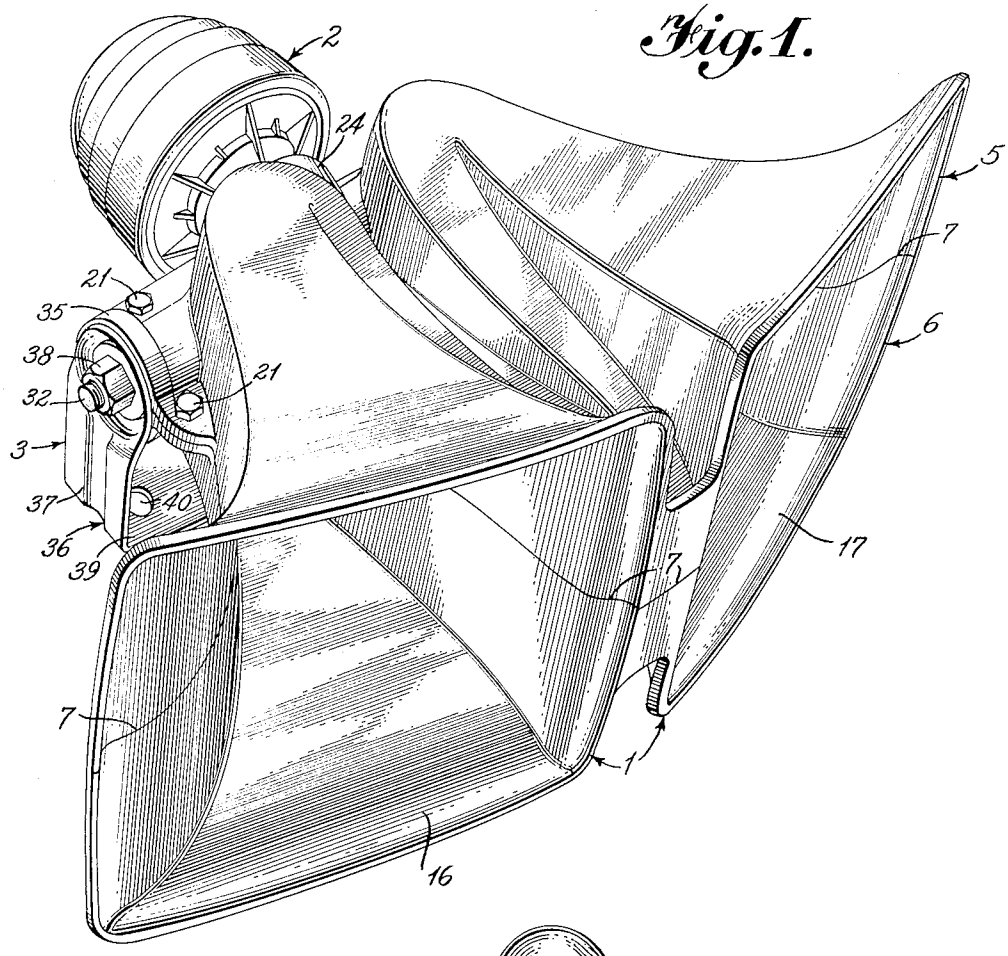
May 22, 1956 S. E. LEVY 2,746,558

REFLEX TYPE LOUDSPEAKERS

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Fig. 1.



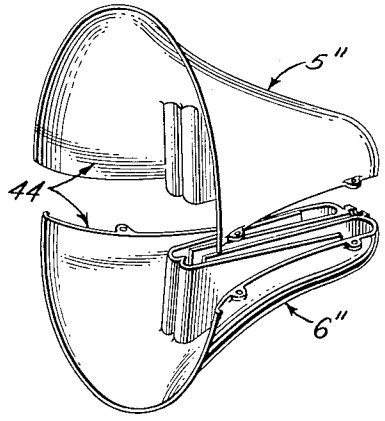


Fig. 6.

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Fig. 2.

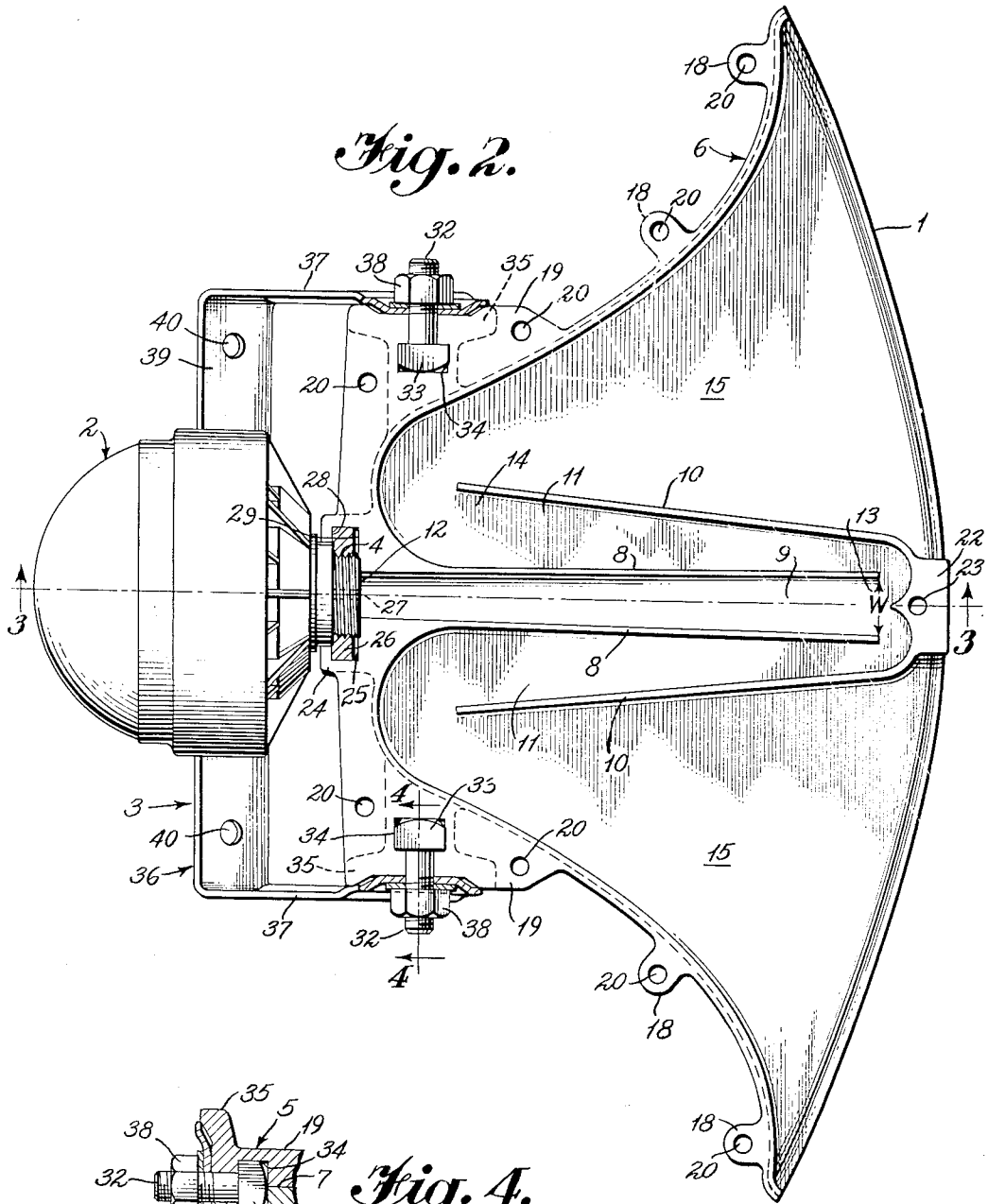
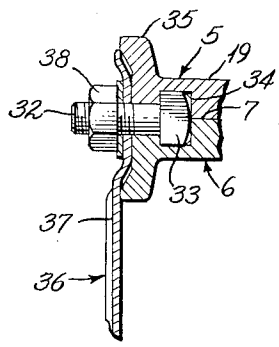


Fig. 4.



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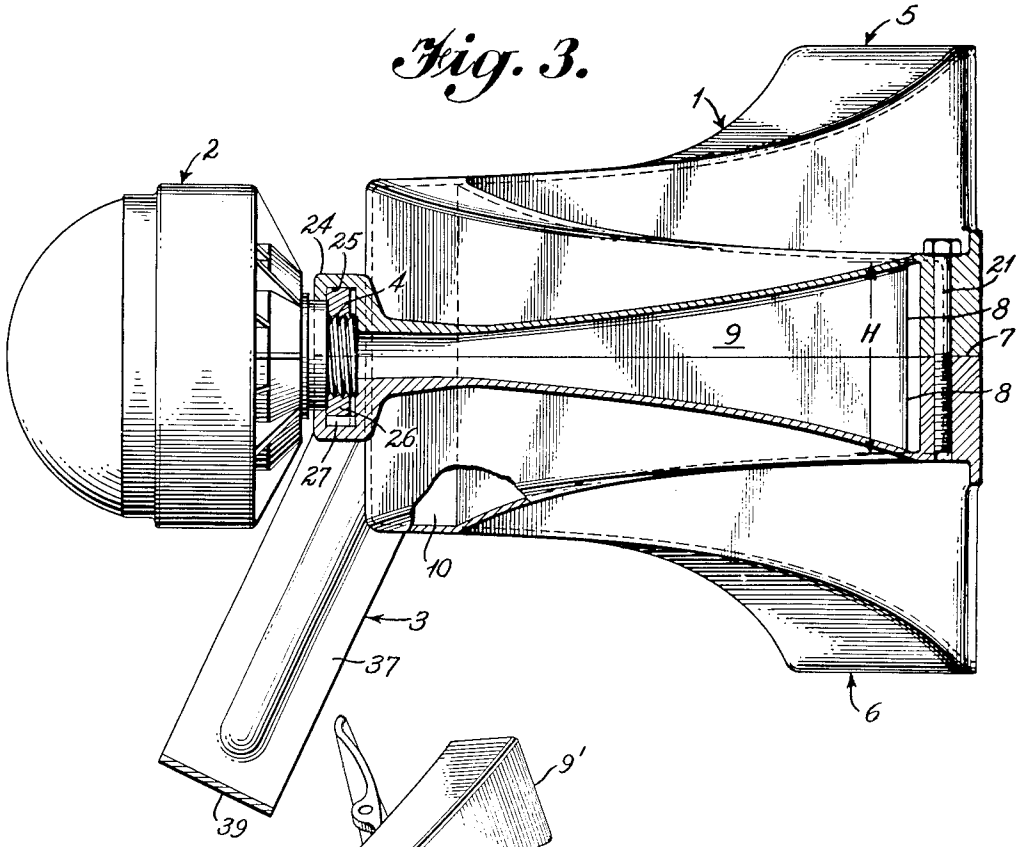
ATTORNEYS

May 22, 1956 S. E. LEVY 2,746,558

REFLEX TYPE LOUDSPEAKERS

Filed June 24, 1952 3 Sheets-Sheet 3

Fig. 3.



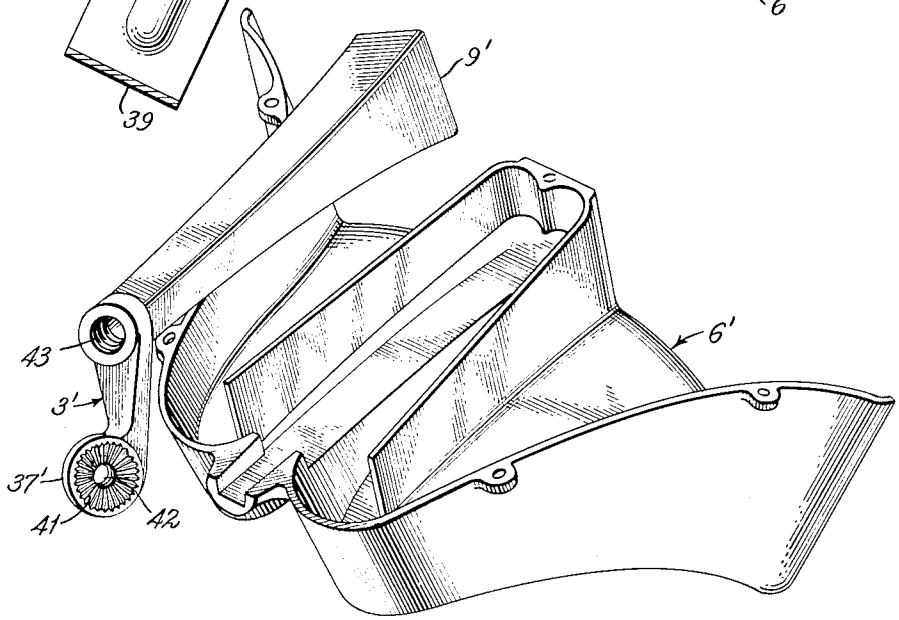


Fig. 5.

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United States Patent Office

2,746,558

Patented May 22, 1956

2,746,558

REFLEX TYPE LOUDSPEAKERS

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Application June 24, 1952, Serial No. 295,238

10 Claims. (Cl. 181—27)

The present invention relates to sound reproducing devices, and more particularly, to loudspeakers and horns therefor of the internally reversed or reflex type, by means of which the sounds being reproduced are directed in and confined to a predetermined continuous path which reverses its direction at least one or more times between the inlet or throat of the speaker and the outlet or mouth thereof.

Heretofore, double-bend reflex loudspeaker horns, as conventionally manufactured, have been constructed by assembling numerous component parts which essentially constitute three separate elements that form an air column or duct having a cross-sectional area that increases in proportion to the distance from the throat or inlet of the column and in accordance with a predetermined exponential formula. The first element, starting at the throat, is commonly referred to as the "tone arm." At the mouth or large end of the tone arm, the sound is reversed between the outer walls of the tone arm and the inner walls of an element commonly known as a "reflector." At the opposite large end of the reflector, the sound is again reversed between the outer walls of the reflector and the inner walls of a member known as the "bell." Usually in these conventional horns, the sounds are radiated in all directions about the central axis of the speaker as the sounds travel forwardly from the throat to the mouth thereof along the continuous air duct or column which usually is of annular form beyond the tone arm after the first reversing bend in the case of a double reflex type speaker.

When loudspeakers are made of such conventional component parts as above described, the parts often tend to work loose, with consequent development of spurious and disagreeable vibrations during operation of the speaker.

Accordingly, one of the primary objects of the present invention is to provide an improved, efficient and rugged loudspeaker horn of the reflex type which is composed of relatively few individual component parts which may be quickly and easily assembled, and which, when assembled, virtually eliminate any likelihood of producing spurious vibrations, with consequent superior fidelity of sound reproductions, and improved smoothness and consistency in operation.

A further object of the invention is to provide a loudspeaker horn of the reflex type which is preferably composed primarily of two identical and symmetrical horn sections, each of unitary form, and which, when assembled together, define a continuous air column or duct of re-entrant channel form and of substantially rectangular cross-section throughout its full length, and serving to direct and confine the sound travel in an axial direction in one plane.

Another object of the invention is to provide a loudspeaker horn of the aforementioned type, wherein the height and width of the air or sound column bear a predetermined proportional relationship to each other at substantially all points along the path of travel of the

sound, and more particularly, at each reversal or bending point of the sound, commonly referred to as the "window radius," whereby to attain a minimum window radius that is consistent with a cross-sectional area of the required size, and thereby minimizing phase inequalities and consequent losses of high frequencies in the normal audible range. I have found that by proportioning the dimensions of the sound channel or column so that its height is greater than its width at the window radius, only relatively few high frequency tones are lost, and only then near the extreme upper limit of the audible frequency range where such losses are tolerable and do not substantially affect the fidelity of the sound reproductions.

In carrying out the aforementioned objectives, it is a still further object of the invention to provide a simplified and improved mounting means for mounting or supporting the loudspeaker assembly, said mounting means including a part or parts recessed in the respective half-sections of the horn and rigidly and fixedly clamped therebetween when the aforesaid helf-sections are secured together in assembled condition.

Still another object of the invention is to provide an improved mounting for operatively connecting the usual driver or motor unit to the speaker horn, said latter mounting preferably including an internally threaded, non-rotatable collar recessed in the respective half-sections of the horn and loosely confined therein when the half-sections are secured together in assembled condition, said collar being adapted to threadedly engage an externally threaded neck on the driver unit, and thus draw both the driver unit and the collar tightly against the horn when the threaded parts aforesaid are screwed together, thereby insuring a firm and rigid locking of the driver unit to the horn.

Other and further objects and advantages of the invention will be hereinafter described and the novel features thereof defined in the appended claims.

In the drawings:

Fig. 1 is a perspective view of a complete loudspeaker assembly constructed in accordance with one illustrative embodiment of the present invention;

Fig. 2 is a view partly in top plan and partly in horizontal section of the assembly shown in Fig. 1 with the upper half-section of the horn removed;

Fig. 3 is a vertical sectional view of the complete speaker assembly as taken on the plane of the line 3—3 of Fig. 2, through the central axis of the speaker assembly;

Fig. 4 is a fragmentary sectional detail view as taken on the plane of the line 4—4 of Fig. 2, through one of the mounting trunnions;

Fig. 5 is an exploded perspective view of a modified horn and mounting construction, with only one of the two main horn sections being shown, and the complementary identical horn section omitted for the sake of clarity; and

Fig. 6 is an exploded perspective view on a somewhat smaller scale of another modified form of the horn assembly which consists of two symmetrical and identical half-sections.

Like reference characters designate corresponding parts in the several figures of the drawings.

Referring first to Figures 1 to 4 inclusive in which I have illustrated one practical embodiment of my invention, it will be seen that the speaker assembly as a whole includes three principal elements or units, namely, a horn generally designated 1, a driver or motor unit generally designated 2 and which may be of any suitable construction, and a mounting bracket generally designated 3. The motor or driving unit 2 as illustrated in the drawings corresponds to a typical and well-known conventional con-

struction, and the details thereof are not material to the present invention except to the extent that the motor or driver unit is preferably provided with a reduced, externally threaded neck 4 on the forward end thereof to facilitate its connection with the horn 1. Otherwise, the motor or driver unit 2 functions in the usual and well-known manner to generate and direct the sounds being reproduced into and through the horn 1.

In this particular form of my invention, the horn 1 is essentially and primarily composed of two identical and symmetrical horn sections respectively designated 5 and 6, each section constituting a half-section of the horn assembly. In the arrangement as illustrated in the drawings, the section 5 is the upper section, and the section 6 is the lower section of the horn, and the two sections are superposed one upon the other in opposed relation and butt together on a horizontal plane embracing the central axis of the horn and driver assembly of the speaker, as represented by the parting line 7 which clearly appears in Fig. 1 of the drawings.

Since each of the sections 5 and 6 is identical with the other, a detailed description of one section will suffice, and reference will now be more particularly made to Fig. 2 of the drawings. In this figure, which best shows the interior construction of the lower horn section 6, it will be seen that the section has the general form of a hollow housing or shell which is closed at its bottom, as well as at its back and at its two opposite sides thereof, the back and the sides being extended upwardly from the bottom in substantially perpendicular relation thereto.

Within this horn section 6 and extending forwardly from the back to a point near the front thereof are provided two upstanding walls or ribs designated 8, 8, said walls being joined to the bottom of the horn section and being disposed on opposite sides of the central axis of the section, with their upper edges terminating on a plane common to the outer upper edges of the horn section 6. However, it will be seen that the walls 8, 8 diverge slightly away from each other from back to front of the horn section, thereby defining therebetween a hollow air or sound channel of generally rectangular form and of progressively increasing cross-sectional area, as indicated at 9. From the forward end of the section 6, the section is provided with two reversely extended walls or ribs designated 10, 10, which likewise extend upwardly from the bottom of the horn section in substantially perpendicular relation thereto, but which diverge away from each other from front to back of the horn section. These walls 10, 10 are disposed in outwardly spaced relation to the walls 8, 8, thereby defining two re-entrant air or sound channels designated 11, 11 of generally rectangular form, and the upper edges of the walls 10, 10 likewise terminate in a horizontal plane common to the upper edges of the walls 8, 8 and the upper outer marginal edges of the horn section. It will be further seen from reference to Fig. 2 that the forward ends of the walls 10, 10 are joined together so that any sounds travelling forwardly from the throat end 12 of the duct or channel 9, will divide and reverse their direction of travel as the sounds pass from the mouth end 13 of the channel 9 into the two channels 11, 11.

The rear ends of the walls 10, 10 terminate in spaced relation to the rear wall of the horn section 6, so that as the sounds emerge from the mouth ends of the reflector walls 10, 10, at 14, the sounds will again reverse their direction of travel and will be directed forwardly through the large ducts or channels 15, 15 that are defined between the respective walls 10, 10 and the opposite side walls of the housing or horn section 6 which generally forms an outer bell from which the sounds are ultimately discharged at the extreme forward end of the horn section 6.

It will be understood from the foregoing that when the two half-sections 5 and 6 are assembled together, one upon the other, in the manner shown in Fig. 1 of the drawings, there will be defined within the assembled horn a central

duct or sound column of generally rectangular form and of progressively increasing cross-section, said central duct or column constituting the tone arm of the speaker. The discharge end of the central duct leads without interruption into two sepaarte ducts or sound columns located outwardly and on opposite sides thereof, and through which the sounds are directed in a reverse direction as guided by the walls 10, 10 of the assembled abutting horn sections 5, 6, these walls corresponding to the usual reflector. The ducts or channels defined by the reflector walls are likewise of generally rectangular form and of progressively increasing cross-sectional area, and on leaving the latter ducts or sound columns, the sounds are again reversed in their direction of travel and continue forwardly through the enlarged channels at the opposite outer sides of the reflector walls 10, 10, said enlarged channels likewise being each of generally rectangular form and of progressively increasing cross-sectional area as defined by the belled shape of the outer side walls of the speaker sections. As the result of the construction just described, the sounds emerge through two separate and distinct channels respectively designated 16 and 17 in Fig. 1, the discharge mouth of these channels being of any suitable or desired design, shape or size, but preferably corresponding to that disclosed in Patent No. 2,690,231 dated September 28, 1954, thereby causing a relatively wide spread or horizontal distribution of the sounds emitted from the mouth of the speaker.

By reason of the construction of the speaker sections 5 and 6 in the form as hereinbefore described, the sound travelling through the speaker is always confined and directed in an axial direction in one plane, and it cannot spread radially in all directions while passing through the speaker. This has the important advantage of improving the fidelity of the sound reproduction, and at the same time improving the smoothness and consistency of operation of the speaker.

I have also found that in loudspeakers of the reflex type, it is important that the width or clearance around each bend in the path of the sound travel, and commonly denoted the "window radius," should be as small as possible in order that there will be a minimum of path-length inequality around this bend or radius. Any substantial differences between the shortest and longest path-lengths around each bend will result in phase inequalities, with a consequent loss of high frequencies. When these window radii are held to a minimum, phase discrepancies occur only at very high frequencies at the upper limit of the audible range where such losses are tolerable. To obtain a window radius which is small, it is necessary that the ratio of duct height to duct width of the tone arm mouth shall be as great as possible, within reasonable limits. However, since the window must have a prescribed area, this area may be achieved with infinite combinations of duct height to duct width. From a practical standpoint, I have found that superior and very satisfactory results may be obtained in loudspeakers constructed in accordance with the present invention by maintaining the duct height always greater than its width and within a range on the order of from 1:1 to 10:1. In the drawings, the duct height is designated H, and the duct width is designated W, and while these designations have been applied more particularly to the mouth of the tone arm duct of the speaker, it will be understood that they are equally applicable to the mouth ends of the ducts defined by the reflector walls of the speaker, as well as at other points along each continuous sound duct or column.

In order to secure the two half-sections 5 and 6 of the speaker horn 1 together, each section is preferably provided with a plurality of laterally extended ears or webs, such as the ears 18 and webs 19, which are disposed at spaced intervals along the upper and lower outer marginal edges of the respective sections, said ears and webs being formed with suitable openings 20 extended therethrough

for receiving clamping bolts 21 or other appropriate fastening means for clamping the two sections 5 and 6 together in abutting relation to each other along the separating line 7. At the front end of the horn 1, beyond the extreme forward ends of the walls 8, 8 which define the tone arm of the horn, the horn sections are suitably thickened as at 22 and merge into the reflector walls 10, 10, said thickened portions 22 of each section closing the front ends of the respective channels 11, 11, and abutting together on the parting line 7. An opening 23 is formed in the thickened portion 22 of each horn section 5, 6 for receiving therethrough one of the clamping bolts 21 (see Fig. 3).

At the rear end of the horn assembly, the webs 19, 19 are preferably rearwardly extended and enlarged, as at 24, so as to form a cylindrical boss or hub which is in axial communication with the throat end 12 of the tone arm defined between the walls 8, 8. This hub-forming portion of each horn section is preferably provided with an interior annular groove 25 within which is adapted to be seated an internally threaded annular ring or collar 26, said collar preferably being freely shiftable axially in the groove to a limited extent when the two horn sections are clamped or secured together in assembled condition, but being held against rotation within the groove by any suitable means such as a key 27 seating in an axially extended key seat in the outer periphery of the collar and also seated in a complementary axially extended key seat formed in the base of the groove 25. To secure the driver or motor unit 2 to the horn assembly, the threaded neck 4 of the driver is screwed into the collar 26 until the nose of the threaded neck of the driver butts against the forward wall 29 of the annular groove 25 surrounding the throat end 12 of the sound channel or tone arm 9, after which, continued rotation of the driver will cause the collar 26 to move rearwardly on the threaded neck 4 until the collar butts tightly against the rear wall 28 of the annular groove so as to firmly lock the driver to the horn 1, with the neck of the driver tightly pressed against the throat end of the tone arm. It will thus be understood that the collar 26 is recessed in both horn sections 5 and 6 and is enclosed between these horn sections when the sections are secured together in assembled condition, while serving to rigidly and tightly lock the driver or motor unit 2 to the horn 1.

As will be seen from reference to Figures 1 to 4 inclusive, the horn 1 is preferably provided with means for conveniently mounting the speaker assembly on a support, and also to permit the speaker assembly to be pivotally adjusted about an axis transverse to the central axis of the speaker. According to the illustrative embodiment shown in the drawings, the mounting means aforesaid includes two oppositely and laterally extended trunnions designated 32, 32, said trunnions each having the form of a bolt provided with a square or other non-circular head 33 on its inner end. The head 33 of each bolt 32 is partially seated in a recess of corresponding shape formed in each of the two horn sections 5, 6, said recesses being designated 34, and on assembly of the horn sections, said recesses serving to clamp both heads between the horn sections and positively lock or hold the bolts 32 against rotation relative to the horn sections. Each recess 34 is laterally extended to the outer side of the webs 19 so as to snugly fit about the shank of each trunnion bolt 32 near the head of each bolt, and each web 19 may be appropriately thickened or otherwise enlarged as at 35, to strengthen the horn structure in the zone of the trunnion bolts 32.

Each trunnion bolt 32 is of sufficient length to extend somewhat beyond the outer side of the horn structure so that a U-shaped mounting bracket 3 may be connected to the trunnions, each trunnion extending through one of the arms 37, 37 of the bracket 3. A nut 38 is preferably engaged on the outer threaded end of each trunnion bolt 32 so that the speaker assembly may be tightly

clamped in any desired position of pivotal adjustment about the axis of the trunnions and relative to bracket 3. The base 39 of the bracket 3, which extends transversely between the arms 37, 37 and interconnects the latter together, may be provided with any suitable number of apertures 40 for anchoring the bracket to any suitable supporting structure such as a wall, post or the like.

It will be readily recognized from the foregoing description of the speaker assembly that each half-section of the horn may be suitably fabricated of sheet metal, but may preferably and more economically be made in the form of a unitary die-casting of aluminum or other appropriate metal. When made of a metal die-casting, each horn section can be cast complete in one piece, and will be especially rugged and durable, without having any individual component parts that could work loose during operation of the speaker. The two sections of the horn assembly can be quickly assembled and clamped together by means of a relatively few clamping bolts 21, and the driver or motor unit 2 can be quickly and easily assembled with the horn by screwing the driver into the collar or ring 26 until the driver is tightly locked against the rear end of the horn.

In Fig. 5 of the drawings, I have shown a slightly modified form of horn construction which primarily differs from the construction shown in Figures 1 to 4 inclusive by the fact that the tone arm or central duct is formed separately and preferably in one piece, as indicated at 9', said tone arm preferably being of rectangular form and of progressively increasing cross-sectional area just as in the case of the construction first described. In this modified construction, the tone arm 9' is seated within and is firmly clamped between two horn sections which may correspond exactly with the sections 5 and 6 respectively in the construction first described herein, except for the omission of the walls 8, 8 in the latter sections which define the tone arm in the first form. Only the lower horn section designated 6' of the modified construction is shown in Fig. 5, but it will be understood that this section 6' is adapted to be assembled with an identical section which forms the upper half of the horn assembly when inverted and mounted on the lower section 6', with the tone arm 9' firmly clamped between the two sections.

In this modification shown in Fig. 5, the tone arm is shown as being provided with an integral mounting bracket or arm 3' having an enlarged circular head 37' formed on the free end thereof, said head 37' being preferably serrated on one face thereof as at 41 and further provided with a central opening 42 extended laterally therethrough for the reception of a clamping bolt (not shown) to adjustably clamp the serrated head 37' to a corresponding complemental serrated mounting (not shown).

Also in this modified construction, the end of the mounting arm 3' which joins the tone arm 9' is bored and internally threaded as at 43 so that the threaded neck 4 of a driver unit like that shown in Figs. 1 to 4 inclusive, may be tightly screwed into the threaded bore 43 until the driver is firmly seated against and locked to the rear end of the tone arm 9'.

Still another modified horn construction is shown in Fig. 6 of the drawings. According to this modified construction, the horn is also composed of two identical and preferably one-piece symmetrical horn sections respectively designated 5'' and 6'' which are assembled together in the same manner as the sections 5, 6 in the form shown in Figs. 1 to 4 inclusive. The horn sections 5'', 6'' generally correspond in the form to the sections 5, 6, except that the outer shape of the assembly is generally circular in cross-section and flares outwardly from back to front in the manner of a bell. In this modified construction, the sound ducts, beginning with the throat of the tone arm, are formed in exactly the same manner as in the construction shown in Figs. 1 to 4 inclusively, but instead of the sounds being discharged at the mouth end of the

speaker assembly directly from two separate horizontally diverging rectangular outlets as in the construction of Figs. 1 to 4 inclusive, the sounds emerge from the two outlets within a common outwardly flared mixing chamber designated 44 in the modified construction illustrated in Fig. 6. This modified horn construction may be connected with a driver or motor unit in the same manner as that shown in Figs. 1 to 4 inclusive, or in any other suitable manner as may be preferred, and the speaker assembly may be mounted or supported in any of the various ways as described in the foregoing with respect to the other forms, or otherwise as desired.

While the specific details have been herein shown and described, it is to be understood that my invention is not confined thereto as changes and alterations may be made without departing from the spirit thereof as defined by the appended claims.

I claim:

1. A loudspeaker horn of the reflex type, comprising two unitary, identical and symmetrical half-sections having abutting walls defining a continuous rectangular sound channel within the same, the sound path through said channel expanding in two directions at right angles to one another and being substantially reversed at least once between the throat end of said channel and its mouth, and said channel being of such form as to substantially confine and direct the sounds in one plane extending in the direction of travel of the sounds through said channel.

2. A loudspeaker horn as defined in claim 1, wherein said rectangular sound channel is of progressively increasing cross-sectional area and has a height greater than its width.

3. A loudspeaker horn as defined in claim 1, wherein the walls of the respective half-sections of the horn have abutting contact with each other on a common median plane between the top and bottom of the sound channel throughout the length of said channel, and said channel being of progressively increasing cross-sectional area and having a height to width ratio within a range on the order of from 1:1 to 10:1.

4. A loudspeaker horn of the double reflex type, comprising two identical, symmetrical and unitary opposed horn sections, each of said sections having the form of a hollow half-shell and being closed at its outer marginal sides except at its front, a pair of laterally spaced walls disposed substantially normal to the bottom of one section and to the top of the opposed section and longitudinally extended from the back of each section toward the front thereof, said latter walls defining a central sound channel therebetween, a second pair of laterally spaced walls respectively disposed in each half-shell in outwardly spaced relation to the walls of the central sound channel aforesaid and in inwardly spaced relation to the outer marginal side walls of each half-shell, said second pair of walls also being disposed substantially normal to the bottom of one half-shell and to the top of the other half-shell and longitudinally extending rearwardly from the front of each horn section but terminating in spaced relation to the back thereof, said second pair of walls in each half-shell being interconnected at their front ends by a transversely extended front wall disposed in spaced relation to the forward ends of the walls of the central sound channel, said second pair of walls defining two re-entrant sound channels disposed respectively at opposite sides of the central sound channel, but having continuous communication with the common central sound channel so that the sounds from the central sound channel will divide and pass into both re-entrant channels near the front of the horn, and then will be directed to the rear of the horn and finally back to the front of the horn from which the sounds will be emitted from two divergent mouths at the front of said horn.

5. A loudspeaker horn as defined in claim 4, wherein the edges of the marginal side walls and the spaced pairs of sound channel defining walls of each half-shell lie in a common plane for abutting engagement with each other when the horn sections are assembled in opposed relation to each other, and the sound channels all being of substantially rectangular cross-section and of progressively increasing cross-sectional area, with the height of each sound channel greater than the width thereof.

6. A loudspeaker of the class described, comprising two identical and symmetrical unitary horn half-sections defining a continuous sound channel therethrough when assembled together in opposed relation to each other, means for separately securing said horn sections together in assembled relation, a driver operatively connected to and communicating with the sound channel aforesaid, and mounting means for supporting said horn sections and driver, said mounting means including a member recessed in each horn half-section and rigidly clamped therebetween when said half-sections are secured together.

7. A loudspeaker of the class described, comprising two identical and symmetrical unitary horn half-section defining a continuous sound channel therethrough when assembled together in opposed relation to each other, means for separably securing said horn sections together in assembled relation, a driver operatively connected to and communicating with the sound channel aforesaid, and mounting means for supporting said horn sections and driver, said mounting means comprising a trunnion member recessed in each horn half-section and rigidly clamped therebetween when said half-sections are secured together.

8. A loudspeaker of the class described, comprising two identical and symmetrical unitary horn half-sections defining a continuous sound channel therethrough when assembled together in opposed relation to each other, means for separably securing said horn sections together in assembled relation, a driver operatively connected to and communicating with the sound channel aforesaid, and mounting means for supporting said horn sections and driver, said mounting means comprising a trunnion member laterally extended from each of the opposite sides of the horn assembly, each of said trunnion members being recessed in each horn half-section and rigidly clamped therebetween when said half-section are secured together.

9. A loudspeaker of the class described, comprising two identical and symmetrical unitary horn half-sections defining a continuous sound channel therethrough when assembled together in opposed relation to each other, means for separably securing said horn sections together in assembled relation, a driver operatively connected to and communicating with the sound channel aforesaid, and locking means for rigidly locking said driver to the assembled horn sections, said locking means comprising an internally threaded collar recessed in each horn half-section and non-rotatably clamped therebetween but free for limited axial movement relative thereto when the horn sections are secured together, and said driver having an externally threaded neck for threaded interlocking engagement with said collar, the extreme outer end of said threaded neck being tightly pressed against the horn half-sections at the entrance to the sound channel when the driver is locked to the assembled horn sections by the locking means aforesaid.

10. A loudspeaker of the class described, comprising two identical and symmetrical unitary horn half-sections defining a continuous sound channel therethrough when assembled together in opposed relation to each other, means for separably securing said horn sections together in assembled relation, a driver operatively connected to and communicating with the sound channel aforesaid, and locking means for rigidly locking said driver to the assembled horn sections, said horn sections having an annular recess formed therein adjacent to the entrance to said sound channel, and said locking means comprising an internally threaded collar seated in said annular recess and non-rotatably clamped therebetween but free for limited axial movement relative thereto when the

horn sections are secured together, and said driver having an externally threaded neck for threaded interlocking engagement with said collar, the extreme outer end of said threaded neck being tightly pressed against the horn half-sections at the entrance to the sound channel when the driver is locked to the assembled horn sections by the locking means aforesaid.

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