April 20, 1965 G. McL. COLE ET AL 3,179,202

ENCLOSURE FOR FOCUSING A LOUDSPEAKER SOUND COLUMN

Filed April 15, 1963 2 Sheets-Sheet 1

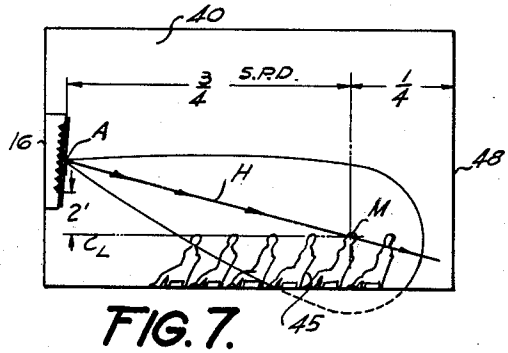


FIG. 7.

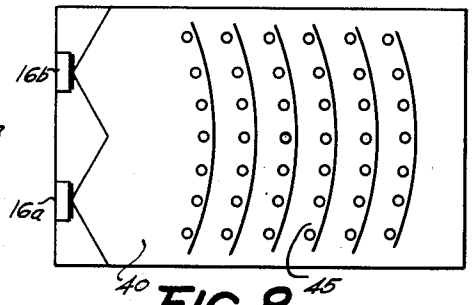


FIG. 8.

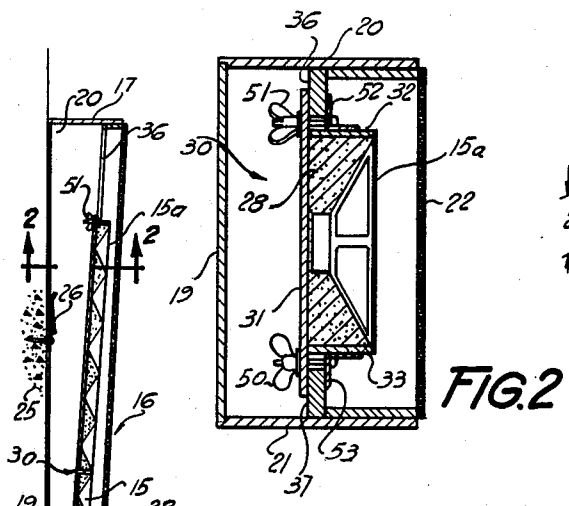


FIG. 2.

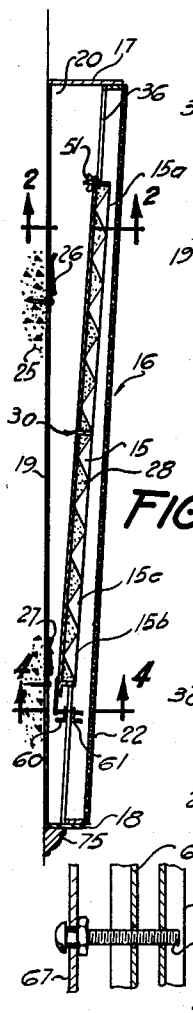


FIG. 1.

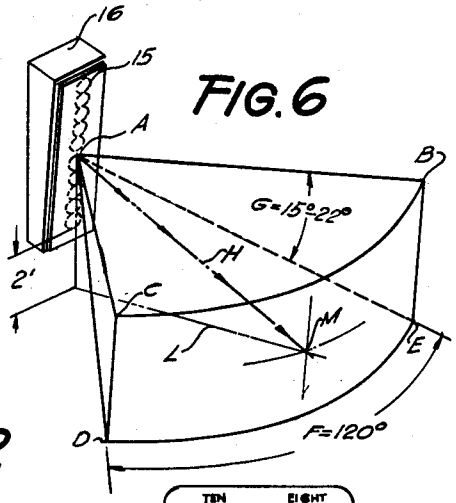


FIG. 6.

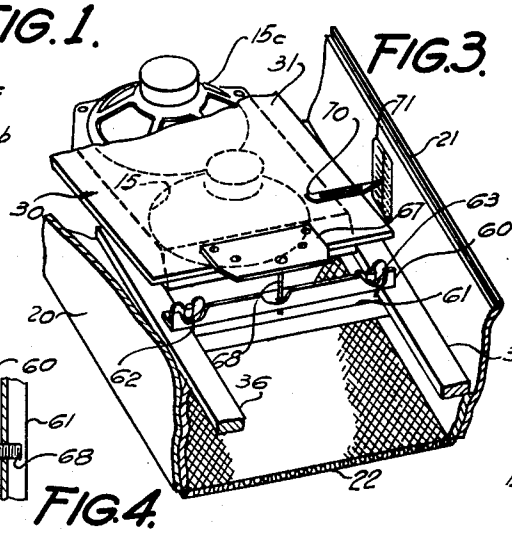


FIG. 3.

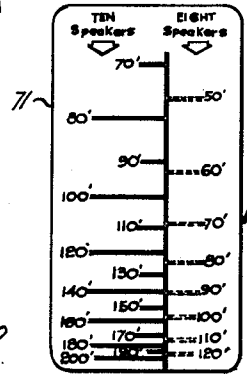


FIG. 5.

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ENCLOSURE FOR FOCUSING A LOUDSPEAKER SOUND COLUMN

Filed April 15, 1963 2 Sheets-Sheet 2

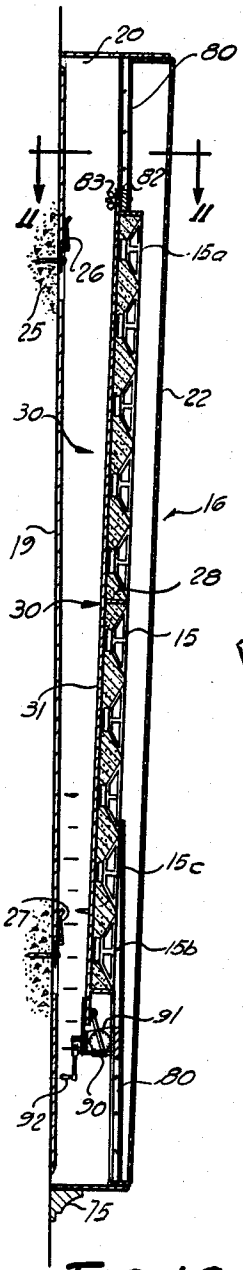


FIG. 10.

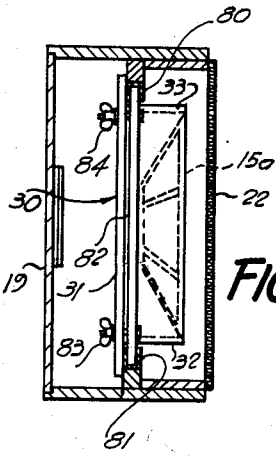


FIG. 11

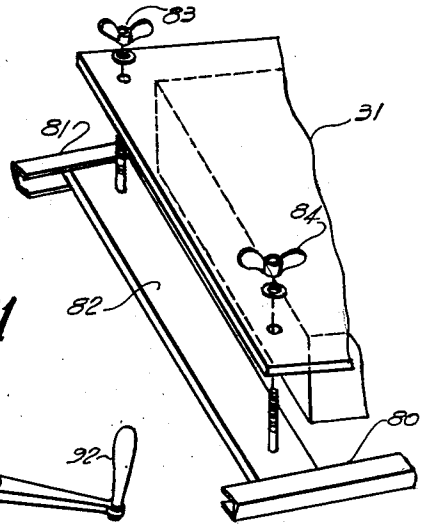


FIG. 12.

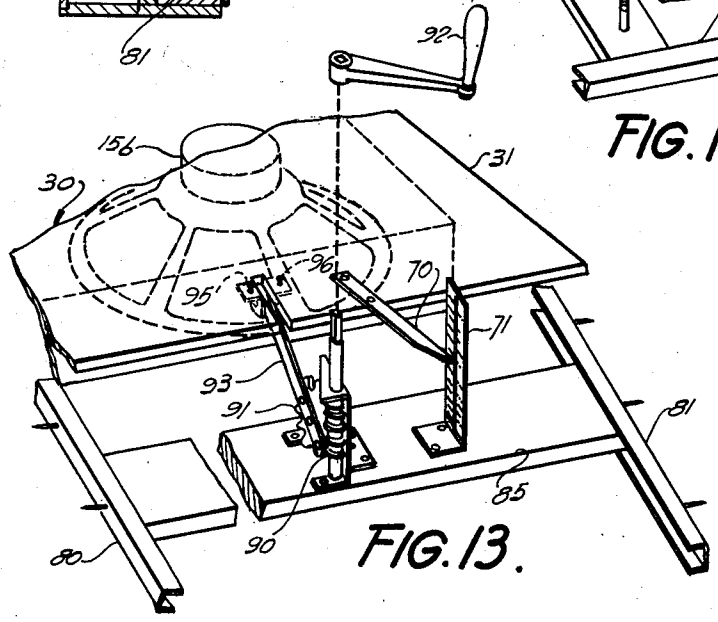


FIG. 13.

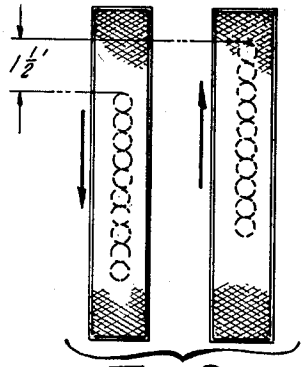


FIG. 9.

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ENCLOSURE FOR FOCUSING A LOUDSPEAKER SOUND COLUMN

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5 Claims. (Cl. 181—31)

This invention relates to loudspeaker systems of the type employing sound columns, and in particular to improvements in enclosures for focusing sound columns. A sound column comprises a plurality of loudspeakers, usually six to ten units, arranged within an enclosure or on a baffle with the speaker cones being rectilinear and their axes parallel or substantially parallel.

If a loudspeaker sound column is vertically disposed, the resultant sound is beamed or focused in a pattern which is wide horizontally and narrow vertically. This sound pattern is ideally suited for high reverberation rooms, such as large auditoriums, churches and theatres, all of which require voice reinforcing public address systems. In rooms of this type, the beamed pattern concentrates the sound so as to cover wide listening areas in the horizontal plane; and at the same time this particular pattern minimizes undesirable reverberation created by the sound reflections from the back wall and ceiling.

On the other hand, when a single loudspeaker, or several single loudspeakers, are used in a large room with hard surfaces, sounds reflected by the back wall and ceiling, as well as the sounds radiated by the loudspeaker, all reach the listener. The sounds from these several apparent sources arrive at the listener's ear at different times. The resulting reverberation makes the speech hard to understand and in some cases unintelligible.

Because of the sound focusing characteristics of a sound column, the enclosure or baffle supporting the loudspeakers must be properly disposed within a room so that audience coverage will be optimum. This usually requires accurate focusing or aiming of the column's sound axis by making critical column tilt and height adjustments.

With most sound column enclosures of the prior art, it is necessary for the installer to obtain the proper tilt angle for mounting the unit by using a variety of chains, brackets, clamps, etc. These arrangements require a great deal of installation labor, in addition to being unsightly in most cases. Additionally, proper acoustic placement of the sound column often dictates a relatively high mounting height which is detrimental to room decor.

Accordingly, a principal object of this invention is to provide a sound column enclosure which may be readily mounted without creating an unsightly installation and which may be accurately focused to cover audience areas of various sizes and rooms of varying lengths.

Another object is to improve the sound characteristics of loudspeaker systems employing sound columns.

A preferred embodiment of the sound column enclosure of this invention features an enclosure box which may be fixedly mounted at a relatively low height within a room. This box may be advantageously mounted flush against a wall and mounted upon an existing dado rail without the use of adjusting straps or adjusting links. Thus, the sound column installation is pleasing when viewed by the audience, and does not require the use of long ladders for mounting.

The column of loudspeakers is mounted within the enclosure upon a movable column support which is preferably adjustable in both the horizontal and vertical planes. Thus, the focusing of the loudspeaker column occurs within a fixed enclosure, and the heretofore externally disposed and unsightly adjusting linkages are isolated from the sight of the audience. Additionally, the sound column enclosure box is readily flush mounted by simple wall brackets or like devices.

Heretofore, focusing a sound column, has required trial-and-error techniques, or in the alternative, the installer had to make complicated mounting angle calculations.

Another feature of the sound column enclosure of the present invention relates to a focusing gauge which enables the installer to focus the device by making simple adjustments which control both the height and the inclination angle of the movable column support which carries the loudspeaker column. The gauge indicates the proper focusing angle for a given room length without the necessity for trial and error adjustments or calculations.

In order that all of the features for attaining the objects of this invention may be readily understood, reference is herein made to the drawings wherein:

FIG. 1 is a side elevational view in section showing a loudspeaker sound column employing a first preferred embodiment of the invention;

FIG. 2 is a sectional view taken along line 2—2 of FIG. 1 and showing the manner in which the loudspeaker column support is adjusted to effect focusing;

FIG. 3 is an enlarged perspective view of that portion of the sound column of FIG. 1 which effects angular inclination of the loudspeaker column support to effect focusing;

FIG. 4 is a fragmentary view showing the coupling details of the inclination adjusting bolt;

FIG. 5 is a focusing scale showing optimum room lengths for various angular inclinations of the loudspeaker column support of the sound column enclosure shown in FIGS. 1 through 3;

FIG. 6 shows the sound projection pattern for a loudspeaker sound column;

FIG. 7 shows the proper focusing of the sound projection pattern to cover a sitting audience;

FIG. 8 shows the proper disposition of a pair of sound column enclosures to cover adequately a listening audience in a large rectangular room;

FIG. 9 is a view showing the limits to which the loudspeaker sound column support can be moved upwardly and downwardly in the embodiments of this invention shown in FIGS. 1 and 10;

FIG. 10 is a side elevational view in section showing a loudspeaker sound column employing a second preferred embodiment of the invention;

FIG. 11 is a sectional view taken along line 11—11 of FIG. 10 and showing in detail the arrangement by which the loudspeaker column support is adjusted to effect focusing;

FIG. 12 is an exploded view showing the adjustment structure of FIG. 11 in greater detail; and

FIG. 13 is an enlarged perspective view showing the structure of FIG. 10 for inclining the loudspeaker sound column support to effect focusing.

Referring now to the loudspeaker enclosure shown in FIGS. 1 through 3, a plurality of conventional cone type loudspeakers 15 are disposed in a column within an elongated rectangular enclosure box 16. This box is formed with top 17, bottom 18, back 19, side walls 20 and 21, and front wall 22 which has a cloth covered opening for efficient sound transmission.

The enclosure box 16 is vertically mounted flush with a wall 25 of a room by a pair of clips 26 and 27.

Ten cone type loudspeakers 15 are fixedly mounted on column support 30 to form the column. Column support 30 comprises a back 31, facing the enclosure box back 19, and connecting sides 32 and 33. The front and back of each loudspeaker cone are not isolated so that undesirable

low frequency sounds will be canceled. Loose woven acoustic material 28 may, however, be loosely packed around the back of each loudspeaker cone.

Column support 30 is movably supported on a pair of guide rails 36 and 37 in a manner which will be outlined in greater detail hereinafter so that column support 30 and the loudspeaker column may be angularly inclined within enclosure box 16, and also moved upwardly or downwardly in a vertical plane as is shown in FIG. 9.

FIG. 6 shows the sound projection pattern for sound columns of the type shown in FIGS. 1 through 3 and also FIGS. 10 through 13. The principle of operation of a sound column is similar to that of a highly directional antenna array in which each antenna element reinforces and directs the radiation emanating from other elements. The sound projection pattern of enclosure 16 is wide horizontally and narrow vertically, resembling a piece of pie. In particular, the sound emanating from the column is beamed so as to be confined principally within the pie shaped volume defined by lines AB, AC, AD, AE, BE, DE, BC and CD.

The horizontal projection angle F is of the order of 120° regardless of the number of loudspeakers used in the column. For example, an eight loudspeaker column and a ten loudspeaker column both display horizontal projection angles of the order of 120°.

The vertical projection angle G is very narrow and varys with the number of loudspeakers used in the column. A 15° vertical projection angle is characteristic of a ten loudspeaker column, and this angle is widened to approximately 22° when the column is modified to an eight loudspeaker column. Thus, the greater the number of loudspeakers employed in the column the narrower the vertical projection angle G becomes.

The focus line or sound axis of a sound column is that line which defines the center of symmetry for the sound projection pattern of the column. Focus line H is normal to the plane which contains the open cone faces of the speaker column; and this line emanates midway from the top loudspeaker 15*a* and the bottom loudspeaker 15*b* of the column.

The placement of a sound column in relation to the sidewalls of a room is not extremely critical because of the wide horizontal projection angle. As is shown in FIG. 8, in a rectangular room 40 requiring two sound columns 16*a* and 16*b*, each column should be placed approximately one quarter of the room width away from the adjacent side wall. Likewise, the column should be placed at the same end of the room as the microphone. With such an arrangement the wide projection pattern of each sound column enables the listening audience 45 to be adequately covered.

In order that the focusing features of this invention can be employed in an optimum manner, it is important that sound columns so constructed be placed at the proper vertical height in relation to the audience 45. A preferred "rule of thumb" for this height is 2 feet above the heads of the audience for a ten loudspeaker column. A horizontal line drawn at the same elevation as the heads of an audience sitting on a horizontal floor is herein defined as the average listening level line. In FIGS. 6 and 7 the average listening level line is line L.

For a sitting audience line L is approximately 4 feet above the floor; and for reason hereinafter outlined in detail, the bottom cone edge of the bottom speaker 15*b* of the column should be approximately 6 feet from the floor or 2 feet above line L. If the audience area slants upwardly, the average audience head height should be computed, and the bottommost edge of the loudspeaker 15*b* should be placed 2 feet higher than this average height.

The foregoing height figure relates to a ten loudspeaker column. In the event a lesser number of speakers is used, then this height should be increased to approximately 2½ feet.

Tests have shown that a listening audience 45 (FIG. 7) will best be covered when the focus line H of the loudspeaker column intersects line L at a point M which is located ¾ of the distance between the back wall 48 of the room 40 to the point A. This distance is called the sound projection distance (S.P.D.), and for practical purposes is equal to the room length when the sound column is mounted at one end wall of the room.

In open field tests intelligible speech from a sound column has been transmitted from ¼ to ½ mile, even with a moderate breeze blowing. However, in a sound column for use in rooms designed so as to be flush mounted on a wall, the sound must be projected at an angle which is slightly downward. Because of this built in projection angle and the narrowness of the pattern in the vertical plane, the ideal minimum and maximum throws are important.

The maximum ideal throw for a ten loudspeaker sound column is approximately 200 feet. The minimum throw is approximately 70 feet. A sound column can be focused or aimed to cover throws in between these ideal limits.

The maximum ideal throw for an eight loudspeaker sound column is approximately 120 feet, and the minimum throw is approximately 40 feet. Focusing may be achieved for these intermediate distances. A first principal feature of the present invention relates to the manner in which this focusing is accomplished so that the point of intersection M of the focus line H with average listening level line L may be properly positioned for various room lengths.

By keeping the sound column 16 at a relatively low height, that is 2 feet for a ten loudspeaker column and 2½ feet for an eight loudspeaker column, it is possible to angularly incline the column support 30 through a very narrow adjustment range which may be accomplished within an enclosure box 16 having a practical depth.

In the loudspeaker enclosure of FIGS. 1 through 3, column support 30 is adjustable about its uppermost portion by means of the structure shown in FIG. 2. In particular, the bolt and wing nut combinations 50 and 51 which are passed through back 31 cooperate with angle iron sections 52 and 53 so that the back 31 may be tilted to a desired inclination and then fixed in position. Angle sections 52 and 53 are fastened to sides 32 and 33. Nuts 50, 51 must be drawn fairly tight to hold column support 30 in a desired vertical adjustment, as frictional engagement between elements 31, 52, 53 and guide rails 36, 37 hold column support 30 in position. However, tilting of column support 30 requires that nuts 50, 51 be sufficiently loose to permit angular adjustment of column support 30 with respect to guide rails 36, 37.

A pair of angle iron sections 60 and 61 span the distance between guide rails 36 and 37 immediately below column support 30 as is shown in FIG. 3. Bolt and wing nut combinations 62 and 63 clamp angle iron sections 60 and 61 relative to guide rails 36 and 37.

An adjustment plate 67 is attached to the lower edge of the channel back 31, and a threaded adjustment bolt 68 (FIG. 4) couples adjustment plate 67 to angle iron sections 60 and 61. The angle of inclination of the sound column support 30 may be varied by screwing bolt 68 inwardly and outwardly as required. As this angular adjustment is made it is obvious that the focus line H will likewise be moved so that the intersection point M will be moved along average listening level line L.

Pointer 70 of a focusing gauge 70–71 is affixed to the back 31 of column support 30. This pointer cooperates with a focusing scale 71 shown in detail in FIG. 5 so that proper focusing adjustments of a sound column can be made as required. Focusing scale 71 cooperates with pointer 70 so that the angle of inclination of the column support 30 may be accurately adjusted for varying room lengths and for both eight loudspeaker and ten loudspeaker columns.

The detailed use of the sound column shown in FIGS. 1 through 3 is as follows:

At the outset a determination must be made of the sound projection distance. If this distance is of the order of 70 to 200 feet, then focusing can be accomplished by a ten loudspeaker column by means of the focusing gauge **70–71** (FIG. 5). If, however, the distance is of the order of 50 to 120 feet then focusing can be accomplished by an eight loudspeaker column by use of the focusing gauge **70–71** (FIG. 5).

Assuming that the sound column is to be employed in a rectangular room **40** (FIG. 7) which is approximately 160 feet long, then a ten loudspeaker column will provide optimum coverage. The loudspeaker enclosure box **16** should be mounted at the front of the room generally as is shown in FIG. 7 by means of a pair of clips such as **26** and **27** (FIG. 1) after the following adjustments are made. The exact enclosure height is not critical so long as vertical adjustment of the support channel **30** within the enclosure can position the lowermost edge of the speaker **15***b* exactly two feet above the average listening level line L.

As is shown in FIG. 9, approximately 1½ feet of vertical adjustment of column support **30** can be provided in a preferred embodiment. Before the enclosure box **16** is mounted on the wall, column support **30** should be adjusted so that pointer **70** mates with focusing scale **71** as is shown in FIG. 3. Column support **30** is moved vertically relative guide rails **36** and **37** by loosening wing nuts **50, 51, 62** and **63**.

Angular inclination adjusting bolt **68** is thereafter screwed inwardly or outwardly as required so that pointer **70** is aligned with the 160 foot mark shown on the ten speaker scale of FIG. 5. With this adjustment the angular inclination of the column support **30** is such that the focus line H will intersect the average listening level line L at a point M which is approximately 120 feet from the sound column enclosure.

Thereafter the sound column support **30** should be raised or lowered as required within enclosure box **16** so that the lowermost edge of loudspeaker cone **15***b* will be two feet above the average listening level line L when the enclosure is flush mounted on the front wall of the room **40**.

Wing nuts **50, 51, 62** and **63** should thereafter be tightened so that column support **30** is fixed relative the interior of enclosure box **16**. After this has been accomplished the enclosure box **16** is flush mounted on the wall and hung by clips **26** and **27**. If all adjustments have been properly made the sound axis or focus line H of the sound column should intersect the line L at the proper point for optimum coverage.

A second preferred embodiment of the focusing structure of this invention is shown in FIGS. 10 through 13. This embodiment operates in essentially the same manner as the first embodiment shown in FIGS. 1 through 4 with the single exception that the focusing gauge moves with the loudspeaker column support **30**. With this arrangement, angular inclination adjustments can be made regardless of the relative position of the column support **30** with enclosure box **16**.

In the embodiment of FIGS. 1 through 3, angular inclination adjustments could only be made when the support channel **30** is so adjusted vertically that pointer **70** mates with scale **71**.

Referring now to FIGS. 10 through 13, guide rails **80** and **81** are formed as channels which have recesses best shown in FIG. 13.

Adjustment board **82** extends between guide rails **80** and **81** immediately above column support **30**. Wing nut and bolt combinations **83** and **84** couple the upper edge of back **31** to adjustment board **82** so that the column support **30** can be adjusted. Nuts **83, 84** must be drawn fairly tight to hold column support **30** in a desired vertical adjustment, as frictional engagement between elements **31, 82** and rails **80** and **81** hold column support **30** in position. However, tilting of column support **30** requires that nuts **83, 84** be sufficiently loose to permit angular adjustment of column support **30** with respect to guide rails **80, 81**.

Focusing gauge board **85** extends between guide rails **80** and **81** immediately below column support **30**. Focusing scale **71** is mounted on this board so as to cooperate with pointer **70**.

Worm **90** and gear **91** are also supported on board **85**. Manual rotation of handle **92** turns worm **90** and the mating gear **91** so as to drive link **93**. Link **93** is pivotally supported relative back **31** by brackets **95** and **96**. Thus, rotation of handle **92** adjusts the relative position of pointer **70** on scale **71**.

It is important to note, however, that in the enclosure of FIGS. 10 through 13, the focusing gauge comprising elements **70** and **71** moves with column support **30** because of the mechanical connection between board **85** and back **31** provided by link **93**. Accordingly, the required angular inclination adjustments can be made in this embodiment without regard to the relative vertical placement of column support **30** within enclosure box **16**.

It should be understood that the above described features are merely illustrative of the principles of this invention, and that modifications can be made without deviating from the scope of the invention.

What is claimed is:

1. A loudspeaker sound column comprising an elongated enclosure box adapted for generally vertical mounting in the direction of its dimension of elongation and having a front wall fixed relative to the box and formed with an opening for efficient sound transmission, means mounting a column support within the box, and a plurality of loudspeakers columnarly arranged on the column support, said mounting means allowing relative movement between the column support and the enclosure box with the column support being movable through an angle of inclination with respect to the front wall and also movable with respect to the direction of elongation of the box.

2. A loudspeaker sound column comprising an elongated enclosure box having a wall formed with an opening for efficient sound transmission, a loudspeaker support guide disposed within and fixedly attached to the box, means mounting an elongated loudspeaker column support within the box and on the guide, and a plurality of loudspeakers columnarly arranged on the column support, said mounting means allowing relative movement between the column support and the support guide with the column support being movable through an angle of inclination with respect to the wall having the sound opening and also movable in the direction of elongation of the box.

3. A loudspeaker sound column comprising an elongated enclosure box having a wall formed with an opening for efficient sound transmission, means mounting an elongated loudspeaker column support within the box with clearance from each end of the box, and a plurality of loudspeakers columnarly arranged on the column support, said mounting means allowing relative movement between the column support and the enclosure box with the column support being movable through an angle of inclination with respect to the wall having the sound opening and also movable in the direction of elongation of the box.

4. The loudspeaker sound column of claim 3 including means measuring the relative inclination angles of the column support to determine and indicate the focus of the sound axis of the sound column.

5. The loudspeaker sound column of claim 4 in which said measuring means includes a pointer and a scale which indicates the intersection of the column sound axis and a line of average listening height.

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7

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