

Sept. 26, 1939.

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2,174,163

SOUND REPRODUCING APPARATUS

Filed April 30, 1937

2 Sheets-Sheet 1

Fig. 2.

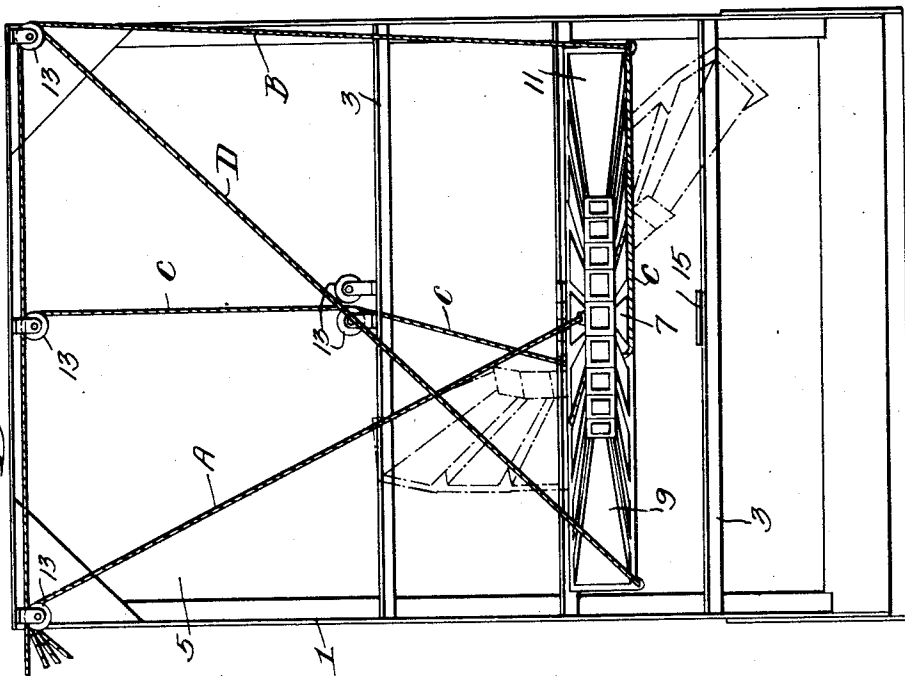
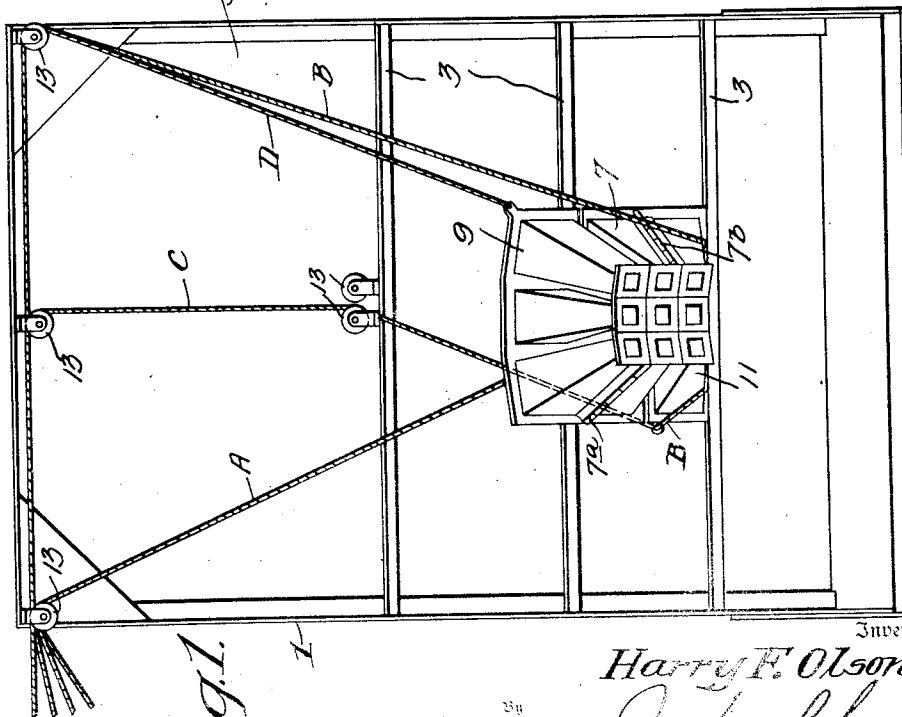


Fig. 1.



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Fig. 3.

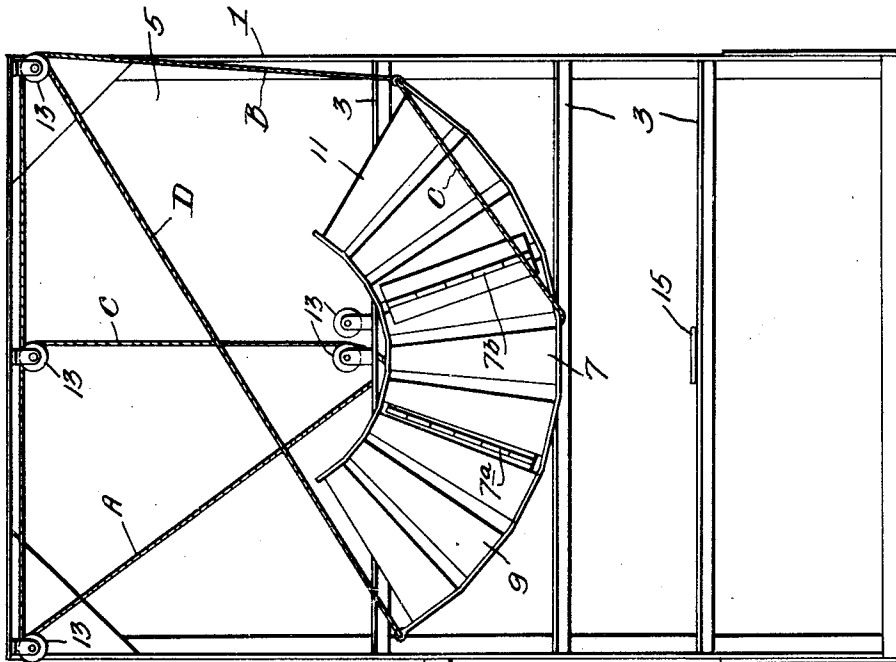
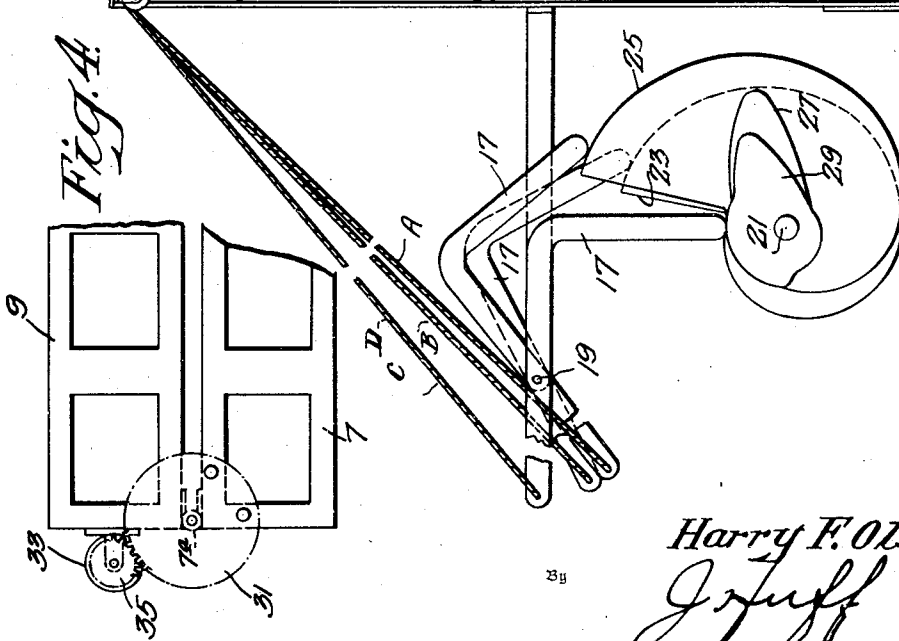


Fig. 4.



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2,174,163

SOUND REPRODUCING APPARATUS

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Application April 30, 1937, Serial No. 140,023

18 Claims. (Cl. 181—27)

This invention relates to sound reproducing apparatus, and more particularly to a horn loudspeaker system for use in theaters as part of the talking moving picture reproducing equipment.

The desirability of placing immediately behind a moving picture screen one or more loudspeakers in order to create the illusion that the characters portrayed on the screen are actually emitting sound has long been recognized. It has also been recognized that horn loudspeakers have certain inherent advantages over the direct radiator flat baffle type, and for this reason horn loudspeakers have been generally adopted in theater sound reproducing systems, a plurality of horns being usually employed to obtain uniform directional characteristics.

Placing the horn loudspeakers behind the screen necessitates their removal each time the screen is raised for a stage presentation and their subsequent replacement when the screen is lowered. In order to reduce the bulk of the horns and to facilitate handling, compound horn speakers have been used wherein the high frequencies are reproduced through one or more short horns having small throats and rapid flares, and the low frequencies are reproduced through a long, folded horn having a large throat and a small rate of flare. While a compound horn of this type also has, among other advantages, those of greater over-all efficiency than the single horn because of the smaller range covered by each horn and smaller space requirement, it has the disadvantage of phase difference between the sound emanating from the two units due to difference in path length, as well as other disadvantages resulting from filters usually employed to discriminate between the signal energy supplied to each of the units. The latter disadvantages, among others, therefore make it desirable to use a single horn system for each driver.

In my copending application, Serial No. 139,848, filed April 30, 1937, I have disclosed and claimed a novel straight-axis, single-horn loudspeaker which has the advantages of the multi-horn systems described above without having their disadvantages. A single horn loudspeaker must, however, be made very long if it is to cover a wide range within the audio spectrum, and making the horn long imposes the serious limitation noted before of rendering it difficult to move the loudspeaker out of sight when the screen is raised for a stage presentation. The horn or horns, as the case may be, can, of course, be mounted to fly with the screen. However, long horns not only make it difficult to raise the screen, but also def-

initely limit the distance that the screen may be raised.

The primary object of my present invention is to provide an improved horn loudspeaker system for theater and like use which will not be subject to the aforementioned difficulties.

More specifically, it is an object of my present invention to provide an improved horn loudspeaker system for theater and like use which will require a minimum of space behind the screen.

Another object of my present invention is to provide an improved horn loudspeaker system as aforesaid which can be mounted for ready and easy flying with the screen.

Still another object of my present invention is to provide an improved multi-horn loudspeaker system for theater and similar use which is simple in construction, which can readily be manipulated, and which is highly efficient in use.

In accordance with my present invention, I arrange a cluster of horn loudspeakers in three rows with each row in a plane substantially at right angles to the screen, and hinge adjacent rows to each other in a manner such that the several rows of horns may be unfolded into a single row in a plane at an angle to that of the screen. The middle row is also hingedly connected to the framework on which the screen is mounted whereby, after the several rows of horns are unfolded, they may all be swung about the hinge connection of the middle row to lie in a plane parallel with and close to the screen. During the showing of a picture, the horns are in their folded position behind the screen with their axes extending away from the screen, but when the screen is to be raised, the horns are unfolded and swung into position against the screen with their axes in a plane parallel thereto. When in unfolded position against the screen, the horns extend to the rear of the screen a distance equal substantially to the greatest mouth dimension of the individual horns, which is far less, of course, than the length of each horn. This permits flying the horns with the screen without any difficulty and with a minimum space requirement behind the screen.

The novel features that I consider characteristic of my invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and method of operation, together with additional objects and advantages thereof, will best be understood from the following description, when read in connection with the accompanying drawings, in which

Figure 1 is a rear elevation of a horn loud-

speaker system with the horn cluster folded and in reproducing position,

Figure 2 is a similar view but showing, in dot-and-dash lines, the horn cluster partly unfolded, and in solid lines, the horn cluster fully unfolded,

Figure 3 is a similar view showing the unfolded horn cluster in raised position against the screen, this figure also showing mechanism for automatically raising the horns to the position shown, and

Figure 4 is a fragmentary detail view of a slightly modified form of coupling between the several rows of horns.

Referring more specifically to the drawings, wherein similar reference characters designate corresponding parts throughout, there is shown a supporting framework 1 made rigid by a plurality of cross-pieces 3 and having a suitable, plane, sound-porous screen 5 stretched over the front thereof in vertical position. Hingedly connected to one of the cross-pieces 3 (for example, the middle one), is a row of long, straight-axis loud-speaker horns 7, each of which may be driven by an individual driver of suitable design, such as an electrodynamic signal translating device (not shown). The row of horns 7 normally lies in a substantially horizontal plane, or a plane substantially normal to the screen 5, and the respective horns are preferably of the type disclosed in my above-identified copending application.

Associated with the middle row of horns 7 and also lying in substantially horizontal planes are a top row of horns 9 and a bottom row of horns 11, the several horns of the three respective rows constituting a horn cluster for amplifying sound produced in conjunction with the subject matter portrayed upon the front of the screen 5. The horn row 9 is hingedly connected to the middle row 7 along the edge 7a thereof, while the bottom row 11 is hingedly connected to the middle row 7 along the diagonally opposite edge 7b thereof. Thus, the horn rows 9 and 11 may each be swung in a counter-clockwise direction, as viewed in the drawings, to bring the latter two horn rows into coplanar relation with the middle horn row 7. After being brought into this relation, the unfolded horn cluster may then be raised to lie in a plane substantially parallel with and close to the screen 5, as shown in Fig. 3.

For manipulating the several rows of horns, I provide a series of lines or other suitable flexible elements A, B, C and D which are trained around a number of pulleys 13. The line A is connected to the throat end of the middle horn of the row 7, as clearly shown in Fig. 2, while the line B is connected to a corner of the mouth end of that horn in row 11 which is most remote from the hinge connection 7b. The line C is also connected to the same point on the last named horn as the line B, while the line D is connected to the mouth end of that horn of row 9 which is most remote from the hinge connection 7a. In operation, the line A is first pulled to raise the horn row 9 substantially to the dot-and-dash line position shown in Fig. 2 after which both lines A and B are pulled together. This raises the entire horn cluster slightly about the hinge connection between the horn row 7 and the middle cross-piece 3 to free the lower horn row 11 from a supporting ledge 15 which supports the weight of the entire horn cluster when in the position shown in Fig. 1. Continued pull on the lines A and B, with a somewhat faster pull on the line B than on the line A, will then raise the unfolded horn cluster to the position shown in Fig. 3, the horn rows 9

and 11 meanwhile falling into coplanar relation with the horn row 7 and the aligned horn rows coming to rest in a plane substantially parallel with the screen 5. To lower and refold the horn cluster, the lines A and B are gradually slackened, with the line B slackened somewhat faster than the line A, until the unfolded cluster has reached a position somewhat above the solid line position shown in Fig. 2. Thereupon, the line B is permitted to slacken while the line C is pulled to bring the horn row 11 up against the horn row 7. Thereafter, while holding the line C taut, the lines A and B are together slackened to permit the cluster to be lowered by gravity until the bottom row 11 rests upon the ledge 15, after which the line D is pulled to fold the horn row 9 over onto the horn row 7.

It will be understood that the foregoing manipulation may be performed manually. However, it is preferable to have this done mechanically and automatically, and for this purpose, I secure the free ends of the lines A, B, C and D to one end of a plurality of individual bell-cranks 17, each pivotally mounted on a shaft 19. Fixed to a motor driven shaft 21 are a plurality of cams 23, 25, 27 and 29, with which the opposite ends of the bell-cranks 17 are in engagement and which are suitably shaped to effect the operations heretofore set forth and in the sequence set forth. The motor (not shown) for operating the cam shaft 21 may be mounted on an extension of the base of the framework 1, so that the entire mechanism, together with the raised horn cluster, may be flown with the screen by conventional means at present in use for this purpose.

In Fig. 4, I have shown another arrangement for unfolding the horn cluster prior to raising the unfolded cluster to the elevated position. In this arrangement, a relatively large sun gear 31 is fixed to the middle row of horns 7 in axial alignment with the axis of the hinge 7a. At a suitable point on the row of horns 9 is mounted a motor 33 to the revoluble shaft of which is fixed a relatively small gear 35 which is in mesh with the gear 31. By causing the shaft of the motor 33 to rotate in the proper direction, the gear 35 will move about the sun gear 31 as a planet, and this will carry the horn row 9 around with it into coplanar relation with the horn row 7. A sun gear similar to the gear 31 may be mounted on the diagonally opposite corner of the horn row 7 for cooperation with another planet gear 35 carried by the horn row 11. Reversing the rotation of the motor shaft will, of course, refold the horn cluster.

Although I have shown and described several modifications of my invention, it will be apparent to those skilled in the art that many other modifications thereof and changes in those shown and described are possible. For example, in place of a cluster of horns, a single, long, straight-axis horn may be employed, and it may be arranged either to swing in a vertical plane from a position with its axis normal to the screen to a position where its axis is substantially parallel thereto, or it may be pivotally mounted on one of the cross-pieces 3 for pivotal movement in a horizontal plane to effect a similar result. Also, instead of employing three rows of horns with three horns in each row, as shown in the drawings, any suitable number of horns may be employed, although the horn rows should preferably be limited to not more than three. In any event, it will be obvious that, whereas the horns extend to the rear of the screen a considerable distance when in sound reproduc-

ing position, the space requirement behind the screen when the screen is to be flown is reduced to only the greatest dimension of the mouth of the horn, regardless of the number of horns used. It will also be obvious to those skilled in the art that, where an arrangement such as that shown in Fig. 4 is employed, for example, the unfolded horn cluster may be raised by the same mechanism which flies the screen through a suitable arrangement of block and tackle in the balanced harness conventionally employed for flying the screen. Many other changes and modifications will, no doubt, readily suggest themselves to those skilled in the art. I therefore desire that my invention shall not be limited except insofar as is made necessary by the prior art and by the spirit of the appended claims.

I claim as my invention:

1. In combination, a moving picture screen, and a cluster of loudspeaker horns associated therewith, said cluster comprising a plurality of rows of individual horns of which each row is pivotally connected to its adjacent rows in a manner to permit unfolding said cluster into a single row.

2. In combination, a moving picture screen, and a cluster of loudspeaker horns associated therewith, said cluster comprising a plurality of rows of individual horns of which each row normally lies in a plane substantially normal to the screen, and each of said rows being hingedly connected to its adjacent rows in a manner to permit unfolding said cluster into a single row in coplanar relation.

3. In combination, a supporting framework, a moving picture screen supported thereby, and a cluster of loudspeaker horns associated with said screen, said cluster comprising a plurality of rows of individual horns of which each row is hingedly connected to its adjacent rows to permit unfolding of said cluster into a single row, and one of said rows being hingedly connected to said framework to permit swinging the unfolded cluster as a unit relative to said screen.

4. In combination, a supporting framework, a moving picture screen supported thereby, and a cluster of loudspeaker horns associated with said screen, said cluster comprising a plurality of rows of individual horns of which each row normally lies in a plane substantially normal to the screen and of which each row is hingedly connected to its adjacent rows to permit unfolding of said cluster into a single row in coplanar relation, and one of said rows being hingedly connected to said framework to permit swinging the unfolded cluster as a unit into a plane substantially parallel with said screen.

5. The invention set forth in claim 4 characterized in that said screen lies in a vertical plane, characterized further in that each of said rows of horns lies in a substantially horizontal plane when the cluster is in normally-folded condition, and characterized still further in that said cluster is free to be swung into a substantially vertical plane closely adjacent said screen.

6. The invention set forth in claim 4 characterized in that said cluster comprises three rows of horns each lying in a substantially horizontal plane when the cluster is in normally-folded condition, characterized further in that the top row is hingedly connected to the middle row for swinging movement in one direction relative thereto in a clockwise sense and the bottom row is hingedly connected to said middle row for swinging movement in the same direction relative thereto in a clockwise sense whereby said

top and bottom rows may be swung into coplanar relation with said middle row, and characterized still further in that said middle row is the one which is hingedly connected to said framework.

7. In combination, a supporting framework, a moving picture screen supported thereby, a cluster of loudspeaker horns associated with said screen, said cluster comprising a plurality of rows of individual horns of which each row is hingedly connected to its adjacent rows to permit unfolding of said cluster into a single row in coplanar relation, one of said rows being hingedly connected to said framework to permit swinging the unfolded cluster as a unit relative to said screen into another plane, and means for unfolding said cluster and swinging it into said last named plane.

8. In combination, a supporting framework, a moving picture screen supported thereby, a cluster of loudspeaker horns associated with said screen, said cluster comprising a plurality of rows of individual horns of which each row normally lies in a plane substantially normal to the screen, each of said rows of horns being hingedly connected to its adjacent rows to permit unfolding of said cluster into a single row in coplanar relation, one of said rows being hingedly connected to said framework to permit swinging the unfolded cluster as a unit relative to said screen, and means for unfolding said cluster and swinging the unfolded cluster into a plane substantially parallel with said screen.

9. The invention set forth in claim 8 characterized by the addition of means for supporting said cluster on said frame when in normally-folded condition.

10. The invention set forth in claim 8 characterized in that said unfolding and swinging means is adapted also to return the unfolded cluster and refold said cluster to normal position.

11. The invention set forth in claim 8 characterized in that said unfolding and swinging means comprises a plurality of flexible elements connected to the respective rows of horns and cam means for operating said flexible elements, and characterized further in that said cam means also controls the return of the unfolded cluster and the refolding of said cluster to normal position.

12. In a horn loudspeaker system, the combination of a plurality of horns hingedly connected to each other to permit swinging of said horns relative to each other.

13. In a horn loudspeaker system, the combination of a plurality of horns arranged in a plurality of rows, each of said rows being hingedly connected to its adjacent rows to permit unfolding of said rows into a single, coplanar row.

14. In a horn loudspeaker system, the combination of a plurality of horns arranged in three rows, one of said rows being hingedly connected to the middle row along one edge thereof for swinging movement in one direction relative thereto in a clockwise sense, and the third row being hingedly connected to said middle row along the diagonally opposite edge thereof for swinging movement relative thereto in the same direction in a clockwise sense, whereby said first and third rows may be swung into coplanar relation with said middle row.

15. The invention set forth in claim 14 characterized by the addition of means on said horns for effecting swinging movement of said first and third rows relative to said middle row.

16. The invention set forth in claim 14 characterized by the addition of means on said horns for effecting swinging movement of said first and

third rows relative to said middle row, said means comprising sun gears fixed to said middle row at said diagonally opposite corners and planet gears revolubly carried by said first and third horn rows in mesh with said sun gears.

17. A loudspeaker adapted to be used in conjunction with a moving picture screen comprising a horn, means pivotally mounting said horn for movement relative to the screen between a plane angularly related to the screen and a plane substantially parallel to the screen, and means for moving said horn from one of said planes to the other.

18. A loudspeaker system adapted to be used in conjunction with a moving picture screen, said

system comprising a cluster of horns arranged in a plurality of rows of individual horns of which each row is pivotally connected to its adjacent rows in a manner to permit unfolding said cluster into a single row in coplanar relation, means pivotally mounting said cluster for movement as a unit relative to the screen between one position wherein the axes of said horns are substantially normal to the screen and a second position wherein said axes are substantially parallel to the screen, and means for moving said horn cluster from one of said positions to the other of said positions and vice versa.

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