, with the opposite sides of the mounting frame 160 being respectively received in the grooves or channels 140C and 140D, and with the flush end of the bottom wall unit 121B mating with the recessed end of the side wall unit 121C and with the flush end of the side wall unit 121D mating with the recessed end of the bottom wall unit 121B. In particular, it will be noted that the flush end of the flap 139B and underlying portion of the outer sheet 121B fit into the recess adjacent

to the notch 137C, while the flush end of the wall unit 120D rearwardly of the channel 140D fits into the recess 135C; and in like manner the flush end of the side wall unit 120D mates with the recesses 137B and 135B in the bottom wall unit 120B. Then, the top wall unit 120A is lowered into position, with the top part of the frame 160 being received snugly in the notch 140A and with the flush end of the wall unit 120A mating with the recessed end of the side wall unit 120B, while the flush end of the side wall unit 121C mates with the recessed end of the top wall unit 120A. There is thereby formed an adhesively secured-together rigid wall structure 110 which surrounds and snugly holds in place the loudspeaker mounting frame 160. If desired, the frame 160 may also be adhesively secured in the grooves or channels 140 to provide a more secure bond between the frame 160 and the wall units 120C. In order to further secure the wall units 120 together and to protect the junctures therebetween, strips of tape 146 are preferably adhesively applied to the outer surfaces of each of the corners of the wall structure 110 from the front to the rear edges thereof, as indicated in FIG. 4.

The decorative facing sheet 141 may now be adhesively applied to the outer surfaces of the wall structure 110, the facing sheet 141 preferably being wrapped entirely around the wall structure 141 and seamed along the bottom wall unit 120B. The decorative facing sheet 141 is preferably flush with the rear end of the wall structure 110 but is wrapped around the front edges thereof as at 142 (FIG. 11) to completely cover the front edges and the exposed surfaces of the flaps 139.

Referring now also to FIGS. 12 through 14 of the drawings, the rear wall 104 includes a rear wall unit, generally designated by the numeral 150, and comprising a plurality of sheets of corrugated material, preferably corrugated fiberboard. More particularly, the rear wall unit 150 includes an outer sheet 151 and an inner sheet 155, the sheets 151 and 155 being of identical rectangular shape and size. Preferably, the outer sheet 151 is of single-wall construction, including an outer facing layer 152 and an inner facing layer 154 having a corrugated layer 153 sandwiched therebetween. The inner sheet 155 is preferably of double-wall construction, including an outer facing layer 156, an inner facing layer 157, and an intermediate spacing layer 159, and having two corrugated layers 158 respectively sandwiched between the outer and intermediate layers 156 and 159 and between the inner and intermediate layers 157 and 159.

The rear wall unit 150 is assembled in a manner similar to that described above with respect to the side wall units 120. More particularly, a layer of suitable adhesive is applied to the surface of the outer sheet 151, and the inner sheet 155 is then positioned on the outer sheet 155 and adhesively secured thereto substantially congruent therewith, with the corrugations of the inner sheet 155 extending in directions substantially perpendicular to the direction of the corrugations of the outer sheet 151. The sheets 151 and 155 are each provided with a small aperture therein, which apertures are substantially congruent when the rear wall unit 150 is assembled for accommodating the jack coupler. Preferably, the jack coupler is provided with an attachment flange adapted to be laid flat and sandwiched between the sheets 151 and 155 with the coupler projecting through the apertures in the sheets 151 and 155. The

inner and outer sheets 151 and 155 may then be compressed together to form a rigid laminated wall unit, after which the decorative facing sheet 147 is adhesively applied to the outer facing layer 152 of the outer sheet 151.

The rear wall unit 150 is then assembled with the wall structure 110, the rear wall unit 150 being dimensioned to snugly fit in the combined rear recesses 134 of the wall structure 110, as illustrated in FIG. 14. Preferably, a coating of suitable adhesive is first applied to the edges of the rear wall unit 150 and to the surfaces of the wall structure 110 at the rear recesses 134 so as to securely hold the rear wall unit 150 in its assembled position.

The loudspeaker enclosure 100 is now ready to have assembled therein a loudspeaker assembly, generally designated by the numeral 170, including a baffle board 180 having a loudspeaker 185 mounted thereon and a grille frame 190 for mounting a grille cloth 195 thereon. A strip 175 of sealing and cushioning material such as a pressure-sensitive plastic foam is applied to the front surface 161 of the loudspeaker mounting frame 160 around the entire periphery thereof. More particularly, the sealing strip 175 preferably has a width of about $\frac{1}{4}$ inch and a thickness of about $\frac{1}{8}$ inch and is applied at the juncture between the front surface 161 of the frame 160 and the flaps 139A through 139D to seal this juncture and provide a cushion for the baffle board 180.

The baffle board 180 is rectangular in shape and dimensioned to fit snugly within the recess defined by the folded-back flaps 139A through 139D, the baffle board 180 preferably being formed of chip board or composition board or other suitable solid material and having a front surface 181 and a rear surface 182 and a generally circular opening 183 formed therein centrally thereof. Secured to the rear surface of the baffle board 180 is a loudspeaker 185, which may be of any desired type, but is preferably of the cone-type, the loudspeaker 185 including a cone-shaped diaphragm 188 having mounting flanges 187 at the front end thereof for fixedly securing the loudspeaker 185 to the rear surface 182 of the baffle board by any suitable means. The cone 188 is preferably shaped and dimensioned to conform to and substantially surround the circular opening 183 in the baffle board 180, as illustrated in FIG. 12.

The loudspeaker 185 also includes a connecting cable 189 for connection to the jack in the rear wall of the loudspeaker enclosure. In assembling the loudspeaker in the loudspeaker enclosure, the cable 189 is first connected to the jack and then the baffle board 180 is mounted in position against the sealing strip 175 and is preferably adhesively secured thereto, the strip 175 serving to cushion the baffle board 180. Adhesively secured to the outer surface 181 of the baffle board 180 is a mounting strip 184 of suitable material such as velcro, the strip 184 extending around the entire periphery of the baffle board 180.

The grille frame 190 is formed of any suitable solid material such as wood, plastic, or the like, and is substantially identical in shape with the baffle board 180, the grille frame 190 having a front surface 191, a rear surface 192, and a circular opening 193 formed centrally therein. The grille frame 190 is adapted to be snugly received in the recess defined by the flaps 139 of the wall structure 110, with the opening 193 posi-

tioned substantially congruent with the opening 183 in the baffle board 180. Adhesively secured to the rear surface 192 of the grille frame 190 and extending around the entire periphery thereof is a mounting strip 194 of suitable strip such as velcro for cooperation with the strip 184 on the baffle board 180 for mounting the grille frame 190 in position in the loudspeaker enclosure 100.

A grille cloth 195 is secured by suitable means such as glue or staples to the front surface 191 of the grille frame 190 for completely covering same. A decorative trim or molding strip 196 of suitable material such as metal, plastic or the like is secured to the outer surface of the grille cloth 195 around the entire periphery thereof and is wrapped around the adjacent edges of the grille frame 190, as is best seen in FIG. 11. It will be appreciated that in use the grille frame 190 with the grille cloth 195 attached thereto may be removably attached to the baffle board 180 by means of the velcro strips 184 and 194 for completely covering and concealing the baffle board 180 and the loudspeaker 185.

As is more extensively set forth in the co-pending U. S. application Ser. No. 222,263, of Scott F. Everitt, entitled Sound Reproduction System and filed on Jan. 31, 1972 now U.S. Pat. No. 3,757,889 and assigned to the assignee of this invention, the cross-corrugations of the side wall units 120 and of the rear wall unit 150 cooperate to effect suppression of undesirable sound waves emitted from the loudspeaker enclosure 110. Thus, there is provided a simple and economical loudspeaker enclosure which affords the desirable acoustical properties much more complex and expensive enclosures.

Referring now to FIGS. 15 through 17 of the drawings, there is illustrated an alternative embodiment, generally designated by the numeral 210, of the wall structure of the present invention. The wall structure 210 comprises four identically constructed side wall units 220, the top, bottom and opposite side wall units being respectively designated by the postscripts A, B, C, and D. Since the wall units 220A through 220D are identically constructed, only one will be described in detail, it being understood that the same construction applied to the other wall units. However, it will be appreciated that the loudspeaker enclosure may be provided in other shapes and sizes such that the wall units 220 need not be of identical shapes and sizes.

Referring now in particular to the bottom wall unit 220B in FIG. 17, each of the wall units 220 comprises a plurality of sheets of corrugated material, preferably corrugated fiberboard arranged in a stack. In the preferred embodiment illustrated, three such sheets have been provided, namely, an outer sheet 221, an intermediate sheet 225, and an inner sheet 230, each of these sheets being of single-wall construction and generally rectangular in shape, with the sheets being progressively smaller in size from the outer sheet 221 to the inner sheet 230.

More particularly, the outer sheet 221 includes an outer facing layer 222, an inner facing layer 224 with a corrugated layer 223 sandwiched therebetween; the intermediate sheet 225 includes an outer facing layer 226 and an inner facing layer 227 with a corrugated layer 228 sandwiched therebetween; and the inner sheet 230 includes an outer facing layer 231 and an inner facing layer 233 with a corrugated layer 232 sandwiched therebetween. In assembling the sheets

221, 225 and 230 to form the wall unit 220, a suitable adhesive such as glue is applied to selected surfaces of the sheets, for example, to both sides of the intermediate sheet 225. Then the intermediate sheet 225 is placed upon the outer sheet 223 in adhesive engagement therewith and with the corrugations of the intermediate sheet 225 extending in directions substantially perpendicular to the directions of the corrugations of the outer sheet 221.

Intermediate sheet 225 is centered with respect to the opposite ends of the outer sheet 221, with the end edges of the intermediate sheet 225 respectively cooperating with the adjacent ends of the outer sheet 221 to form recesses or aprons 236 and 237 at the opposite ends thereof, the recess 236 having a width substantially equal to the thickness of the intermediate sheet 225 and the recess 237 having a width substantially equal to the thickness of the outer sheet 221. Further, it will be appreciated that the intermediate sheet 225 is set back from the front and rear edges of the outer sheet 221 to form front and rear recesses or aprons (not shown) similar to the recesses 134 and 136 in the embodiment of FIG. 6.

Next, the inner sheet 230 is positioned on the intermediate sheet 225 in adhesive engagement therewith, with the corrugations of the inner sheet 230 extending in directions substantially perpendicular to the directions of the corrugations of the intermediate sheet 225, i.e., substantially parallel to the corrugations of the outer sheet 221. The inner sheet 230 is preferably positioned with the front and rear edges thereof respectively flush with the front and rear edges of the intermediate sheet 225, and with the end edges of the inner sheet 230 respectively set back from the adjacent end edges of the intermediate sheet 225 to form end recesses or aprons 238 and 239 at the opposite ends thereof. The end recess 238 has a width substantially equal to the thickness of the inner sheet 230, while the end recess 239 has a width substantially equal to the thickness of the intermediate sheet 225. After the sheets have been assembled in position, they may be compressed by suitable means, such as a platen press, to insure a firm bond therebetween and provide a rigid laminated wall unit 220. It will be understood that the outer sheet 221 is notched at the front edge thereof and is severed to form a flap folded back to define a frame-receiving channel, in the same manner as was described above with respect to the embodiment of FIG. 6.

Then the wall units 220A through 220D are assembled about a loudspeaker mounting frame 260, which is identical to the loudspeaker mounting frame 160 described above, and shaped to be received snugly in the channels or grooves in the wall units 220. Preferably, coatings of suitable adhesive such as glue are applied to the adjacent ends of each of the wall units 220, as indicated at 245 in FIG. 17, to assure a firm bond therebetween. As can readily be appreciated from FIGS. 16 and 17, the adjacent ends of the wall units 220A through 220D nest together in the assembled configuration thereof. Thus, for example, one end of the sheets 225D and 230D are respectively received in the recesses 236B and 236D at one end of the bottom wall unit 220B, while at the other end of the bottom wall unit 220B, the sheets 221C and 225C are respectively received in the recesses 237D and 239D. After the wall units 220 have thus been assembled together, strips of tape 246 are applied to the corners of the wall structure

210 in the same manner and for the same purpose as was described above with respect to the embodiment of FIG. 10.

While in the embodiment illustrated in FIGS. 15 through 17, the sheets 221, 225 and 230 have all been illustrated as being of single-wall construction and of substantially the same thickness, it will be appreciated that any of these sheets may be of double-wall corrugated construction, such as the sheets 125 in the embodiment of FIG. 6. Further, while three such sheets have been shown as constituting the wall unit 220, it will be understood that other numbers of corrugated sheets may also be used, if desired, in either the wall units 120 or 220.

Further, if desired, an underlay of cushioning and sound-absorbing material such as carpeting, may be provided on the inner surfaces of the wall units of either the wall structure 110 or the wall structure 210 in order to improve the acoustical characteristics thereof. Preferably such an underlay would be applied only to the top and side wall units of the wall structures 110 and 210, but it will be understood that it could also be applied to the bottom wall units if desired. While the details of the plug connector in the rear wall unit has not been described, it will be understood that any of a number of standard types of connectors may be utilized. Preferably, the connector has a socket at one end thereof for receiving a plug therein and is provided with a pair of screw terminals at the other end thereof for securing lead wires thereto.

From the foregoing, it will be seen that there has been provided a novel loudspeaker enclosure of simple and economical construction which affords excellent acoustical characteristics. More particularly, there has been provided a loudspeaker enclosure of corrugated fiberboard constructed by assembling stacks of sheets of corrugated fiberboard and then assembling these stacks to form the walls of the loudspeaker enclosure.

There have also been provided two embodiments of such wall units affording different end configurations for affording a firm nesting fit at the junctures of adjacent wall units to provide a secure and rigid wall structure.

In addition, there has been provided a novel apparatus for mounting the loudspeaker assembly in the loudspeaker enclosure, including a loudspeaker mounting frame firmly received in grooves or channels in the respective side wall units.

In addition, there has been provided a novel method of making the loudspeaker enclosure of this invention and for mounting a loudspeaker therein.

While there have been described what are at present considered to be the preferred embodiments of the invention, it will be understood that various modifications may be made therein, and it is intended to cover in the appended claims all such modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. A loudspeaker enclosure comprising a plurality of wall units interconnected to form a housing, said housing having an opening therein to facilitate the emission of sound waves therefrom, each of said wall units being formed of a plurality of sheets of corrugated material arranged in a laminated stack, the corrugations of each of said sheets of each said wall unit extending in a direction substantially perpendicular to the direction of

the corrugations of adjacent sheets of said wall unit, predetermined ones of said wall units being disposed in use in continuous end-to-end engagement with each other to form a wall structure surrounding said opening, each of the predetermined ones of said wall units having a groove formed in the inner surface thereof, said grooves being disposed in use adjacent to said opening and in alignment with one another, and a rigid mounting frame snugly received in said grooves for facilitating the mounting of an associated loudspeaker assembly in said housing, whereby the perpendicular corrugations of adjacent sheets of said wall units cooperate to facilitate the suppression by said wall units of undesirable sound waves emitted from said housing.

2. The loudspeaker enclosure set forth in claim 1, wherein said rigid mounting frame is formed of wood.

3. The loudspeaker enclosure set forth in claim 1, wherein said wall structure includes four wall units respectively disposed substantially perpendicular to one another, said mounting frame being rectangular in shape with the four sides thereof being respectively disposed in the grooves of said four wall units.

4. A loudspeaker enclosure comprising a plurality of discrete wall units interconnected to form a housing, said housing having an opening therein to facilitate the emission of sound waves therefrom, each of said wall units being formed of a plurality of sheets of corrugated material arranged in a laminated stack, the corrugations of each of said sheets of each said wall unit extending in a direction substantially perpendicular to the direction of the corrugations of adjacent sheets of said wall unit, predetermined ones of said wall units being disposed in use in continuous end-to-end engagement with each other to define said opening with the ends of each wall unit being respectively constructed and arranged complementary to the adjacent end of an adjacent wall unit and being secured thereto, each of the predetermined ones of said wall units having a groove formed in the inner surface thereof and extending from one end of said wall unit to the opposite end thereof, said grooves being disposed in use adjacent to said opening and in alignment with one another and cooperating to form a continuous channel extending entirely around said wall structure, and a rigid frame snugly received in said channel and extending the entire length thereof for facilitating the mounting of an associated loudspeaker assembly in said housing, whereby the perpendicular corrugations of adjacent sheets of said wall units cooperate to facilitate the suppression by said wall units and undesirable sound waves emitted from said housing.

5. The loudspeaker enclosure set forth in claim 4, wherein each of said wall units comprises three sheets of corrugated material, said outermost sheet and the innermost sheet each having a single layer of corrugations and the intermediate sheet having a double layer of corrugations.

6. The loudspeaker enclosure set forth in claim 4, wherein each of said wall units has three sheets of corrugated material, each of said sheets having a single layer of corrugations.

7. The loudspeaker enclosure set forth in claim 4, and further including a decorative facing material completely covering the outer facing layer of said outermost sheet of each wall unit.

8. A sound reproduction system comprising a plurality of discrete wall units interconnected to form a closed housing, said housing having an opening therein to facilitate the emission of sound waves therefrom, each of said wall units being formed of a plurality of sheets of corrugated material arranged in a laminated stack, the corrugations of each of said sheets of each said wall unit extending in a direction substantially perpendicular to the direction of the corrugations of adjacent sheets of said wall unit, said predetermined ones of said wall units being disposed in use in continuous end-to-end engagement with each other to define said opening with each end of each wall unit being respectively constructed and arranged complementary to the adjacent end of an adjacent wall unit and being secured thereto, each of the predetermined ones of said wall units having a groove formed in the inner surface thereof and extending from one end of said wall unit to the opposite end thereof, said groove being disposed in use adjacent to said opening in alignment with one another and cooperating to form a continuous channel extending entirely around said wall structure, a rigid mounting frame snugly received in said channel and extending the entire length thereof, a loudspeaker mounting board disposed in said opening within said wall structure and secured to the outer surface of said mounting frame and having an aperture therein, and a loudspeaker having a cone-shaped diaphragm secured to the inner surface of said loudspeaker mounting board and extending inwardly therefrom in axial alignment with the aperture therein for transmitting there-through to the exterior of said housing sound waves generated at the front surface of said diaphragm and for transmitting into said housing sound waves generated at the rear surface of said diaphragm, whereby the perpendicular corrugations of adjacent sheets of said wall units cooperate to facilitate the suppression by said wall units and undesirable sound waves emitted from said housing.

9. The sound reproduction system set forth in claim 8, and further including a sealing strip disposed in use between said rigid mounting frame and said loudspeaker mounting board and secured to each for sealing the juncture between said mounting frame and said wall units and for cushioning said loudspeaker mounting board.

10. A sound reproduction system comprising a plurality of discrete wall units interconnected to form a closed housing, said housing having an opening therein to facilitate the emission of sound waves therefrom, each of said wall units being formed of a plurality of sheets of corrugated material arranged in a laminated stack, the corrugations of each of said sheets of each said wall unit extending in a direction substantially perpendicular to the direction of the corrugations of adjacent sheets of said wall unit, said predetermined ones of said wall units being disposed in use in continuous end-to-end engagement with each other to define said opening with each end of each wall unit being respectively constructed and arranged complementary to the adjacent end of an adjacent wall unit and being secured thereto, each of the predetermined ones of said wall units having a groove formed in the inner surface thereof and extending from one end of said wall unit to the opposite end thereof, said grooves being disposed in use adjacent to said opening in alignment with one another and cooperating to form a continuous channel

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extending entirely around said wall structure, a rigid mounting frame snugly received in said channel and extending the entire length thereof, a loudspeaker mounting board disposed in said opening within said wall structure and secured to the outer surface of said mounting frame and having an aperture therein, a loudspeaker having a cone-shaped diaphragm secured to the inner surface of said loudspeaker mounting board and extending inwardly therefrom in axial alignment with the aperture therein for transmitting therethrough to the exterior of said housing sound waves generated at the front surface of said diaphragm and for transmitting into said housing sound waves generated at the rear surface of said housing, a grille frame disposed in said opening within said wall structure and connected to the outer surface of said loudspeaker mounting board and having an aperture therein substantially congruent with the aperture in said loudspeaker mounting board, and a grille cloth secured to said grille frame and covering the outer surface thereof for concealing said loudspeaker and said loudspeaker mounting board, whereby the perpendicular corrugations of adjacent sheets of said wall units cooperate to facilitate the suppression by said wall units and undesirable sound waves emitted from said housing.

11. The sound reproduction system set forth in claim 10, and further including two mounting strips respectively secured to said loudspeaker mounting board and said grille frame and extending around the entire periphery thereof in facing relationship with each other, said mounting strips cooperating in use for releasably mounting said grille frame on said loudspeaker mounting board.

12. The sound reproduction system set forth in claim 10, and further including a strip of decorative molding

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secured to said grille cloth around the margin thereof.

13. A sound reproduction system comprising a plurality of wall units interconnected to form a housing, said housing having an opening therein to facilitate the emission of sound waves therefrom, each of said wall units being formed of a plurality of sheets of corrugated material arranged in a laminated stack, the corrugations of each of said sheets of each said wall unit extending in a direction substantially perpendicular to the direction of the corrugations of adjacent sheets of said wall unit, predetermined ones of said wall units being disposed in use in continuous end-to-end engagement with each other to form a wall structure surrounding said opening, each of the predetermined ones of said wall units having a groove formed in the inner surface thereof, said grooves being disposed in use adjacent to said opening and in alignment with one another, a rigid mounting frame snugly received in said grooves, a loudspeaker mounting board disposed in said opening and secured to said mounting frame and having an aperture therein, and a loudspeaker having a cone-shaped diaphragm secured to said loudspeaker mounting board and extending inwardly therefrom in axial alignment with the aperture therein for transmitting therethrough to the exterior of said housing sound waves generated at the front surface of said diaphragm and for transmitting into said housing sound waves generated at the rear surface of said diaphragm, whereby the perpendicular corrugations of adjacent sheets of said wall units cooperate to facilitate the suppression by said wall units of undesirable sound waves emitted from said housing.

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