Feb. 17, 1942. F. WALLER 2,273,074

SCREEN FOR PICTURE PROJECTION

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Fig. 1.

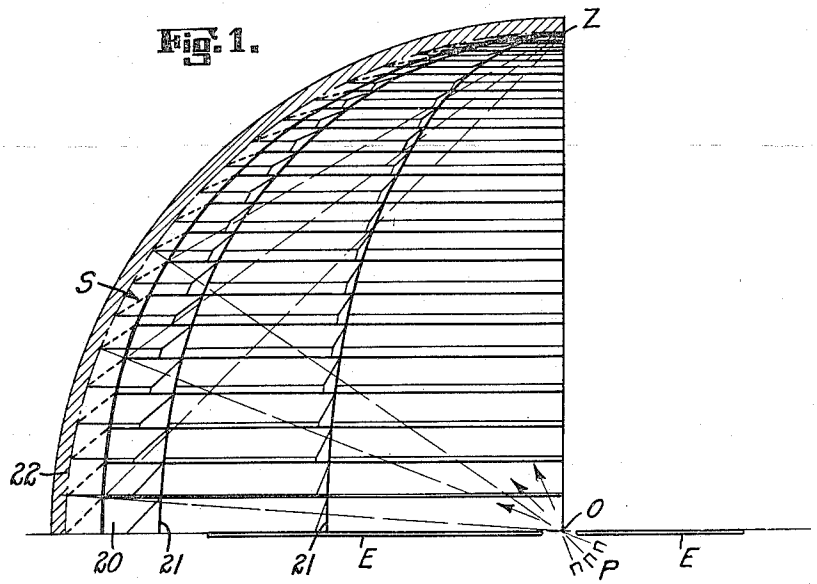
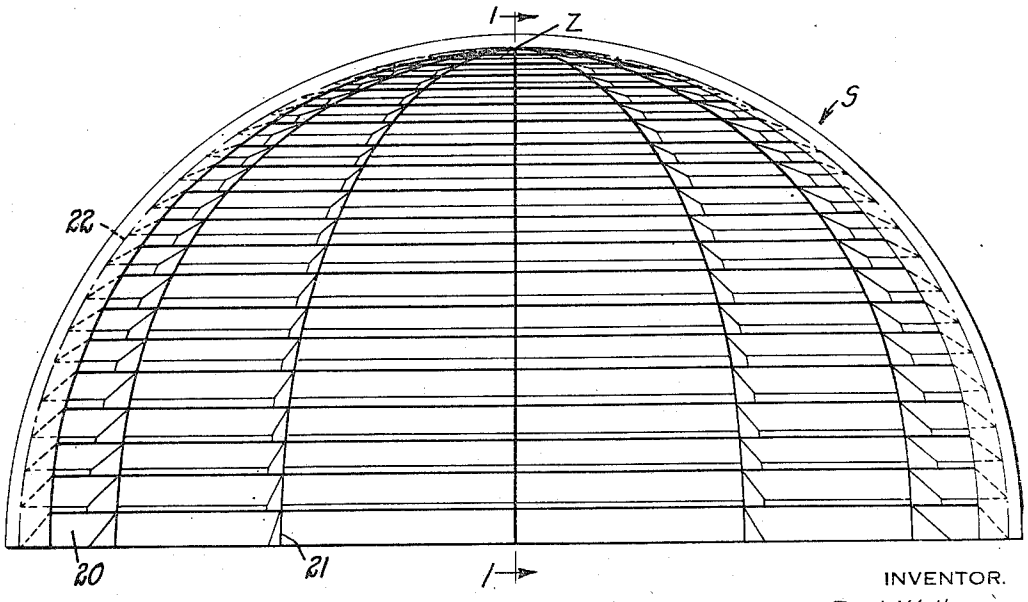


Fig. 2.



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SCREEN FOR PICTURE PROJECTION

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Fig. 3.

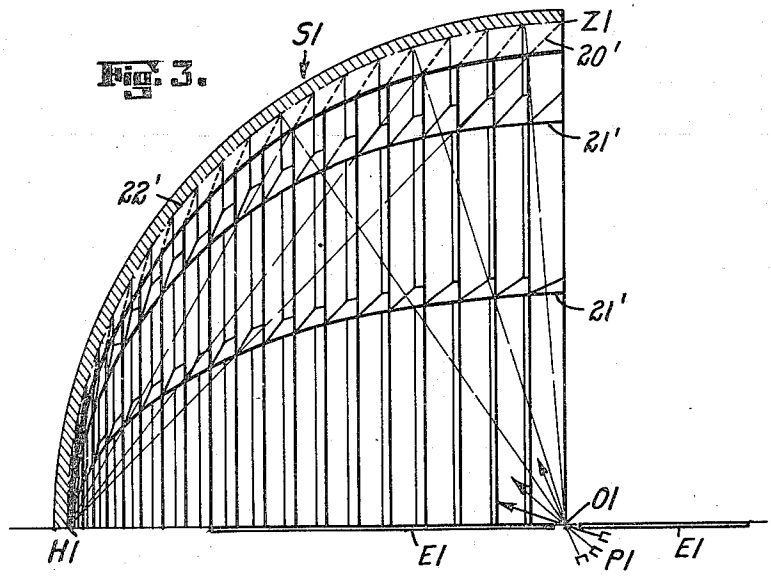

Fig. 4.

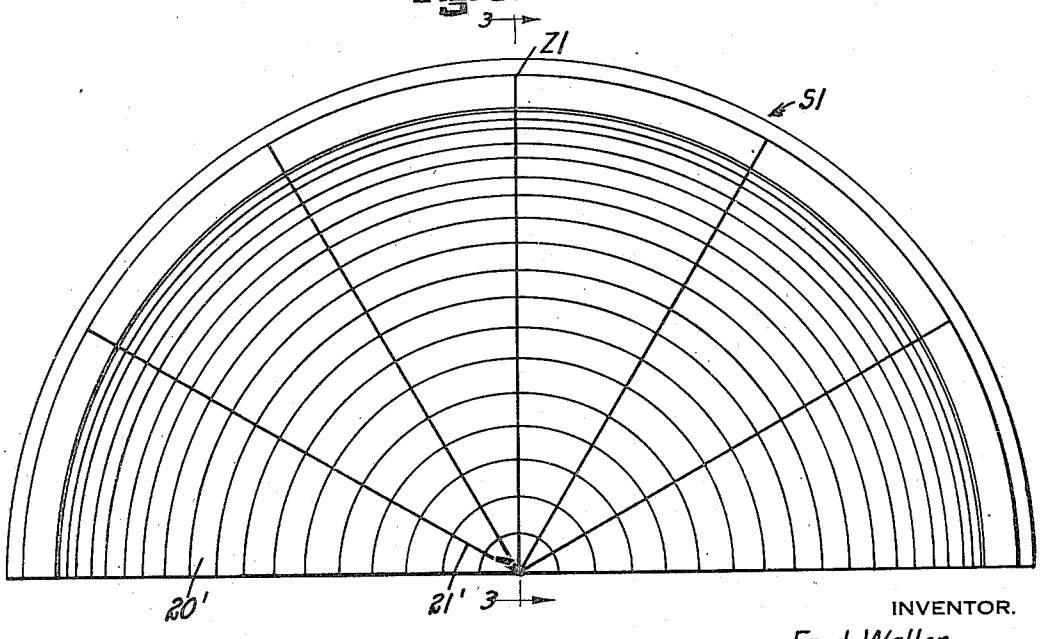

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Fig. 5.

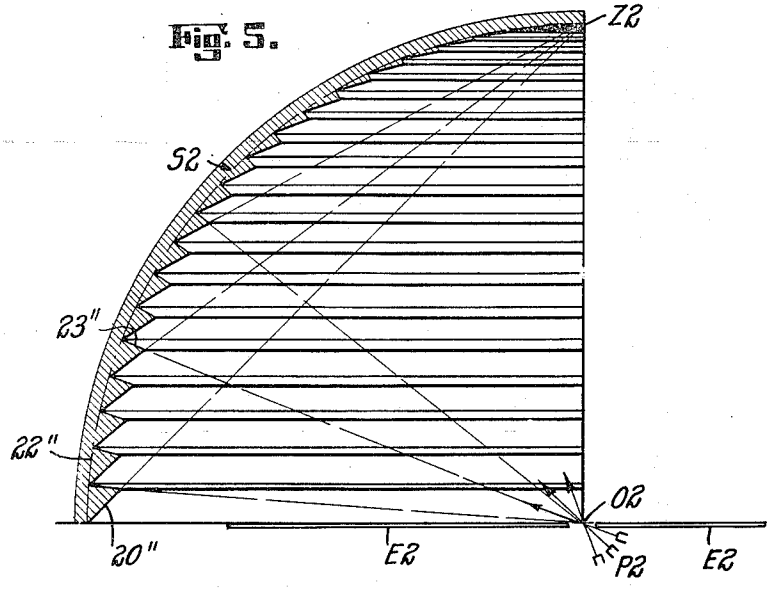

Fig. 6.

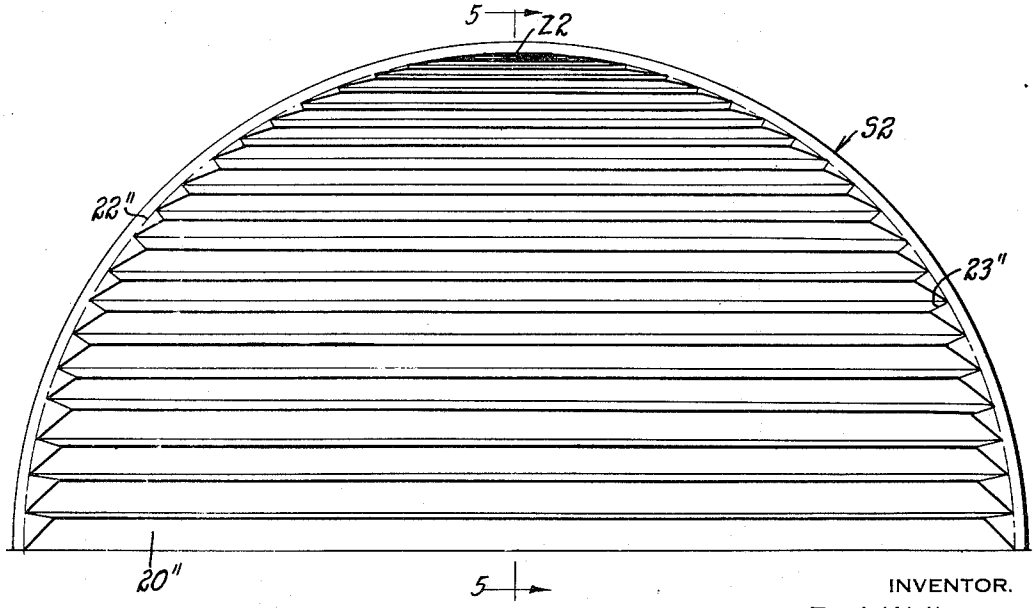

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Fig. 7.

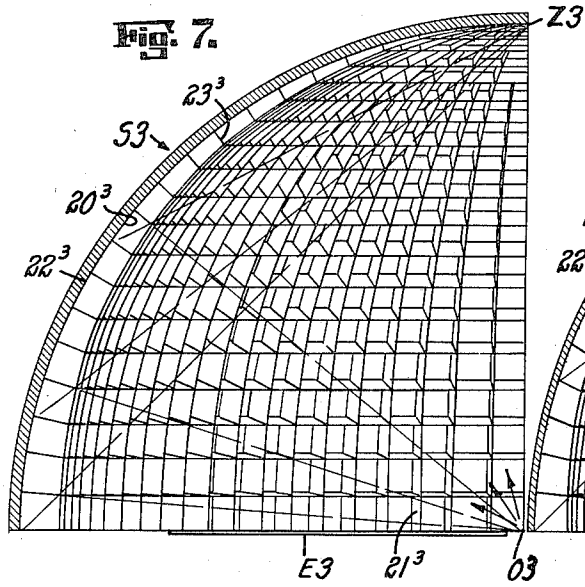

Fig. 8.

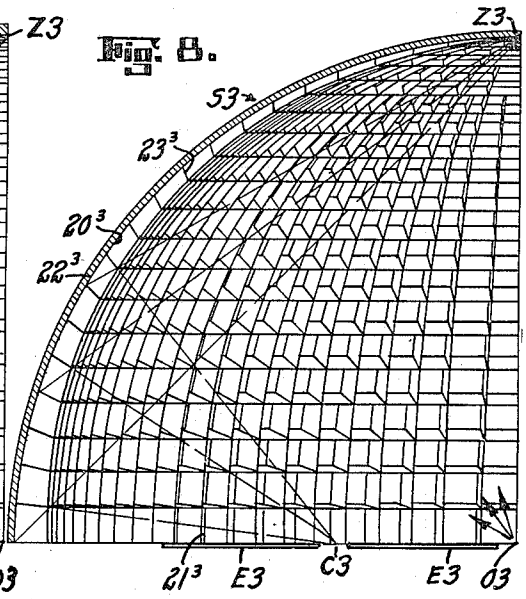

Fig. 9.

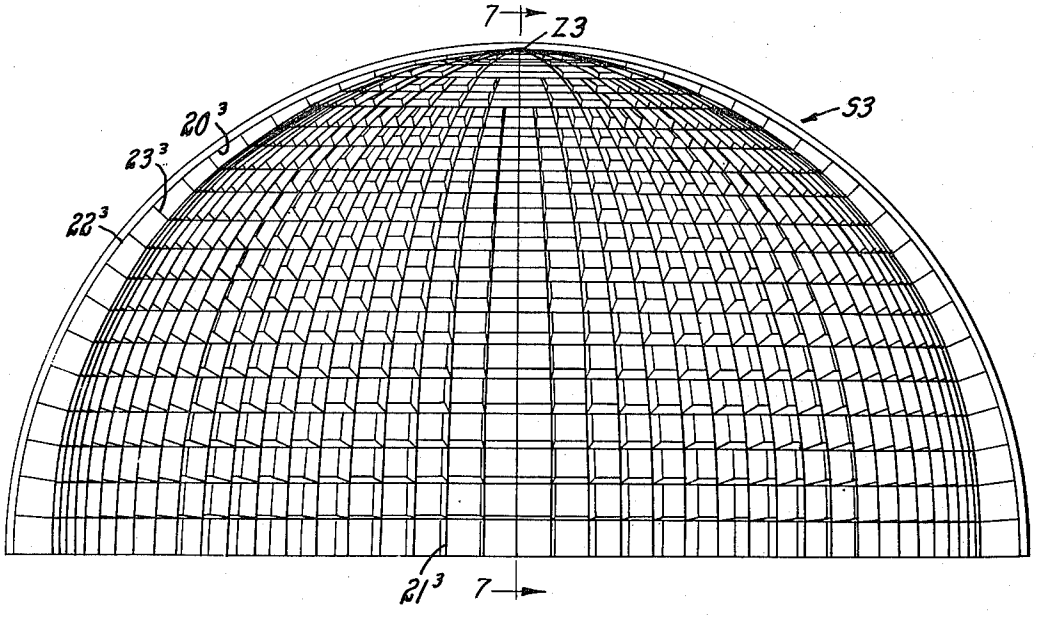

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Fig. 10.

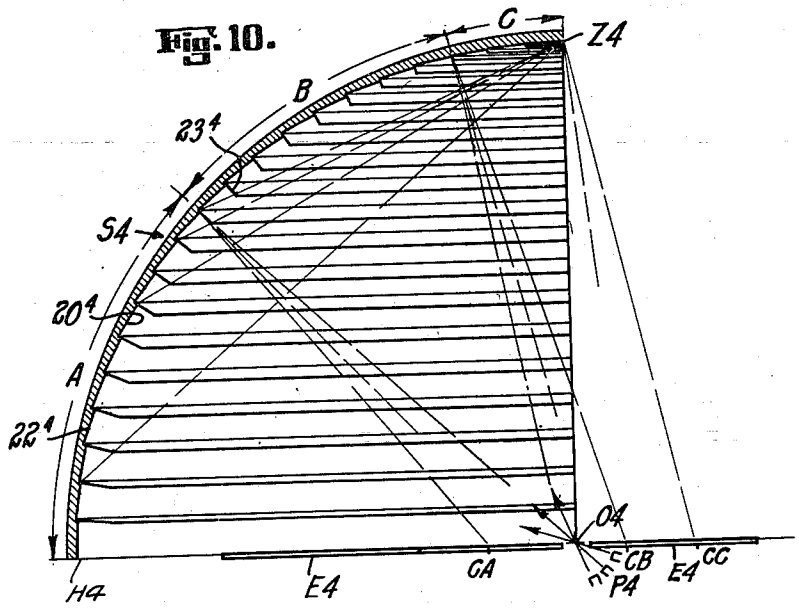
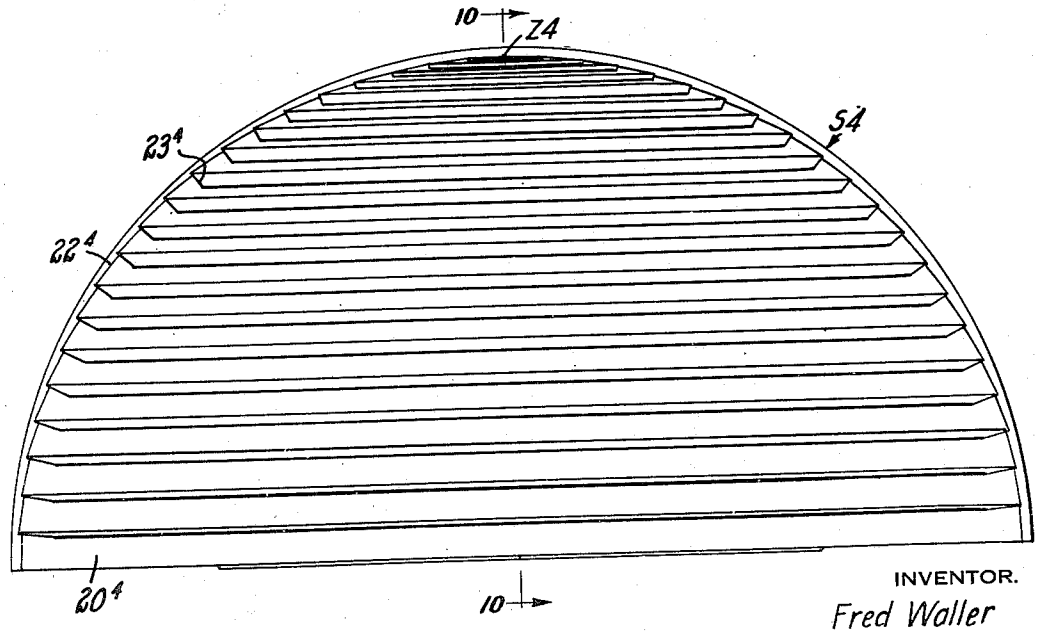


Fig. 11.



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Patented Feb. 17, 1942 2,273,074

UNITED STATES PATENT OFFICE

2,273,074

SCREEN FOR PICTURE PROJECTION

Fred Waller, Huntington, N. Y., assignor, by direct and mesne assignments, to Vitarama Corporation, New York, N. Y., a corporation of New York

Application June 14, 1938, Serial No. 213,565

15 Claims. (Cl. 88—24)

This invention relates to screens for picture projection.

In a co-pending application, Serial No. 163,712 filed September 14, 1937, by Ralph Walker and myself, there is described a method of projecting pictures from a plurality of projectors against contiguous areas of a curved screen of great area, in order to produce the effect or illusion that the spectator is actually in and surrounded by the environment depicted.

I have discovered that some of the light projected against one area of such curved screens is "scattered" or diffused radially so as to strike other areas, thereby degrading the images projected upon such other areas. For example, light projected to form a white image such as the figure of a woman wearing a white dress would scatter to degrade and reduce the contrast of other images.

It is an object of this invention to provide a curved screen of the type and for the purposes described in said co-pending application, but in which the projection surface is so constructed as to minimize the effects of "scattered" light as previously described.

Other objects and advantages of the invention will appear hereinafter.

A few preferred embodiments of the invention selected for purposes of illustration are shown in the accompanying drawings, in which:

Fig. 1 is a vertical section taken on the line 1—1 of Fig. 2;

Fig. 2 is an elevation of the screen as viewed from within the theatre, showing one form of construction for minimizing the effects of scattered light, this form being characterized by the employment of a plurality of conical surfaces;

Fig. 3 is a vertical section taken on the line 3—3 of Fig. 4;

Fig. 4 is an elevation of the same construction as that of Fig. 2 but with the screen turned through 90° from the Fig. 2 position;

Fig. 5 is a section taken on the line 5—5 of Fig. 6;

Fig. 6 is an elevation of an embodiment similar to that of Figs. 1–4 but employing a corrugated or connected-surface construction instead of a spaced vane or louvre construction;

Fig. 7 is a section taken on the line 7—7 of Fig. 9;

Fig. 8 is a section similar to Fig. 7 but with the focal point of the vanes located away from the projection center;

Fig. 9 is an elevation of an embodiment in which light confining or partition vanes are employed;

Fig. 10 is a section taken on the line 10—10 of Fig. 11; and

Fig. 11 is an elevation of an embodiment in which the screen surfaces are generated on several centers according to normal audience viewpoints.

A curved surface, particularly a double curved surface, such as a parti-sphere disclosed in the co-pending application referred to above, is well suited to give realistic three dimensional effects, especially when several complementing picture projecting machines are used simultaneously to conjointly cover the entire area of the screen. But I have found that pictures projected on a curved screen, and particularly a screen of double curvature, are degraded in a manner not encountered with plane screens. When a plane screen is used the light rays are all reflected in straight paths principally away from its surface in such manner that no laterally diffused rays from one part of the screen can strike any other part of the screen. Consequently every part of the picture, whether brilliant or dull assumes its proper value when viewed by the audience. If a screen having a single curved surface is used, there is a tendency to degrade the images; when a screen having a double surface of curvature is used the degrading effect is increased.

I eliminate this degrading effect by dividing the screen into isolated integrating areas which are so small and so disposed that the tendency of scattered light from one area striking another area is greatly reduced. The effects are dual and supplementary. That is, the lateral diffusion from any integrating area to other areas is minimized, on the one hand; and the ability of given areas to receive laterally diffused rays from other areas is minimized, on the other hand.

These integrating areas may be formed by physically enclosing small areas as by vanes which are disposed substantially normal to the surface of the screen or so as to present only edges to the audience. These partitions may extend in any direction or in more than one direction. In the latter case the partitions will form cells or a kind of honeycomb construction.

Another way of forming the integrating areas is to build up the large curved surface with a plurality of smaller surfaces each of which is of such shape and placed at such an angle as largely to prevent the laterally diffused rays from being directed toward or striking other surfaces.

Or the integration may be produced by a com-

bination of partitions and small angularly disposed screen surfaces.

Referring first to Figs. 1 and 2, the screen S in general is formed as a double surface of curvature, in this case specifically a quadrant of a sphere, with the zenith Z substantially directly above the center of projection O. In the preferred embodiment illustrated the projection center coincides with the center of the sphere. Several projectors P are shown, each placed below the center O and each having its optical axis passing through the center O. As disclosed in the co-pending application there may be any number of projectors, each filling its own area with a certain amount of overlapping and masking and all operated simultaneously to give a realistic three dimensional panoramic effect.

The approximate eye plane of the audience for one form of construction is indicated at E in Fig. 1.

The screen S is composed of a number of small screen surfaces 20 formed as angularly inclined louvres anchored at their ends in radially disposed partition vanes 21. Each of the vanes or louvres 20 is formed as a surface of single curvature, the curvature being generally in a horizontal direction and the vane where cut by a vertical plane (such as 21) giving a straight line. In the actual construction illustrated in Fig. 1 each vane 20 constitutes a circumferential segment of a conical surface generated about the zenith Z as an apex. A few dotted construction lines are shown in Fig. 1 to indicate this.

The vanes 20 may be of any convenient width but preferably are relatively narrow, depending on the total size of the screen, projection distance, distance from audience center, construction costs, and other factors. They may be as small as an inch or two in width like the slats of venetian blinds or may be wider for screens of usual commercial motion picture houses. For smaller screens they may be narrower, the consideration being that the separate vanes as such are not unduly obvious to the body of the audience. In any case each lower vane will be wide enough to substantially reach the lower edge of the adjacent higher vane as viewed by the audience. Obviously, the vanes cannot be shown in scale for a large screen in the present drawings. Actually they need extend only a short distance from the foundation or "pitch" surface 22 of the screen S proper, whereas they are shown as extending a relatively great distance from the pitch surface.

The physical construction of the screen S1 shown in Figs. 3 and 4 is exactly the same as that of Figs. 1 and 2 but the quarter sphere of Fig. 3 may be considered as having been turned through an angle of 90° about a horizontal axis through the center O1. In Figs. 3 and 4, Z1 designates the zenith, 20' the small screen surfaces, 21' the partition vanes, 22' the pitch surface, and P1 the projectors. One advantage of this construction is that a relatively flat surface is presented near the lower central portion of the screen which is designated as H1.

The construction shown in Figs. 5 and 6 is similar to that of Figs. 1 to 4 except that the small conical surfaces 20'' are not formed as open louvres but are connected by surfaces 23'' which are so disposed as to be invisible except possibly from the rear of the audience where they will appear so small as to be hardly noticeable. They are painted or provided with light absorbing or non-reflecting surfaces further to avoid notice and to prevent the re-scattering of light. Even if visible, the bands will be so narrow and dull that they will not appear as bands in the picture but at most will produce only a very slight darkening of the picture as a whole.

The surfaces 20'' and 23'' may be formed as jointed vanes or may be mere faces or corrugations on a solid foundation. The conical surfaces 20'' are generated about an apex at the zenith Z2 and the surfaces 23'' are conical surfaces generated about an apex at some convenient place selected along the eye plane E2, as for example at the projection center O2. In Figs. 5 and 6 the partition vanes are not required for structural support as in Figs. 1 to 4, and may be omitted if desired. The size and disposition of the stepped screen vanes in the constructions shown in Figs. 1 to 6, and in fact all constructions except in Figs. 7 to 9, are such that all lateral diffusion in vertical planes and substantially all in horizontal plane toward other surfaces is eliminated and for this reason it is not necessary to use the partition vanes unless a very high degree of perfection is sought.

In Figs. 5 and 6 the pitch surface is designated as 22'' and the projectors as P2.

In Figs. 7, 8 and 9, the spherical pitch surface 22^3 of the screen S3 is preserved but it is divided into a plurality of isolated integrating areas by a plurality of horizontal vanes 23^3 and intersecting vertical vanes 21^3 forming a cell-like or honeycomb construction. In Figs. 7 and 9 the vanes are directed toward the projection center O3. This is a construction which for a particular size of threatre and a given seating arrangement will be least noticed by the audience. The vanes increase in depth from the zenith Z3 to the lower edge of the screen but even the deepest vanes are so narrow relative to the size of the whole screen as to be hardly noticeable. A few of the generating lines for the horizontal vanes are shown in Fig. 7, the construction being almost the same as that of Figs. 5 and 6 with the angularly disposed or reflecting screen vanes 20'' omitted. The integrated light reflecting areas are represented in these views by 20^3 and the audience eye-plane by E3.

All partition or edge-viewed surfaces are preferably provided with a light absorbing finish to promote invisibility and minimize re-scattering of laterally scattered rays reaching them.

In Fig. 8 the horizontal vanes center at a point C3 in front of the projection center O3. A few constructional lines are dotted in to show this.

In Figs. 10 and 11 there is shown a construction employing both conical screen surfaces 20^4 and horizontal partition vanes 23^4. Vertical partition vanes may also be employed if desired for greater perfection of image but are omitted for simplicity.

In this construction account is taken of the fact that spectators sitting near the screen S4 about a center CA see little of the upper part, whereas spectators further back about the centers CB and CC see progressively more of the upper part of the screen. The screen is therefore divided into zones A, B and C from the horizon H4 to the zenith Z4. The audience eye-plane is represented by E4, the projectors by P4, and the pitch surface by 22^4.

In the zone A the horizontal partition vanes 23^4 are directed along bisecting lines in the angles between the lines which converge at the

half center CA of the audience and the projection center O4 respectively; the vanes in zone B are directed along bisecting lines in the angles between the lines which converge at the quarter center CB of the audience and the projection center O4 respectively; and the vanes in zone C are directed along bisecting lines in the angles between the lines which converge at the right center CC of the audience and the projection center O4 respectively. The screen reflecting surfaces are placed at an angle of 90° to the respective partition vanes or fins thereabove. This construction is indicated by a few dotted construction lines in Fig. 10. This gives approximately maximum reflection from the conical screen surfaces and maximum invisibility of the non-reflecting vanes for the respective spectator groups about the centers CA, CB and CC.

It will be obvious from Fig. 10 that the audience, represented by the eye-plane E4 (shown in double lines), is grouped near the projection and geometric center O4, the audience half center CA being between a quarter and an eighth audience length in front of the projection center, the quarter center CB being less than an eighth audience length behind the projection center, and the eighth center CC being less than a quarter audience length behind the projection center. Therefore the bisectors of the angles for group A will strike the horizontal axis between CA and O4 less than one-fourth audience length from the projection center; the bisectors of the angles for group B will strike the horizontal axis between CB and O4 less than one-eighth audience length from the projection center; and the bisectors of the angles for group C will strike the horizontal axis between CC and O4 less than one-fourth audience length from the projection center. It is therefore seen that the focal points of the angle bisectors for the groups are located near the projection center or geometric center of the pitch surface. Therefore, while the compromise construction aids the audience considerably, it does not depart to any great extent from the true basic construction and the projection effects are not materially affected.

In all of the constructions disclosed the screen surface is sufficiently broken up or integrated to insure that degrading effects due to laterally diffused rays will be substantially eliminated.

It is to be understood that the invention may be variously embodied within the limits of the prior art and the scope of the subjoined claims.

I claim:

1. A picture projection screen adapted to prevent degrading effects of diffused light, comprising in combination, a double-curved concave foundation structure or pitch surface, and a plurality of surface integrating elements carried by said foundation structure for preventing dispersed rays of light reflected from one part of the screen from impinging on another part of the screen, said surface integrating elements comprising relatively small surfaces joining said pitch surface at the root edge and having the other edge spaced from the pitch surface, the height of the spaced edges of the small integrating surfaces increasing progressively away from a fixed point on the pitch surface, said small integrating surfaces being formed as truncated cones generated from a focal point in an axis of said pitch surface, and the height of the outer edges of the small integrating surfaces being determined by their intersection with other conical surfaces generated from a focal point in an axis of said pitch surface and which pass approximately through the root or intersection of the next adjacent integrating surface with the pitch surface.

2. A picture projection screen adapted to prevent degrading effects of diffused light, comprising in combination, a double-curved concave foundation structure or pitch surface, and a plurality of surface integrating elements carried by said foundation structure for preventing dispersed rays of light reflected from one part of the screen from impinging on another part of the screen, said surface integrating elements comprising relatively small surfaces joining said pitch surface at the root edge and having the other edge spaced from the pitch surface, the height of the spaced edges of the small integrating surfaces increasing progressively away from a fixed point on the pitch surface, said small integrating surfaces being formed as truncated conical light reflecting surfaces all generated from a common focal point in the pitch surface on a major axis adjacent one edge of the screen.

3. A picture projection screen adapted to prevent degrading effects of diffused light, comprising in combination, a double-curved concave foundation structure or pitch surface, and a plurality of surface integrating elements carried by said foundation structure for preventing dispersed rays of light reflected from one part of the screen from impinging on another part of the screen, said surface integrating elements comprising relatively small surfaces joining said pitch surface at the root edge and having the other edge spaced from the pitch surface, the height of the spaced edges of the small integrating surfaces increasing progressively away from a fixed point on the pitch surface, said small integrating surfaces being formed as truncated conical surfaces generated and subtended by coordinate conical surfaces having focal points in the two major axes of the pitch surface.

4. A picture projection screen adapted to prevent degrading effects of diffused light, comprising in combination, a double-curved concave foundation structure or pitch surface generated about a center near the projection center of the source of light, and a plurality of surface integrating elements carried by said foundation structure for preventing dispersed rays of light reflected from one part of the screen from impinging on another part of the screen, said surface integrating elements comprising relatively small surfaces joining said pitch surface at the root edge and having the other edge spaced from the pitch surface, the height of the spaced edges of the small integrating surfaces increasing progressively away from a fixed point on the pitch surface, said small integrating surfaces being formed as non-reflecting truncated cones each generated from a focal point near the generating center of the pitch surface and being subtended by coordinate conical surfaces all of which are generated about said fixed point on the pitch surface.

5. A picture projection screen adapted to prevent degrading effects of diffused light, comprising in combination, a double-curved concave foundation structure or pitch surface, and a plurality of surface integrating elements carried by said foundation structure for preventing dispersed rays of light reflected from one part of the screen from impinging on another part of the screen, said surface integrating elements com-

prising relatively small surfaces joining said pitch surface at the root edge and having the other edge spaced from the pitch surface, the height of the spaced edges of the small integrating surfaces increasing progressively away from a fixed point on the pitch surface, said small integrating surfaces being formed as reflecting truncated cones generated from a focal point in the pitch surface and being subtended by a conical surface generated from a focal point near the generating center of the pitch surface.

6. A picture projection screen adapted to prevent degrading effects of diffused light, comprising in combination, a double-curved concave foundation structure or pitch surface generated about a center in the region of the projection center of the source of light, and a plurality of surface integrating elements carried by said foundation structure for preventing dispersed rays of light reflected from one part of the screen from impinging on another part of the screen, said surface integrating elements comprising relaatively small surfaces joining said pitch surface at the root edge and having the other edge spaced from the pitch surface, the height of the spaced edges of the small integrating surfaces increasing progressively away from a fixed point on the pitch surface, said small integrating surfaces being formed as truncated conical surfaces generated and subtended by intersecting cones, one set of intersecting cones having their foci in the region of said fixed point in the pitch surface and the other set of intersecting cones having their foci in the region of the generating center of the pitch surface.

7. A picture projection screen adapted to prevent degrading effects of diffused light, comprising in combination, a double-curved concave foundation structure or pitch surface generated about a center in the region of the projection center of the source of light, and a plurality of surface integrating elements carried by said foundation structure for preventing dispersed rays of light reflected from one part of the screen from impinging on another part of the screen, said surface integrating elements comprising relatively small surfaces joining said pitch surface at the root edge and having the other edge spaced from the pitch surface, the height of the spaced edges of the small integrating surfaces increasing progressively away from a fixed point on the pitch surface, said small integrating surfaces being formed as truncated conical surfaces generated and subtended by intersecting cones, one set of intersecting cones having their foci in the region of said fixed point in the pitch surface and the other set of intersecting cones having their foci in the region of the generating center of the pitch surface, said integrating surfaces including non-reflecting surfaces of a finish which will not reflect light.

8. A picture projection screen, comprising in combination, a concave quarter-sphere pitch surface having its edges defined by coordinate planes located approximately in the spherical quarter axes, and a plurality of relatively small straight-sectioned surface-integrating surfaces having their edges parallel to one arcuate edge of the pitch surface and which describe circles about the spherical axis through the other edge of the pitch surface, said small integrating surfaces being generated as truncated cones about a focal point located where said axis intersects the edge of the pitch surface and which are feathered from said pitch surface toward said focal point.

9. A picture projection screen adapted to prevent degrading effects of diffused light, comprising in combination, a concave foundation structure or pitch surface formed as a quadrant of a sphere having a projection center approximately at its geometrical center which in turn is located approximately at the eye-plane of the audience, and a plurality of relatively small surface-integrating reflecting surfaces formed as truncated cones all having a common focal point located approximately in one edge of the pitch surface where intersected by one of the major spherical axes, the conical surfaces being feathered from the pitch surface toward said focal point and being subtended by conical surfaces all having a common focal point in the projection center and passing approximately through the root of the next adjacent conical surface.

10. A picture projection screen adapted to prevent degrading effects of diffused light, comprising in combination, a concave foundation structure or pitch surface formed as a quadrant of a sphere having a projection center approximately at its geometrical center which in turn is located approximately at the eye-plane of the audience, and a plurality of relatively small surface-integrating reflecting surfaces formed as truncated cones all having a common focal point located approximately in one edge of the pitch surface where intersected by one of the major spherical axes, the conical surfaces being feathered from the pitch surface toward said focal point and being subtended by conical surfaces all having a common focal point in the projection center and passing approximately through the root of the next adjacent conical surface, the focal point of said reflecting surfaces being at the horizon or lower edge of the pitch surface.

11. A picture projection screen adapted to prevent degrading effects of diffused light, comprising in combination, a concave foundation structure or pitch surface formed as a quadrant of a sphere having a projection center approximately at its geometrical center which in turn is located approximately at the eye-plane of the audience, and a plurality of relatively small surface-integrating reflecting surfaces formed as truncated cones all having a common focal point located approximately in one edge of the pitch surface where intersected by one of the major spherical axes, the conical surfaces being feathered from the pitch surface toward said focal point and being subtended by conical surfaces all having a common focal point in the projection center and passing approximately through the root of the next adjacent conical surface, the reflecting surfaces being formed as feathered vanes of approximately uniform width.

12. A picture projection screen adapted to prevent degrading effects of diffused light, comprising in combination, a double-curved concave foundation structure or pitch surface generated about a center near the projection center of the source of light, and a plurality of surface integrating elements carried by said foundation structure for preventing dispersed rays of light reflected from one part of the screen from impinging on another part of the screen, said surface integrating elements comprising relatively small surfaces joining said pitch surface at the root edge and having the other edge spaced from the pitch surface, the small integrating surfaces being formed as truncated conical surfaces sub-

tended by coordinate conical surfaces which pass through the outer edge of one small integrating surface and approximately through the root or inner edge of the next adjacent small integrating surface, one set of coordinate conical surfaces having their foci in an axis of the screen surface in the region of the generating center and the other set of coordinate conical surfaces having their foci in an axis of the screen surface and located in the region of a fixed position on the pitch surface.

13. A picture projection screen adapted to prevent degrading effects of diffused light, comprising in combination, a double-curved concave foundation structure or pitch surface generated about a center near the projection center of the source of light, and a plurality of surface integrating elements carried by said foundation structure for preventing dispersed rays of light reflected from one part of the screen from impinging on another part of the screen, said surface integrating elements comprising relatively small surfaces joining said pitch surface at the root edge and having the other edge spaced from the pitch surface, the small integrating surfaces being formed as truncated conical surfaces subtended by coordinate conical surfaces which pass through the outer edge of one small integrating surface and approximately through the root or inner edge of the next adjacent small integrating surface, one set of coordinate conical surfaces having their foci in an axis of the screen surface in the region of the generating center and the other set of coordinate conical surfaces having their foci in an axis of the screen surface and located in the region of a fixed position on the pitch surface, said integrating element surfaces forming acute angles with said pitch surface, the angles varying in size between the marginal edges of the screen.

14. A picture projection screen adapted to prevent degrading effects of diffused light, comprising in combination, a curved concave foundation structure or pitch surface generated about a center near the projection center of the source of light, and a plurality of surface integrating elements carried by said foundation structure for preventing dispersed rays of light reflected from one part of the screen from impinging on another part of the screen, said surface integrating elements comprising relatively small surfaces joining said pitch surface at the root edge and having the other edge spaced from the pitch surface, the small integrating surfaces being formed as narrow elements which are formed and subtended by generating coordinate surfaces which respectively pass through the outer edge of one small integrating surface and approximately through the root or inner edge of the next adjacent small integrating surface, one set of coordinate generating surfaces having their foci in an axis of the screen surface in the region of the generating center and the other set of coordinate surfaces having their foci in an axis of the screen surface and located in the region of a fixed position on the pitch surface.

15. A picture projection screen adapted to prevent degrading effects of diffused light, comprising in combination, a curved concave foundation structure or pitch surface generated about a center near the projection center of the source of light, and a plurality of surface integrating elements carried by said foundation structure for preventing dispersed rays of light reflected from one part of the screen from impinging on another part of the screen, said surface integrating elements comprising relatively small surfaces joining said pitch surface at the root edge and having the other edge spaced from the pitch surface, the small integrating surfaces being formed as narrow elements which are formed and subtended by generating coordinate surfaces which respectively pass through the outer edge of one small integrating surface and approximately through the root or inner edge of the next adjacent small integrating surface, one set of coordinate generating surfaces having their foci in an axis of the screen surface in the region of the generating center and the other set of coordinate surfaces having their foci in an axis of the screen surface and located in the region of a fixed position on the pitch surface, said integrating surfaces forming acute angles with said pitch surface, the angles varying in size between the marginal edges of the screen.

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