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Everitt

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[54] **SOUND REPRODUCTION SYSTEM**

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[73] Assignee: **The Indiana National Bank,** Indianapolis, Ind.

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Related U.S. Application Data

[62] Division of Ser. No. 222,262, Jan. 31, 1972.

[52] **U.S. Cl.** ..... **181/156,** 229/14 C

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

[58] **Field of Search** ..... 181/31 B; 229/14 C; 93/39.1 P

[56] **References Cited**

UNITED STATES PATENTS

2,041,477	5/1936	Olney et al.	181/31 B
2,160,221	5/1939	Masters et al.	229/14 C
2,992,695	7/1961	Everitt	181/31 B
3,592,290	7/1971	Armstrong	181/31 B

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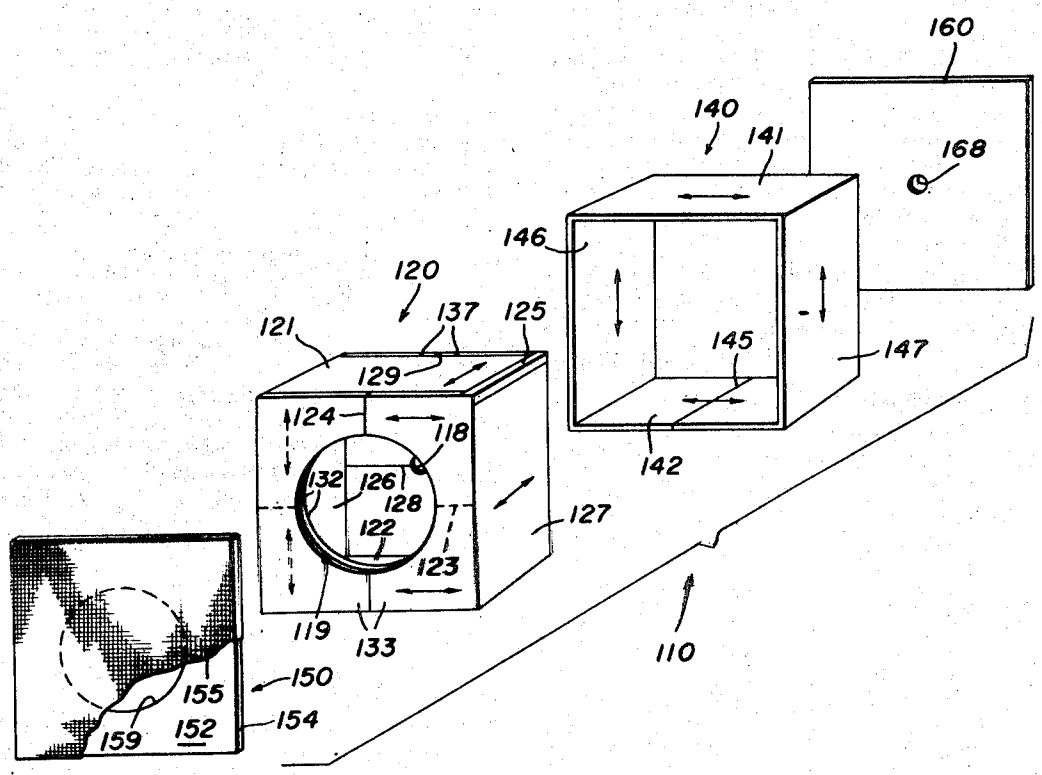
[57] **ABSTRACT**

A plurality of generally tubular members of corrugated fiberboard, each rectangular in transverse cross-section and including four panels, are nested one within the other to form a closed six-walled housing, each wall comprising back-to-back panels secured together with the corrugations thereof extending in mutually perpendicular directions, each tubular member being formed of a continuous sheet of fiberboard folded to the tubular configuration and having opposite side edges thereof joined together to form a seam disposed centrally of one of said panels. One form of the invention comprises three tubular members nested together with the axes thereof mutually perpendicular. Another form of the invention comprises two tubular members nested together coaxially, with the inner member having four end flaps at each end thereof disposed in use in a folded configuration wherein opposed flaps are coplanar and joined together to form back-to-back end panels at each end of the tubular member for closing same.

13 Claims, 7 Drawing Figures



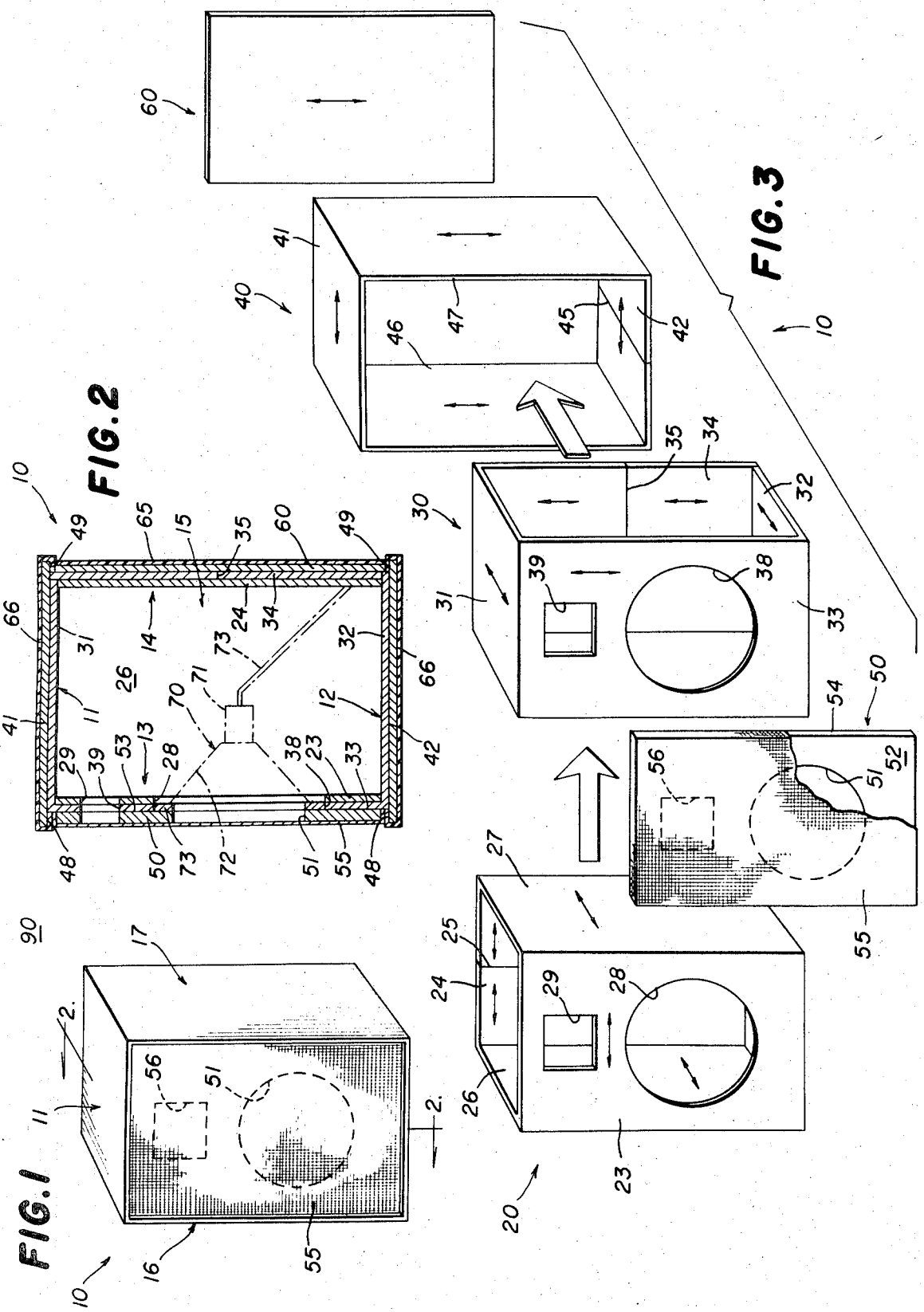


FIG. 1
FIG. 2
FIG. 3

FIG. 4

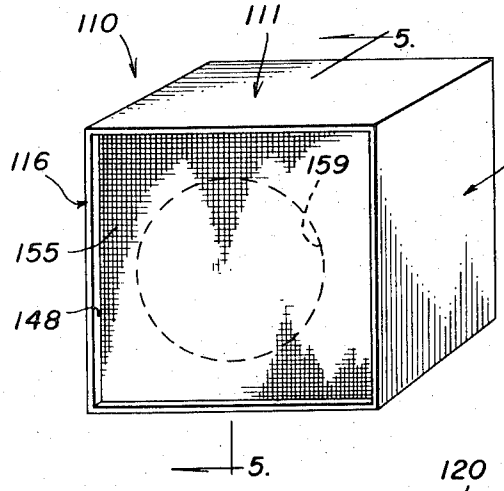
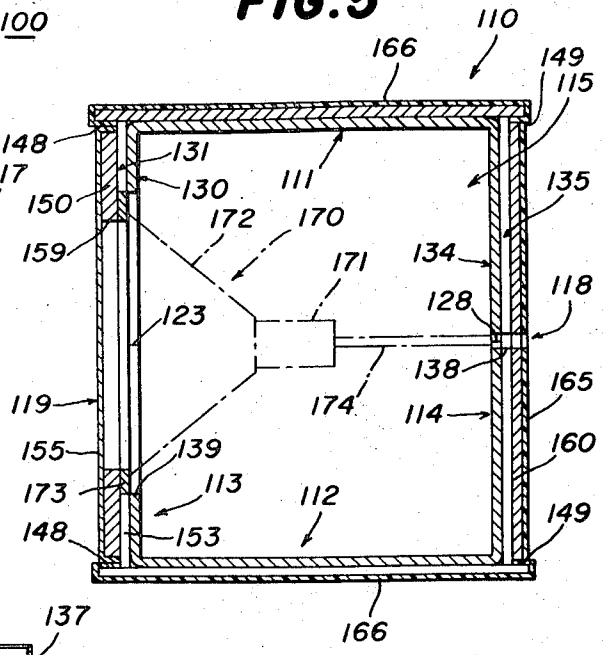


FIG. 5



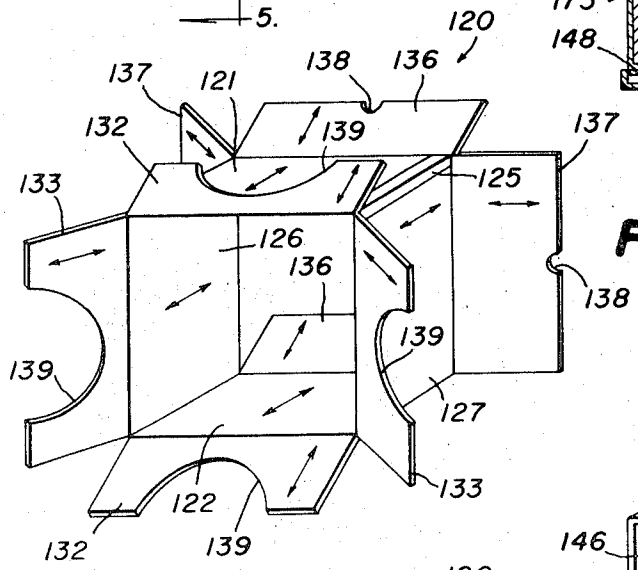


FIG. 6

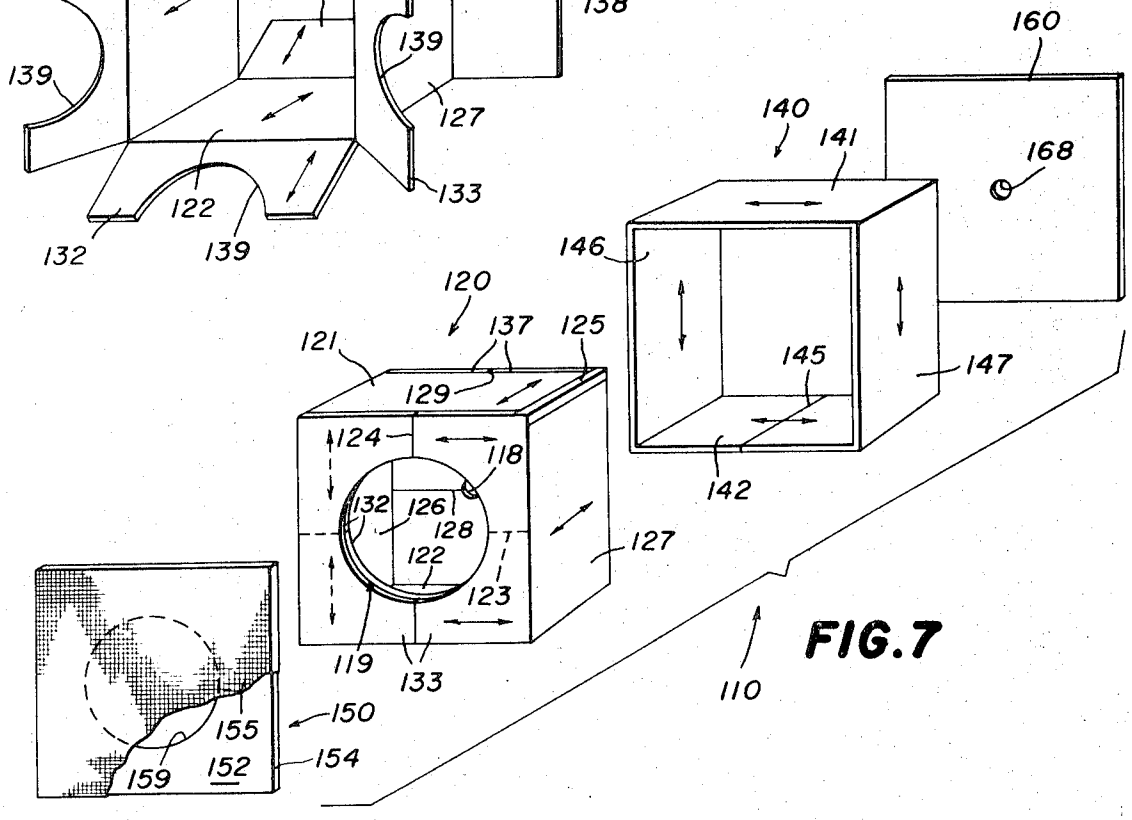


FIG. 7

SOUND REPRODUCTION SYSTEM

This is a division, of application Ser. No. 222,262, filed Jan 31, 1972.

This invention relates to a sound reproduction system comprising a loudspeaker enclosure and a loudspeaker mounted therein.

More particularly, the present invention relates to loudspeaker enclosures formed of corrugated board, and is an improvement of the loudspeaker enclosure disclosed in my U.S. Pat. No. 2,992,695, entitled "Loud Speaker Enclosure" and issued on July 18, 1961, and of the loudspeaker enclosure disclosed in my copending U.S. application Ser. No. 222,263, entitled "Sound Reproduction System," which application is assigned to the assignee of the present invention.

It is a general object of the present invention to provide an improved loudspeaker enclosure of simple and economical construction which affords excellent acoustical characteristics and improved structural strength.

It is an important object of the present invention to provide a loudspeaker enclosure comprising a plurality of continuous sheets of corrugated material constructed and arranged to define a closed housing having a plurality of walls, the housing having an opening therein to facilitate the emission of sound waves therefrom, each of the housing walls including back-to-back portions of the sheets with the corrugations of each of the sheet portions extending perpendicular to the corrugations of adjacent sheet portions of the wall, each of the sheets having opposite side edges thereof joined together to form a seam disposed substantially centrally of one of the walls thereby to insure the integrity of the junctures between the walls, whereby there is provided a housing of increased structural strength with the perpendicular corrugations of adjacent sheet portions in each housing wall facilitating the suppression by the walls of undesirable sound waves emitted from the loudspeaker enclosure.

Another object of this invention is to provide a loudspeaker enclosure comprising three tubular members, each formed of one of the sheets of corrugated material folded to a tubular configuration substantially rectangular in transverse cross-section and including four panels disposed substantially parallel to the longitudinal axis of the tubular member with the seam being disposed centrally of one of the panels of the tubular member, the tubular members being disposed in use in an assembled configuration snugly received one within another and secured together with the longitudinal axes thereof being mutually perpendicular for forming a closed housing having six walls, each one of the walls comprising back-to-back panels of different tubular members having the corrugations thereof mutually perpendicular.

Still another object of the present invention is to provide a loudspeaker enclosure of the type set forth, comprising a closed box-like member formed of a first continuous sheet of folded corrugated material and including four side panels and two end panels, each of the side panels including a single layer of corrugations extending in a predetermined direction, each of the end panels including at least two layers of corrugations with the corrugations of each layer extending in directions substantially perpendicular to the directions of the corrugations of adjacent layers of the panel, and a tubular member formed of a second continuous sheet of corrugated material including four side panels and disposed in use in surrounding relationship with the box-like member and secured thereto with the side panels of the tubular member respectively disposed in back-to-back engagement with the side panels of the box-like member, the corrugations of each of the side panels of the tubular member extending in a direction substantially perpendicular to the directions of the corrugations of the adjacent side panel of the box-like member.

In connection with the foregoing object, it is another object of the present invention to provide a loudspeaker enclosure of the type set forth, wherein the box-like member comprises a generally tubular member of square transverse cross-section, each of the side panels thereof having flaps at each end disposed in use in a folded configuration defining two-ply end walls closing the ends of the tube, the flaps at one end having recesses therein which mate when folded to define the opening in the one end wall.

In connection with the foregoing objects, it is another object of the invention to provide a sound reproduction system which includes a loudspeaker enclosure of the type set forth, and a loudspeaker mounted in the enclosure in alignment with the opening for radiating front sound waves therethrough and for emitting back sound waves into the enclosure.

Further features of the invention pertain to the particular arrangement of the parts of the sound reproduction system 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 first embodiment of a sound reproduction system and loudspeaker enclosure constructed in accordance with and embodying the features of the present invention;

FIG. 2 is an enlarged view in vertical section taken along the line 2—2 in FIG. 1, with the mounted position of the loudspeaker and electrical conductor being illustrated in broken line;

FIG. 3 is an exploded view of the loudspeaker enclosure of FIGS. 1 and 2, indicating the manner in which the parts of the loudspeaker enclosure are assembled;

FIG. 4 is a front perspective view, similar to FIG. 1, of a second embodiment of a sound reproduction system and loudspeaker enclosure constructed in accordance with and embodying the features of the present invention;

FIG. 5 is a view in vertical section taken along the line 5—5 in FIG. 4, with the mounted position of the loudspeaker and electrical conductor being illustrated in broken line;

FIG. 6 is a front perspective view of the inner tubular member of the loudspeaker enclosure of FIG. 4, with the end flaps open; and

FIG. 7 is an exploded view of the loudspeaker enclosure of FIG. 4, indicating the relationship of the various parts of the loudspeaker enclosure, and showing the inner tubular member with the end flaps closed.

Referring now to FIGS. 1 through 3 of the drawings, there is illustrated a sound reproduction system, generally designated by the numeral 90, including a loudspeaker enclosure 10 having a loudspeaker 70 mounted

therein. The loudspeaker enclosure **10** is preferably in the shape of a rectangular parallelepiped and includes a top wall **11**, a bottom wall **12**, a front wall **13**, a rear wall **14**, and a pair of opposed side walls **16** and **17**, all of which cooperate to form a closed housing **15**. The housing **15** is formed of three generally tubular members, including an inner tubular member **20**, an intermediate tubular member **30** and an outer tubular member **40**, all nested together in an assembled configuration to form the closed housing **15**. Each of the tubular members **20**, **30** and **40** is formed of corrugated material, preferably corrugated paper board or fiberboard, each of the tubular members **20**, **30** and **40** being formed of a single continuous sheet of the corrugated paper board, folded to the desired tubular configuration.

More particularly, the inner tubular member **20** is constructed of a single continuous sheet of corrugated paper board, folded into a tubular configuration substantially rectangular in transverse cross-section, thereby to form a front panel **23**, a rear panel **24**, and a pair of opposed side panels **26** and **27**, opposed side edges of the corrugated sheet being joined together, as by suitable adhesive such as glue, to form a seam **25** extending longitudinally of the inner tubular member **20** substantially centrally of the rear panel **24**. Thus, it will be seen that the inner tubular member **20** comprises an open-ended rectangular tube with the longitudinal axis thereof disposed in use substantially vertically, the corrugations of the inner tubular member **20** extending in directions substantially perpendicular to the longitudinal axis thereof, as indicated by the double-ended arrows in FIG. **3**. Formed in the front panel **23** of the inner tubular member **20** is a relatively large circular speaker opening **28** and a rectangular reflex port **29**, while there is formed in the rear panel **24** a small circular connector opening (not shown), all for a purpose to be explained more fully below.

The intermediate tubular member **30** is formed of a single continuous sheet of corrugated paper board folded to form a tube substantially rectangular in transverse cross-section and arranged with the longitudinal axis thereof disposed in use substantially horizontally. More particularly, the intermediate tubular member **30** includes a top panel **31**, a bottom panel **32**, a front panel **33** and a rear panel **34**, with opposed side edges of the corrugated sheets being joined together, as by a suitable adhesive such as glue, to form a seam **35** extending longitudinally of the tubular member **30** substantially centrally of the rear panel **34** thereof. The corrugations of the intermediate tubular member **30** are arranged to extend in directions substantially normal of the longitudinal axis thereof, as indicated by the double-ended arrows in FIG. **3**. The front panel **33** of the intermediate tubular member **30** has formed therein a relatively large circular speaker opening **38** and a rectangular reflex opening **39**, the openings **38** and **39** being respectively identical in configuration and position to the openings **28** and **29** in the inner tubular member **20**. Further, the rear panel **34** has formed therein a relatively small connector opening (not shown).

The outer tubular member **40** is also formed of a single continuous sheet of corrugated paper board folded to form an open-ended tube substantially rectangular in transverse cross-section. More particularly, the outer tubular member **40** includes a top panel **41**, a bottom panel **42**, and a pair of opposed side panels **46** and **47**, with opposite side edges of the corrugated sheet being joined together, as by a suitable adhesive such as glue, to form a seam **45** extending longitudinally of the outer tubular member **40** substantially centrally of the bottom panel **42**. The corrugations of the outer tubular member **40** are arranged to extend in directions substantially perpendicular to the longitudinal axis thereof, as indicated by the double-ended arrows in FIG. **3**.

It is a significant feature of the present invention that in each of the tubular members **20**, **30** and **40**, the seam is located approximately centrally of one of the rectangular panels formed by the tubular member. More particularly, the seam **25** in the inner tubular member **20** is disposed centrally of the rear panel **24** thereof, the seam **35** of the intermediate tubular member **30** is disposed centrally of the rear panel **34** thereof, and the seam **45** of the outer tubular member **40** is disposed centrally of the bottom panel **42** thereof. The location of seams away from the corners of tubular members **20**, **30** and **40** serves to insure the structural integrity of the junctures between adjacent panels of each of the tubular members under normal wear and tear conditions for the loudspeaker enclosure **10**. In addition, it will be noted that when the tubular members **20**, **30** and **40** are nested together in the assembled configuration thereof, the seams **25** and **35** in the back-to-back rear panels **24** and **34** will be disposed perpendicular to each other, thereby to insure the integrity of the seams and of the rear wall **14** of the closed housing **15**.

In assembling the closed housing **15** of the loudspeaker enclosure **10**, the inner tubular member **20** may be inserted within the intermediate tubular member **30**, as indicated by the solid arrow in FIG. **3**, the intermediate tubular member **30** being dimensioned to receive the inner tubular member **20** therein in a snug sliding fit. When the tubular members **20** and **30** are thus nested together, the top and bottom panels **31** and **32** of the intermediate tubular member **30** respectively close the open top and bottom ends of the inner tubular member **20**, while the opposed side panels **26** and **27** of the inner tubular member **20** respectively close the open sides of the intermediate tubular member **30**. Furthermore, when the tubular members **20** and **30** are nested together in the manner described, the front panels **23** and **33** thereof will be disposed in back-to-back engagement with each other to form the front wall **13** of the closed housing **15**, and the rear panels **24** and **34** will likewise be disposed in back-to-back engagement with each other to form the rear wall **14** of the closed housing **15**. The speaker opening **28** and reflex port **29** of the inner tubular member **20** will be congruent with the speaker opening **38** and the reflex port **39** of the intermediate tubular member **30**. Similarly, the connector openings in the rear panels **24** and **34** will also be disposed in axial alignment with each other. The front panels **23** and **33** are secured together by any suitable means, preferably by face gluing, the rear panels **24** and **34** being secured together in like manner.

It will be noted that when the inner tubular member **20** is nested within the intermediate tubular member **30** in the manner described the corrugations of the back-to-back front panels **23** and **33** will be disposed perpendicular to each other and, likewise, the corrugations of the back-to-back rear panels **24** and **34** will be disposed perpendicular to each other, whereby each of the front and rear walls **13** and **14** of the closing housing **15** com-

prises a criss-cross pattern of corrugations. Further, it will be noted that the seam **35** of the intermediate tubular member **30** is disposed substantially perpendicular to the seam **25** of the inner tubular member **20.**

The intermediate tubular member **30,** with the inner tubular member **20** nested therewithin, may be inserted into the outer tubular member **40,** as indicated by the solid arrow in FIG. **3,** the outer tubular member **40** being dimensioned to receive the intermediate tubular member **30** therein in a snug sliding fit. The top and bottom panels **41** and **42** and the side panels **46** and **47** of the outer tubular member **40** are also dimensioned to extend a predetermined distance forwardly and rearwardly beyond the front and rear panels **33** and **34** of the intermediate tubular member **30,** when the intermediate tubular member **30** is nested within the outer tubular member **40** in the assembled configuration, thereby to form a front recess **48** and a rear recess **49,** as indicated in FIG. **2** of the drawings.

When the tubular members **20, 30** and **40** are thus assembled, the top and bottom panels **31** and **32** of the intermediate tubular member **30** will respectively be disposed in back-to-back engagement with the top and bottom panels **41** and **42** of the outer tubular member **40,** thereby to form the top and bottom walls **11** and **12** of the closed housing **15,** with the corrugations of the top and bottom panels **31** and **32** being respectively disposed substantially perpendicular to the corrugations of the top and bottom panels **41** and **42.** Similarly, the opposed side panels **26** and **27** of the inner tubular member **20** are respectively disposed in back-to-back engagement with the opposed side panels **46** and **47** of the outer tubular member **40,** thereby to form the side walls **16** and **17** of the closed housing **15,** with the corrugations of the side panels **26** and **27** being respectively disposed perpendicular to the corrugations of the side panels **46** and **47.** Thus, Each of the top and bottom walls **11** and **12** and the opposed side walls **16** and **17** of the closed housing **15** comprises criss-cross layers of corrugations, the back-to-back panels of each of these walls being secured together by any suitable means, such as face gluing, to form a rigid unitary structure.

There is also provided a rectangular loadspeaker-mounting or baffle board generally designated by the numeral **50,** having a front surface **52,** a rear surface **53** and a peripheral side surface **54** and adapted to be received in the front recess **48** of the closed housing **15** substantially congruent with the front wall **13.** The baffle board **50** is provided with a circular loudspeaker opening **51** and a rectangular reflex port **56** therein, the opening **51** and port **56** being respectively disposed in use in axial alignment with the openings **28** and **38** and ports **29** and **39** in the front wall **13** of the closed housing **15.** However, the opening **51** has a diameter somewhat smaller than the diameters of the aligned openings **28** and **38.** A grille cloth **55** of sound-transmitting fabric material covers the front surface **52** of the baffle board **50,** the grille cloth **55** preferably being stretched over the peripheral side surface **54** of the baffle board **50** and secured thereto by suitable means, whereby the grille cloth **55** conceals the speaker opening **51** and the reflex port **56.** While the baffle board **50** is preferably constructed of plywood, it will be appreciated that any other suitable material such as solid wood, particleboard, flakeboard, pressed fiberboard, composition board or plastic, either foamed or solid, or corrugated board may also be used.

There is also provided a rectangular rear cover panel **60** formed of corrugated board and adapted to be received in the rear recess **49** of the closed housing **15** for covering the rear wall **14** thereof, the rear cover panel **60** being secured to the rear wall **14** by any suitable means, such as face gluing. The rear cover panel **60** is provided with a small circular connector opening (not shown) therein, disposed in use in axial alignment with the connector openings in the rear wall **14.**

Preferably, the top and bottom walls **11** and **12,** the side walls **16** and **17** and the rear cover panel **60** of the speaker enclosure **10** are covered by a decorative facing of any desired material. More particularly, the rear surface of the rear cover panel **60** is covered by a decorative facing sheet **65** secured thereto by a suitable adhesive, while the outer surfaces of the top and bottom walls **11** and **12** and the side walls **16** and **17** are all covered by a single continuous decorative facing sheet **66** with opposed side edges thereof joined together to form a seam substantially along the seam **45** in the bottom panel **42** of the outer tubular member **40.** The front and rear edges of the decorative facing sheet **66** are respectively wrapped around the overhanging front and rear margins of the panels **41, 42, 46** and **47** of the outer tubular member **40** which define the front and rear recesses **48** and **49,** for completely covering these overhanging portions as is best shown in FIG. **2.** The decorative facing sheet **66** is secured to the outer tubular member **40** by suitable means such as face gluing.

In the preferred embodiment of the present invention, the decorative facing sheets **65** and **66** are formed of suitably covered vinyl material, but it will be appreciated that any desired material may be used. Thus, it is anticipated that such materials as patterned paper or vinyls, either supported or non-supported, wood veneers, metals, plastics, either flexible or rigid, cloth, non-woven materials, leather, furs, foams, stone veneers, various woven or metal fabrics and materials, cork, glass or painted or sprayed materials may be used to form the decorative facing sheets **65** or **66** to suit the needs and desires of individual customers.

A loudspeaker, generally designated by the numeral **70,** is mounted within the loudspeaker enclosure **10.** While the loudspeaker **70** may be of any desired type such as electrostatic, cone-type, etc., for purposes of illustration a cone-type loudspeaker is shown, including an electromagnet structure **71,** and a cone-shaped diaphragm **72** provided at the open end thereof with one or more mounting flanges **73** extending radially outwardly therefrom. In use, the mounting flanges **73** are secured to the inner surface **53** of the baffle board **50** by a suitable adhesive or by any other desired means, such as screws, bolts, staples, clips and the like, with the diaphragm **72** disposed in axial alignment with the speaker opening **51** in the baffle board **50** and extending rearwardly therefrom, as is more clearly shown in the aforementioned copending application Ser. No. 222,263. When the baffle board **50** is mounted in the front recess **48,** as described above, the speaker diaphragm **72** will extend inwardly through the speaker openings **28** and **38** in the front wall **13,** whereby sound waves generated at the front surface of the diaphragm **72** will be radiated outwardly through the aligned speaker openings **28, 38** and **51** to the exterior of the

loudspeaker enclosure **10**, while sound waves generated at the rear surface of the diaphragm **72** will be transmitted into the closed housing **15**. At predetermined frequencies, these back sound waves will be radiated outwardly through the aligned reflex ports **29**, **39** and **56** in a well-known manner, while at other frequencies these back sound waves will be substantially suppressed by the walls of the loudspeaker enclosure **10**, as will be explained more fully hereinafter

Alternatively, the speaker flanges may be sandwiched between the front panels **23** and **33** of the front wall **13** in such a way that the speaker mounting flanges are adhesively bonded or otherwise firmly supported and secured between these panels, thus holding the loudspeaker **70** rigidly in position in the speaker openings provided. Other alternative arrangements disclosed in my aforementioned copening U.S. application, Ser. No. 222,263, may also be used. In this case, the baffle board may be eliminated and the grille cloth **55** may be mounted on a suitable pad or frame disposed in the front recess **48**. Also, a baffle board of corrugated fiberboard having a recess in the rear surface thereof in surrounding relationship with the loudspeaker opening for receiving by loudspeaker mounting flanges may also be used, which arrangement is disclosed in greater detail in my aforementioned copending U.S. application, Ser. No. 222,263. It will, of course, also be appreciated that, if desired, the mounting flanges **73** may be secured to the inner surface of the front wall **13**, in the manner disclosed in the aforementioned U.S. Pat. No. 2,992,695.

The electromagnet structure **71** of the loudspeaker **70** is connected by a conductor **74** to a connector (not shown) mounted in the rear wall **14** of the loudspeaker enclosure **10**, and adapted to be connected to an associated source of electrical signal power. The structure and mounting arrangement of a preferred embodiment of such a connector is disclosed in my aforementioned copending application, Ser. No. 222,263.

In the preferred embodiment of the invention, as was described above, each of the walls of the closed housing **15** comprises two layers of corrugated paper board or fiberboard, the corrugations of which layers are disposed in directions perpendicular to each other. Each of these layers of corrugated paper board thereby serves to align incident sound waves in the direction of the corrugations, whereby the sound waves are aligned in mutually perpendicular directions in the two layers of corrugations in each wall of the closed housing **15**, the net effect being substantially to cancel out the transmission of audible sound waves through the combined layers of corrugated material. Thus, this crisscross pattern of corrugations serves to effect suppression of those undesirable sound waves generated within the loudspeaker enclosure **10** which are not radiated outwardly through the reflex port, and to prevent generation of undesirable audible sound waves by the walls of the enclosure itself.

It will, of course, be appreciated that the loudspeaker enclosures of the present invention may be provided with a plurality of loudspeaker openings therein for respectively accommodating a plurality of different loudspeakers in more complex speaker systems. It will also be appreciated that the reflex ports **56** may be eliminated or additional reflex ports may be added as desired to meet the requirements of any specific sound system. Furthermore, it will be understood that the description of the assembly of the parts of the loudspeaker enclosure herein is simply for purposes of illustration and that other methods of forming the loudspeaker enclosures of the present invention may in fact be used.

Referring now to FIGS. **4** through **7** of the drawings, there is illustrated a second embodiment of the sound reproduction system of the present invention, generally designated by the numeral **100**. The sound reproduction system **100** includes a loudspeaker enclosure, generally designated by the numeral **110**, having a loudspeaker **170** mounted therein. The loudspeaker enclosure **110** is in the shape of a rectangular parallelopiped which is substantially square in transverse cross-section. Preferably, the loudspeaker enclosure **110** is in the shape of a cube and includes a top wall **111**, a bottom wall **112**, a front wall **113**, a rear wall **114**, and a pair of opposed side walls **116** and **117**, all of which cooperate to form a closed housing **115**. The housing **115** is formed of two generally tubular members, including an inner tubular member **120** and an outer tubular member **140**, nested together in an assembled configuration to form the closed housing **115**. Each of the generally tubular members **120** and **140** is formed of corrugated material, preferably corrugated paperboard or fiberboard, each of the tubular members **120** and **140** being formed of a single continuous sheet of corrugated paperboard, folded to the desired configuration.

More particularly, the inner tubular member **120** is constructed of a single continuous sheet of corrugated paperboard, folded into a tubular configuration essentially square in transverse cross-section, thereby to form a top panel **121**, a bottom panel **122**, and a pair of opposed side panels **126** and **127**, opposed side edges of the corrugated sheet being joined together, as by taping, to form a seam **125** extending longitudinally of the inner tubular member **120** on any one of the corners thereof, such as the juncture between the top panel **121** and the side panel **127**. Thus, it will be seen that the panels **121**, **122**, **126** and **127** cooperate to define an open-ended rectangular tube with the longitudinal axis thereof disposed in use substantially horizontally, the corrugations of the inner tubular member **120** extending in directions substantially parallel to the longitudinal axis of the inner tubular member **120**, as indicated by the double-ended arrows in FIGS. **6** and **7**.

Integral with each of the top and bottom panels **121** and **122** at the opposite ends thereof respectively, are a front flap **132** and a rear flap **136**, each of the flaps **132** and **136** being generally rectangular in shape and having a width substantially equal to the width of the associated panel **121** or **122** and extending therefrom a distance substantially equal to one-half the width thereof. In like manner, integral with each of the side walls **126** aNd **127** at the opposite ends thereof respectively, are a front flap **133** and a rear flap **137**, the front flaps **133** being shaped and dimensioned substantially identically to the front flaps **132** and the rear flaps **137** being shaped and dimensioned substantially identically to the rear flaps **136**. Each of the front flaps **132** and **133** has formed therein centrally of the free edge thereof, a relatively large semi-circular recess **139**, while each of the rear flaps **137** and **136** has formed therein centrally of the free edge thereof a relatively small semi-circular recess **138**. It will be noted that, as indicated above, the inner tubular member **120** is integrally formed of a single continuous sheet of corru-

gated material, the flaps **132, 133, 137** and **136** being formed by appropriately cutting and scoring the corrugated sheet so that each of the flaps is hingedly connected to the associated panel.

In use, the flaps **132, 133, 137** and **136** are all folded to the configuration illustrated in FIG. **7.** More particularly, the front flaps **132** are folded inwardly to a position wherein they are coplanar with each other with the free edges thereof abutting. The abutting edges of the flaps **132** are then secured together as by gluing to form a seam **123,** the coplanr flaps **132** thereby forming a front inner panel **130** for closing the front end of the inner tubular member **120.** In this folded configuration, the semi-circular recesses **139** of the flaps **132** mate to define a circular opening in the front inner panel **130.** The front flaps **133** are then folded inwardly to a position wherein they are coplanar with each other with the free edges thereof abutting, the folded flaps **133** overlying the flaps **132** in back-to-back engagement therewith. Preferably, the folded flaps **133** are secured to the outer surface of the front inner panel **130** as by face gluing and the abutting edges of the flaps **133** are secured together as by gluing to form a seam **124,** the coplanar flaps **133** thereby forming a front outer panel **131** cooperating with the front inner panel **130** to form the front wall **113** of the closed housing **115.** In this folded configuration, the recesses **139** of the flaps **133** mate to form a circular opening in the front outer panel **131** which is congruent with the corresponding opening in the front inner panel **130,** and cooperates therewith to form a loudspeaker opening **119** in the front wall **113** of the housing **115.**

In like manner, the rear flaps **136** are folded inwardly in use to a position wherein the flaps **136** are coplanar with each other with the free edges thereof abutting. These abutting free edges are joined together as by gluing to form a seam **128,** the coplanar flaps **136** thereby forming a rear inner panel closing the rear end of the tubular member **120.** In this folded configuration, the semi-circular recesses **138** mate to define a small circular opening through the rear inner panel **134.** The flaps **137** are then folded inwardly to a position wherein the flaps **137** are coplanar with each other and overlie the rear inner panel **134** in back-to-back engagement therewith. Preferably, the rear flaps **137** are secured to the outer surface of the rear inner panel **134** as by face gluing, the flaps **137** being secured together along the free edges thereof to form a seam **129,** the coplanar flaps **137** thereby forming a rear outer panel **135** which cooperates with the rear inner panel **134** to form the rear wall **114** of the closed housing **115.** In this folded configuration, the recesses **138** in the flaps **137** mate to form a small circular opening through the rear outer panel **135** which is congruent with the corresponding opening in the rear inner panel **134** and cooperates therewith to form a connector opening **118** in the rear wall **114** of the housing **115.**

It will be noted that when the inner tubular member **120** has the flaps thereof disposed in the folded configuration illustrated in FIG. **7,** the corrugations of the front inner panel **130** extends vertically while the corrugations of the front outer panel **131** extend horizontally. In like manner, the corrugations of the rear inner panel **134** extend vertically, while the corrugations of the rear outer panel **135** extend horizontally. Thus, it will be appreciated that each of the front walls **113** and **114** of the closed housing **115** comprises two panels of corrugated material having the corrugations thereof disposed perpendicular to each other to thereby provide a criss-cross pattern of corrugations to facilitate the suppression of undesirable sound waves by the front and rear walls **113** and **114.**

The outer tubular member **140** is also formed of a single continuous sheet of corrugated paperboard folded to form an open-ended tube substantially rectangular in transverse cross-section. More particularly, the outer tubular member **140** includes a top panel **141,** a bottom panel **142,** and a pair of opposed side panels **146** and **147,** with opposite side edges of the corrugated sheet being joined together, as by a suitable adhesive such as glue, to form a seam **145** extending longitudinally of the outer tubular member **140** substantially centrally of the bottom panel **142** thereof. The corrugations of the outer tubular member **140** are arranged to extend in directions substantially perpendicular to the longitudinal axis thereof, as indicated by the double-ended arrows in FIG. **7.**

In assembling the closed housing **115** of the loudspeaker enclosure **110,** the inner tubular member **120** may be folded to the cubical configuration illustrated in FIG. **7,** as was described above, and inserted within the outer tubular member **140** which is dimensioned to receive the inner tubular member **120** therein in a snug sliding fit. When the tubular members **120** and **140** are thus nested together in their assembled configuration, the top and bottom panels **141** and **142** of the outer tubular member **140** will respectively be disposed in back-to-back engagement with the top and bottom panels **121** and **122** of the inner tubular member **120** to form the top and bottom walls **111** and **112** of the closed housing **115.** In like manner, the opposed side panels **146** and **147** of the outer tubular member **140** will be disposed in back-to-back engagement with the opposed side panels **126** and **127** of the inner tubular member **120,** thereby to form the side walls **116** and **117** of the closed housing **115.** The back-to-back panels of the inner and outer tubular members **120** and **140** are secured together by any suitable means, preferably by face gluing, to provide a rigid unitary structure for the closed housing **115.**

It will be noted that when the inner tubular member **120** is nested within the outer tubular member **140** in the manner described, the corrugations of the back-to-back panels thereof will be disposed perpendicular to each other, whereby each of the top and bottom and side walls **111, 112, 116** and **117** of the closed housing **115** comprises a criss-cross pattern of corrugations for facilitating the suppression of undesirable sound waves emitted from the closed housing **115.** Thus, it will be appreciated that all six walls of the assembled closed housing **115** comprise back-to-back two-panel construction having the criss-cross pattern of corrugations, the panels of the front and rear walls **113** and **114** being formed by the folded flaps of the inner tubular member **120,** as was described above. It will be noted that the top and bottom panels **141** and **142** and the side panels **146** and **147** of the outer tubular member **140** are dimensioned to extend a predetermined distance forwardly and rearwardly beyond the front and rear outer panels **131** and **135** of the inner tubular member **120,** and cooperate therewith to define a front recess **148** and a rear recess **149,** when the tubular members **120** and **140** are nested together in the assembled configuration, as indicated in FIG. **5.**

There is also provided a substantially square loudspeaker-mounting or baffle board, generally designated by the numeral **150,** having a front surface **152,** a rear surface **153** and a peripheral side surface **154** and adapted to be received in the front recess **148** of the closed housing **115** substantially congruent with the front wall **113** thereof. The baffle board **150** is provided with a circular loudspeaker opening **151** therein which disposed in use coaxially with the loudspeaker opening **119** formed in the front wall **113** of the closed housing **115.** However, the diameter of the opening **151** is less than the diameter of the opening in the front wall **113.** A grille cloth **155** of sound-transmitting fabric material covers the front surface **152** of the baffle board **150,** the grille cloth **155** preferably being stretched over the peripheral side surface **154** of the baffle board **150** and secured thereto by suitable means, whereby the grille cloth **155** conceals the speaker opening **151.** While the baffle board **150** is preferably constructed of plywood, it will be appreciated that it may be constructed of other suitable materials such as those mentioned above with respect to the baffle board **50** of the loudspeaker enclosure **10.**

There is also provided a substantially square rear cover panel **160** formed of corrugated board and adapted to be received in the rear recess **149** of the closed housing **115** for covering the rear wall **114** thereof, the rear cover panel **160** being secured to the rear wall **114** by any suitable means, such as face gluing. The rear cover panel **160** is provided with a small circular connector opening **168** therein, disposed in use in axial alignment with the connector opening **118** in the rear wall **114** of the closed housing **115.**

Preferably, the top and bottom walls **111** and **112** and the side walls **116** and **117** and the rear cover panel **160** of the loudspeaker enclosure **110** are covered by decorative facing of any desired material. More particularly, the rear surface of the rear cover panel **160** is covered by a decorative facing sheet **165** secured thereto by a suitable adhesive, while the outer surfaces of the top and bottom walls **111** and **112** and the side walls **116** and **117** are all covered by a single continuous decorative facing sheet **166** with opposed side edges thereof joined together to form a seam, substantially along seam **145** in the bottom panel **142** of the other tubular member **140.** The front and rear edges of the decorative facing sheet **166** are respectively wrapped around the overhanding front and rear margins of the panels **141, 142, 146** and **147** of the outer tubular member **140** which define the front and rear recesses **148** and **149,** for completely covering these overhanging portions, as is best shown in FIG. **5.** The decorative facing sheet **166** is secured to the outer tubular member **140** by suitable means such as face gluing. The decorative facing sheets **165** and **166** are preferably formed of vinyl material, but may be formed of any other suitable material, such as those indicated above with respect to the decorative facing sheets **65** and **66** of the loudspeaker enclosure **10.**

A loudspeaker, generally designed by the numeral **170,** is mounted within the loudspeaker enclosure **110.** While the loudspeaker **170** may be of any desired type, for purposes of illustration a cone-type loudspeaker is shown, including an electromagnet structure **171** and a cone-shaped diaphragm **172** provided at the open end thereof with one or more mounting flanges **173** extending radially outwardly therefrom. In use, the mounting flanges **173** are secured to the inner surface **153** of the baffle board **150** by suitable adhesive or by any other desired means, such as screws, bolts, staples, clips and the like, with the diaphragm **172** disposed in axial alignment with the loudspeaker opening **151** in the baffle board **150** and extending rearwardly therefrom, as is more clearly shown in my aforementioned copending application, Ser. No. 222,263. When the baffle board **150** is mounted in the front recess **148,** as described above, the loudspeaker diaphragm **172** will extend inwardly through the opening **119** in the front wall **113,** whereby sound waves generated at the front surface of the diaphragm **172** will be radiated outwardly through the aligned speaker openings **119** and **159** to the exterior of the loudspeaker enclosure **110,** while sound waves generated at the rear surface of the diaphragm **172** will be transmitted into the closed housing **115.** Alternative modes of mounting the loudspeaker within the closed housing **115,** as described above with respect to the loudspeaker enclosure **10,** may also be used for mounting the loudspeaker **170** in the loudspeaker enclosure **110.** The electromagnet structure **171** of the loudspeaker **170** is connected by a conductor **174** to a suitable connector (not shown) mounted in the rear wall **114** of the loudspeaker enclosure **110,** and adapted to be connected to an associated source of electric signal power. The structure and mounting arrangement of a preferred embodiment of such a connector is disclosed in my aforementioned copending application Ser. No. 222,263.

While in the preferred embodiments of this invention, the tubular members **20, 30, 40, 120** and **140** are constructed of paperboard or fiberboard for simplicity and economy of fabrication, it will be appreciated that other corrugated materials may be used to produce the same sound deadening effect, as long as the adjacent layers of corrugated material have the corrugations thereof disposed at right angles to each other.

From the foregoing, it will be seen that there has been provided a novel loudspeaker enclosure simply constructed of economical materials, and comprising a closed housing of corrugated material having a criss-cross pattern of corrugations in each of the housing walls for suppressing undesirable sound waves emitted from the enclosure, the enclosure providing superior acoustical characteristics while having improved structural strength which insures the integrity of the junctures between adjacent walls of the housing.

More particularly there has been provided a novel loudspeaker enclosure with a plurality of rectangular tubes of corrugated paperboard nested together in an assembled configuration, each of the tubes being formed of a single continuous sheet of corrugated material folded into a rectangular tubular configuration and having opposed free edges thereof joined together to form a longitudinal seam, the seams of each of the tubular members being disposed centrally of one of the rectangular panels thereof.

In addition, there has been provided a loudspeaker enclosure constructed of two tubular members of square transverse cross-section, the inner tubular member having rectangular flaps at the opposite ends of each of the four side panels thereof, the flaps being disposed in use in a folded configuration defining front and rear end walls for the inner tubular member, each of these end walls comprising two back-to-back end

panels having the corrugations thereof disposed perpendicular to each other.

While there has been described what are at present considered to be the preferred embodiments of the present 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 closed box-like member formed of a first continuous sheet of folded corrugated material, said box-like member being substantially rectangular in transverse cross section and including four side panels and two end panels, opposite edges of said first sheet being joined together to form a seam disposed centrally of one of said panels of said box-like member, each of said panels including a single layer of corrugations extending in a predetermined direction, each of said end panels including at least two layers of corrugations with the corrugations of each layer extending in directions substantially perpendicular to the directions of the corrugations of adjacent layers of said panel, a tubular member formed of a second continuous sheet of corrugated material, said tubular member being substantially rectangular in transverse cross-section and including four side panels, opposite side edges of said second sheet being joined together to form a seam disposed centrally of one of said panels of said tubular member, said tubular member being disposed in use in surrounding relationship with said box-like member and secured thereto with the side panels of said tubular member respectively disposed in back-to-back engagement with the side panels of said box-like member, the corrugations of each of said side panels of said tubular member extending in directions substantially perpendicular to the directions of the corrugations of the adjacent side panel of said box-like member, and one of said end panels having an opening therein to facilitate the emission of sound waves therefrom, whereby the perpendicular corrugations of said end panels and said back-to-back side panels cooperate to facilitate the suppression of undesirable sound waves emitted from said loudspeaker enclosure.

2. The loudspeaker enclosure set forth in claim 1, wherein said box-like member is substantially cubical in shape.

3. The loudspeaker enclosure set forth in claim 1, wherein said box-like member and said tubular member are formed of corrugated fiberboard.

4. A loudspeaker enclosure comprising two generally tubular members of corrugated board, each of said tubular members being substantially square in transverse cross-section and including four side panels disposed substantially parallel to the longitudinal axis of said tubular member, the corrugations of each of said panels of one of said tubular members extending in directions substantially parallel to the longitudinal axis thereof, the corrugations of each of said panels of the other of said tubular members extending in directions substantially perpendicular to the longitudinal axis thereof, each of the panels of said one tubular member having two generally rectangular flaps respectively connected thereto at the opposite ends thereof, each of said flaps at one end of said one tubular member having a recess formed therein centrally of the free edge thereof, said flaps being disposed in use in a folded configuration wherein opposed ones of said flaps at each end of said one tubular member are substantially coplanar with each other having the free edges thereof secured together to form two back-to-back end panels closing the adjacent end of said one tubular member, the recesses of opposed ones of said flaps mating to form a loudspeaker opening in the corresponding end panel at said one end of said one tubular member when said flaps are disposed in the folded configuration thereof, the two back-to-back end panels at each end of said one tubular member being secured together with the loudspeaker openings thereof substantially congruent, the corrugations of each end panel of said one tubular member extending in directions substantially perpendicular to the corrugations of the other end panel at the same end of said one tubular member, said tubular members being disposed in use in as assembled configuration with said one tubular member snugly received within the other tubular member coaxially therewith and secured thereto for forming a closed housing, each one of said side panels of said one tubular member being disposed in back-to-back engagement with a corresponding side panel of said other tubular member when said tubular members are disposed in the assembled configuration thereof with the corrugations of the panels of each of said side walls extending in mutually perpendicular directions, whereby the perpendicular corrugations of the back-to-back end panels and side panels of said housing facilitating the suppression by said panels of undesirable sound waves emitted from said loudspeaker enclosure.

5. The loudspeaker enclosure set forth in claim 4, wherein each of said tubular members is formed of a single continuous folded sheet of corrugated material with opposite side edges thereof joined together to form a longitudinally extending seam, said seam being disposed centrally of one of said side panels of said tubular member thereby to insure the integrity of the junctures between adjacent ones of said side panels for providing a housing of increased structural strength.

6. The loudspeaker enclosure set forth in claim 4, wherein the back-to-back end panels at the other end of said one tubular member in the folded configuration thereof are provided with axially aligned connector openings therein.

7. The loudspeaker enclosure set forth in claim 4, wherein each of the flaps at the other end of said one tubular member is provided with a recess formed therein centrally of the free edge thereof, the recesses of opposed ones of said flaps at said other end of said one tubular member mating to form a connector opening in the corresponding end panel at said other end of said one tubular member when said flaps are disposed in the folded configuration thereof.

8. The loudspeaker enclosure set forth in claim 4, wherein the four panels of said other tubular member extend outwardly beyond the end panels at the opposite ends of said one tubular member and cooperate therewith to form two end recesses, and further including a loudspeaker-mounting board disposed in the end recess at said one end of said one tubular member and secured to the adjacent end panel thereof and having an opening therein aligned with the speaker opening in said adjacent end panel for mounting an associated loudspeaker thereon, and a rear cover panel disposed in the end recess at the other end of said one tubular

member and secured to the adjacent end panel thereof.

9. A sound reproduction system comprising two generally tubular members of corrugated board, each of said tubular members being substantially square in transverse cross section and including four side panels disposed substantially parallel to the longitudinal axis of said tubular members, the corrugations of each of said panels of one of said tubular members extending in directions substantially parallel to the longitudinal axis thereof, the corrugations of each of said panels of the other of said tubular members extending in directions substantially perpendicular to the longitudinal axis thereof, each of the panels of said one tubular member having two generally rectangular flaps respectively connected thereto at the opposite ends thereof, each of said flaps having a recess formed therein centrally of the free edge thereof, said flaps being disposed in use in a folded configuration wherein opposed ones of said flaps at each end of said one tubular member are substantially coplanar with each other having the free edges thereof secured together to form two back-to-back end panels closing the adjacent end of said one tubular member, the recesses of opposed ones of said flaps mating to form a loudspeaker opening in the corresponding end panel at said one end of said one tubular member when said flaps are disposed in the folded configuration thereof, the two back-to-back end panels at each end of said one tubular member being secured together with the loudspeaker openings thereof substantially congruent, the corrugations of each end panel of said one tubular member extending in directions substantially perpendicular to the corrugations of the other end panel at the same end of said one tubular member, said tubular members being disposed in use in an assembled configuration with said one tubular member snugly received within the other tubular member coaxially therewith and secured thereto for forming a closed housing, each one of said corresponding side panels of said one tubular member being disposed in back-to-back engagement with a corresponding side panel of said other tubular member when said tubular members are disposed in the assembled configuration thereof with the corrugations of the panels of each of said side walls extending in mutually perpendicular directions, and a loudspeaker mounted in said housing and disposed in axial alignment with said opening for transmitting therethrough to the exterior of said housing sound waves generated at the front surface of the diaphragm thereof and for transmitting into said housing sound waves generated at the rear surface of the diaphragm thereof, whereby the perpendicular corrugations of the back-to-back end panels and side panels of said housing facilitating the suppression by said panels of undesirable sound waves emitted from said loudspeaker enclosure.

10. The sound reproduction system set forth in claim 9, wherein each of said tubular members is formed of a single continuous folded sheet of corrugated board with opposite side edges thereof joined together to form a longitudinally extending seam, said seam being disposed centrally of one of said side panels of said tubular member thereby to insure the integrity of the junctures between adjacent one of said side panels for providing a housing of increased structural strength.

11. A loudspeaker enclosure comprising a closed box-like member formed of a first continuous sheet of folded corrugated material, said box-like member being substantially tubular in transverse cross section and including side panels and two end panels, each of said panels including a single layer of corrugations extending in a predetermined direction, each of said end panels including at least two layers of corrugations with the corrugations of each layer extending in directions crossed with respect to the directions of the corrugations of adjacent layers of said end panel, a tubular member formed of a second continuous sheet of corrugated material, said tubular member being substantially tubular in transverse cross section and including a number of side panels equal to the side panels in said box-like member, said tubular member being disposed in use in surrounding relationship with said box-like member and secured thereto with the side panels of said tubular member respectively disposed in back-to-back engagement with the side panels of said box-like member, the corrugations of each of said side panels of said tubular member extending in directions crossed with respect to the directions of the corrugations of the adjacent side panel of said box-like member, and one of said end panels having an opening therein to facilitate the emission of sound waves therefrom whereby the crossed corrugations of said end panels and said back-to-back side panels cooperate to facilitate the suppression of undesirable sound waves emitted from said loudspeaker enclosure.

12. A loudspeaker enclosure comprising two generally tubular members of corrugated board, each of said tubular members being substantially tubular in transverse cross section and including side panels disposed substantially parallel to the longitudinal axis of said tubular members, the corrugations of each of said panels of one of said tubular members extending in directions substantially parallel to the longitudinal axis thereof, the corrugations of each of said panels of one of said tubular members being crossed with respect to the corrugations of the associated panel of the other of said tubular members, each of the panels of said one tubular members having two flaps respectively connected thereto at the opposite ends thereof, each of said flaps at one end of said one tubular member having a recess formed therein centrally of the free edge thereof, said flaps being disposed in use in a folded configuration wherein said flaps at each end of said one tubular member are secured together to form two back-to-back end panels closing the adjacent end of said one tubular member, the recesses of said flaps mating to form a loudspeaker opening in the corresponding end panel at said one end of said one tubular member when said flaps are disposed in the folded configuration thereof, the corrugations of each end panel of said one tubular member extending in directions crossed with respect to the corrugations of the other end panel at the same end of said one tubular member, said tubular members being disposed in use in an assembled configuration with said one tubular member snugly received within the other tubular member coaxially therewith and secured thereto for forming a closed housing, each one of said side panels of said one tubular member being disposed in back-to-back engagement with a corresponding side panel of said other tubular member when said tubulr members are disposed in the assembled configuration thereof with the corrugations of the panels of each of said side walls extending in mutually crossed directions, whereby the corrugations of the back-to-

back end panels and side panels of said housing facilitating the suppression by said panels of undesirable sound waves emitted from said loudspeaker enclosure.

13. A sound reproduction system comprising two generally tubular members of corrugated board, each of said tubular members including side panels disposed substantially parallel to the longitudional axes of said tubular members, said tubular members being disposed in use in an assembled configuration with one of said tubular members snugly received within the other of said tubular members coaxially therewith, the corrugations of each of said side panels in said one tubular member extending in directions crossed with respect to the directions of the corrugations of the adjacent side panel of said other tubular member, at least certain of the side panels of said one tubular member having flaps respectively connected thereto in the opposite ends thereof, said flaps being disposed in use in a folded configuration with said flaps overlying to provide two layers of corrugation at each end of said one tubular member with the corrugations in one layer being crossed with respect to the corrugations in the other layer to form end panels closing the adjacent end of said one tubular member, the flaps forming the end panel at one end of said one tubular member being shaped to provide a loudspeaker opening in the folded configuraiton thereof, and a loudspeaker mounted in said housing and disposed in alignment with said opening for transmitting therethrough to the exterior of said housing sound waves generated thereby.

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