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A STEREOSCOPIC SYSTEM

Field of the Invention

The invention relates to stereoscopic systems for demonstrating various stereoscopic images.

The invention can be suitably used in many fields of science, engineering, art for imaging the stereoscopic information.

The invention can be preferably used in cinematography, theatres, entertainment and athletic facilities, stadiums and sports grounds, television broadcasting, household and commercial videosystems, computer hardware, vehicles, game machines and simulators, advertisement, for manufacture of stereoscopic photographs, pictures, illustrations and technical drawings.

Prior Art

Main methods for forming the stereoscopic images in the form of a stereogram are extensively used. A stereogram (stereoscopic pair) consists of two parallax-interfaced images (left and right images) of one object in the form of two central projections having the convergence centers divided by the lateral base-line. The left image is intended for viewing it only with left eye, the right one – for viewing with right eye. Stereoscopic viewing of the stereoscopic pair images is performed using optical devices – stereoscopes – or special selective viewing glasses that perform either spectral selection (anaglyptography), or polarization selection (vectrography), or temporal selection (an eclipse system for viewing of stereograms). Another kind of stereoscopic images being the auto-stereograms (parallax-stereograms) is a registered stereogram, wherein the right and left interfaced images are divided into narrow vertical strips. These strips are interlaced such that they alternate successively. For viewing a stereoscopic image, a line lattice is set in front of an auto-stereogram – a raster or lens raster for spatial selection of images, so that left eye will see only the left image strips, and right eye will see only the right image strips. A multi-aspect image is a kind of an auto-stereogram, and therein a great number of strips (generally, up to ten strips) of the interfaced images is interlaced, and these images correspond to successive points of viewing of an object along the common base-line. Parallax-grams (parallax-panoramagrams) is a further evolved auto-stereogram that uses multiple stereoscopic pairs, wherein a discrete series of strips of the interfaced images takes the form of a continuous encoding track, on

which track a continuous sequence of the object aspects viewed from different base-line points is fixed.

Multiple stereoscopic pairs, that use the lens rasters, allow to view the raster stereoscopic images from different positions of the corresponding viewing aspects. Aspectograms is a mosaic of the unit images of an object, said unit images being characterised by both horizontal and vertical parallaxes. Each unit image of an aspectogram is produced by the central projection among a discrete set of projection centers positioned in the plane in front of a lens system. An intergal photography is an aspectogram that is viewed through an optical raster consisting of spherical lenses and registered with the aspectogram image. An intergral photography creates a complete spatial image of an object, and can be viewed from different positions, as the natural one. See: Valyus N.A., Stereo: photography, cinematography, television – Moscow, Iskousstivo publishers, 1986, 263 pages, ill.

Various stereoscopic systems for viewing stereoscopic images without use of viewing glasses are known.

A stereoscopic system, that uses the eclipse technique of the spatial selection of stereoscopic images, comprises a stereoscopic projector for successive projection of right and left interfaced images of a stereoscopic pair in a rapid alternation thereof onto a viewing screen. For stereoscopic viewing of such images used are special devices – viewing glasses that alternately close a viewing screen at the viewer's right eye, at one time, and at the viewer's left eye, at another time, by movable shutters or electronic-optical light modulators (based on liquid crystals). Thus, the viewer's right eye always sees only the right images, and the left eye – only the left images that are retained by conscience and combined into a single cine image owing to the vision inertia of eyes.

An advantage of the eclipse technique is good chromatic and brightness parameters of the reproduced stereoscopic images.

An essential drawback is the necessity to use a large light flux of the cine projection onto a large screen and also a high rate of flickering up to 83 frame changes per second (required so that flickering will not be perceived).

A stereoscopic system that uses the techniques of chromatic anaglyphs (additive and subtractive anaglyphs) comprises a stereoprojector for carrying out projection onto a stereoscreen using the colour filters. For separation, i.e. division of two interfaced images of a stereoscopic pair: according to the additive technique, two interfaced images of a stereoscopic pair are made in the form of two slides, which slides are projected simultaneously at different angles in the horizontal plane onto a screen by two projectors. Each images of a stereoscopic pair is dyed by one of the additional colours, for example: the right image is dyed red, and the left image is dyed green. Images of stereoscopic pairs are separated with the colour (anaglyphic) light filters arranged in viewing glasses in front of viewer's eyes, such that the viewer's right eye will see, through the red filter, the red image on the screen, and the left eye will see, through the green filter, the green image. According to the subtractive technique, the dyed slides (left and right frames of a stereoscopic pair), overlapping one another, are projected onto a screen by one projector having one lens system without filters. The subtractive mixing of colours of the images so interfaced on a screen is carried out by subtraction of a light beam by a second dyed layer of a slide, after the beam has passed through the first layer. According to this technique: the right red images of a stereoscopic pair can be seen through the blue-green eye-glass light filter, and the left blue images – through the red light-filter. According to the additive and subtractive techniques: as a result of the binocular mixing of colours a viewer will perceive an image as a spatial one as dyed with a corresponding mix of two monochromatic colours.

Main drawbacks of the above-mentioned stereoscopic systems (that use anaglyptography techniques) is impossibility to reproduce the natural dyeing of the shown objects. Distortions of the reproduced hues are possible, including an incorrect reproduction of the information relating to volume and colour of objects or image originals. For example, the red portions of an object viewed through the green light-filter will be reproduced as black.

The stereoscopic systems that use polarization technique for stereoscopic pair image selection (by polarization of light in mutually perpendicular planes) comprise a stereoprojector for simultaneous projection, onto a viewing screen, of the left and right interfaced images of a stereoscopic pair using the light-filters having mutually perpendicular planes of polarization for the left and right frames of the stereoscopic pair images. For binocular viewing of the polarized images on a screen, a viewer is provided with polaroid viewing glasses having light-filters, wherein the polarization planes are mutually

perpendicular, for the viewer's left and right eyes. Polaroid viewing glasses provide viewing of the stereoscopic pair image right frame by the right eye, and the left frame – by the left eye.

The positive effect is ensured through that the polarizing filters provide the even light loading imposed on the viewer's eye and are practically neutral in the visible spectrum, so that they can be used in the colour stereotelevision systems.

The main disadvantage of the polaroid technique of selection is a great loss of light - up to 60-70%, and a limited region of image viewing due to a little diffuse scattering of light by a screen.

An advantage of all stereoscopy techniques that use viewing glasses is the possibility to view simultaneously stereoscopic films in a large theatre on viewing screens of any shape and format.

A common essential disadvantage of all systems for viewing the stereoscopic images with viewing glasses is a vision discomfort due to the felt presence of viewing glasses and various unfavourable physiological effects affecting the vision and causing irritation and fatigue of eyes.

Known are different stereoscopic systems for viewing the stereoscopic images without use of viewing glasses.

Stereoprojecting systems having a lens stereoscreen in the form of a big lens, or a mirror-spherical stereoscreen in the form of a large spherical mirror, comprise one or more stereoprojectors for simultaneous projection of several stereoscopic pair images from different projection aspects and simultaneous viewing of each projection by a predetermined viewer. Identical or different stereoscopic images can be simultaneously projected by different stereoprojectors. The rays, having passed through a lens stereoscreen or been reflected from a mirror-spherical stereoscreen, are focused-collected into converging beams that draw, in front of a stereoscreen, images of the output pupils of all projection lens systems (in the stereoscopic image vision zones). The lens system pupils' images for projection of the left images must be disposed on the spatial points of location of viewers' left eyes, and the lens system pupil's images for projection of the right images – on the spatial points of location of

viewers' right eyes, accordingly. The psycho-physiological summation of these interfaced images in the binocular vision creates a spatial image of a viewed picture. For the purpose to simplify design of stereprojectors: a beam that exits from each of the projection lens systems is divided by light-splitting systems into a number of beams. Each such separate beam will draw, on a lens- or mirror-spherical stereoscreen, the complete image of its portion of a stereogram; and the center of projection of such bean will be shifted relative to the center of projection of other beams. Each beam, in front of a screen in the viewers' zone, will be collected separately from other beams, i.e. it will be focused by a screen in a separate zone of viewing, by a predetermined viewer, of one left or right image of a stereoscopic pair. Semitransparent mirrors, multiplying prisms and other optical systems are used as light-splitting systems. A number of pairs of split stereoprojections are selected to be equal to the number of aspects viewing of stereoscopic images viewed by a corresponding number of viewers.

An advantage of the stereoscopic projections that use a lens screen or a concave mirror consists in that the eyesight is tired less, owing to the fact that such stereoscopic projections adjust accommodating efforts of a viewer and adjust the condition of eyes' convergence (convergence of the sight axes of eyes). A positive effect of such stereoprojection systems is the possibility to obtain stereoscopic images having optimum optical parameters, the possibility of optical correction of the optical parameters of each stereoscopic pair image.

Stereoscopic projection systems using the lens-raster stereoscreens having a high aperture ratio, comprise a stereprojector for projecting the interfaced left and right images of a stereoscopic pair onto a stereoscreen. The auto-stereoscopic reproduction of an image on a stereoscreen is provided by a lens raster that forms an auto-stereogram image on that stereoscreen. For viewing the stereoscopic images, a lens raster is positioned in front of an auto-stereogram. A regular parallel raster consists of vertical-parallel cylindrical lenses (arranged on a plate), optically interfaced with the vertical strips of an auto-stereogram. For large theatres accommodating a great number of viewers, used are stereoscreens having the radial (prospective) lens raster (consisting of conical lenses) that provide the greatest aperture ratio of a stereoscopic cine projection system. Two projectors project images of the stereoscopic pair left and right frames at different angles of incidence of the projection axes on a lens-raster viewing screen of the translucent or reflecting types. A lens raster focuses the stereoscopic pair left and right images (frames) in the form of an auto-stereogram registered

in the screen plane and consisting of vertical parallel or radial strips, on a diffuse-scattering screen. These screen images are focused by the lens raster into a theatre into zones of selective viewing of the left and right images by viewers' left and right eyes, respectively.

A positive effect of the transparent stereoscopic projection is elimination of phantom images and creation of the illusion of complete naturalness of a stereoscopic picture (owing to elimination of the projection beam being a cause of a discomfort for viewers). When rasters that differ in respect of the period (raster spacing), relative orifice, focal distance and other parameters are used at the opposite sides of a screen, thus zones of selective viewing having optimum illuminance for viewing a stereoscopic picture with even brightness of the images seen by right and left eyes at a great range of distance form a screen, can be provided at the viewers' side.

Main drawbacks of such stereoscreens that have a lens raster, is the impossibility to demonstrate stereoscopic images within a broad field of view, because a screen cannot be made sufficiently wide and/or with a curved surface, and the useful selective vision zone is extremely small. For the viewers positioned near the screen edge, the stereoscopic images' depth is distorted from the proximate screen edge to the distal edge. In this case, viewers' discomfort is caused by the necessity to keep head tiresomely motionless within the selective vision zones, and the spatial image thereby is imperfect. When the space of clear viewing of the stereoscopic effect is restricted by a small number of predetermined aspect angles (narrow vision zones), this circumstance causes the eyesight discomfort feeling. The cause is that width of each of the vision zones must be less than the basis of eyes (the distance between pupils), a shift of eyes relative to centers of these zones by two or more centimeters results in a substantively reduced brightness of a viewed object. When a viewer changes position and leaves said zones, the stereoscopic effect is disappears. Strict fixing of a viewer's position with respect to the vision zones, even for several minutes, causes a viewer's discomfort – uneasiness, early tiredness, for a viewer has to sit immovably and continuously seek, visually, the optimum aspect angle (the vision zone center) for clear viewing of the stereoscopic effect.

A streoscopic system for multi-aspect stereoscopic projection that provides comfortable viewing of the stereoscopic effect from different aspect angles and/or when a viewer shifts laterally, is the most proximate one to the claimed stereoscopic system in terms of the set of essential features and the technical result achieved thereby. Stereoscopic images

are provided in the form of an auto-stereogram. The optical raster of a stereoscreen is made of sphercial lenses disposed at the viewer's side upon plane of the reflecting screen plate, or at either side of a translucent screen.

A positive effect of the anharmonic type of a screen is the possibility of comfortable viewing of an auto-stereogram image (that comprises a complete recording of information pertaining to a given object filmed from the horizontal and vertical viewing aspects) from any aspect angles (viewing points when viewers shift and shift freely in the lateral directions within the viewing sector and when viewers approach a stereoscopic image). Further, this screen has a substantially greater aperture ratio in comparison with the raster screens having the linear arrangement of lenses. For this reason, brightness of these images considerably exceeds that of the strips drawn by the cylindrical and conical lens elements of rasters. When images of stereoscopic pairs using the lens rasters are viewed without glasses, this viewing is more comfortable than in the case of viewing of stereoscopic pair images with viewing glasses.

The main drawback of aspectograms - when films are shot and reproduced, is the necessity to record a great redundancy of information on a carrier (photographic film, reproduction) when stereoscopic images are shot and formed from a plurality of aspect angles. This is the cause of technical-economic problems of recording, reproducing and viewing of a multi-aspect quality images having a high resolution and without geometrical distortions.

In all known stereoscopic systems that use and do not use viewing glasses, only a small number of viewers positioned in the center of a theatre can see the central projection having a high definition, without geometrical distortions, with maximal resolution and at a broad field of view. The cause is that in such stsreoscopic systems only one common stereoscopic pair image or a multi-aspect image of one object are formed on a stereoscreen. This circumstance prevents correction of the optical distortions of stereoscopic images and excludes the dynamic optimal registration of zones of selective viewing of the stereoscopic images individually for each of the viewers, and also excludes the simultaneous mutual viewing on a common screen of cine or video programs of various content having separate sound tracks.

Summary of the Invention

The main object of the invention is development of a stereoscopic system that will provide comfortable viewing of the stereoscopic effect by viewers, without use of viewing glasses, in viewing of one or simultaneously a number of full-screen stereoscopic images on conventional, wide-format or panoramic viewing screens.

The main technical result to be attained by the invention is as follows: a stereoscopic system provides a dynamic optical registration of the viewing zone of the stereoscopic pair left image projection - by the left eye, and viewing of the right frame – by the right eye, for each viewer, irrespective of free positioning or movement of viewers on any point of the stereoscopic image viewing sector. A number of viewers who simultaneously view one or several different stereoscopic images in the common plane of a stereoscopic picture or on a common stereoscreen may many times exceed a number of viewers in case of viewing without use of viewing glasses - as in the known systems with lens rasters.

Said technical result is to be achieved as follows: a stereoscopic system, for viewing stereoscopic images without viewing glasses comprises a plate with a stereoscopic image, or a stereoscreen to form stereoscopic images in the form of an auto-stereogram. The optical system of a lens raster, or a mirror surface (of a mirror-spherical screen) or a lens plane (of a lens screen) of a stereoscreen is optically continuously interfaced with a stereogram, such that provided is the optical spatial separation of the interfaced left and right images of a stereoscopic pair into respective zones of selective viewing of the left image - by the left eye, and the right image – by the right eye. A novel essential feature of the claimed stereoscopic system is an automatic corrector having an actuator to shift a predetermined optical portion of a stereoscopic system so that to provide the constant dynamic optical registration of the selective zones of viewing of the left and right stereoscopic pair images by the left and right eyes, respectively. This circumstances ensures the constant viewing of the optimal stereoscopic effect in any aspect angle and in any lateral shift of a viewer within the stereoscopic image viewing sector. An actuator can be coupled to movable lens rasters or movable projection lenses or a movable viewer seat. By automatic correction, all optimal optical parameters are maintained automatically and provide a high quality of the viewed stereoscopic images , e.g. – a high definition and resolution, absence of geometrical distortions, optimal and even brightness across the frame field, spatial depth in a stereoscopic

image, exact colour-rendering, etc. For autocorrection, a system comprises a sensor coupled to the autocorrector to continuously monitor coordinates of the viewer's eyes and generate an optimal correction control signal supplied to the autocorrector.

According to the first embodiment of the claimed stereoscopic system automatic correction: a plate or screen, having a stereoscopic image and lens raster, are rotatable about their horizontal or vertical axis. According to the second alternative embodiment of the claimed stereoscopic system automatic correction: a lens raster is movable along the plate or stereoscreen having a stereoscopic image. According to the third embodiment of automatic correction: a stereoscopic system has a stereoprojector to perform projection onto a translucent or reflecting lens-raster, lens or mirror-spherical viewing screen. In the stereoprojector: the projection lens systems are movable in parallel to the path of the viewer lateral shift. According to the fourth embodiment of automatic correction of the stereoscopic system: the viewer seats are movable in parallel with the viewer lateral shift path. A sensor for monitoring the viewer eyes' coordinates (viewing aspect angle) is installed in a seat or theater.

According to claim 2: a stereoscopic system comprises one or more stereoprojectors, a translucent lens-raster viewing screen and autocorrector to register a zone of selective viewing of the left and right stereoscopic pair images by the left and right eyes, respectively. A novel feature of the system is a constructional implementation of stereoprojectors and lens-raster screen for comfortable, without viewing glasses, simultaneous viewing of one or different stereoscopic images on a common viewing screen by a great number of viewers. For that purpose, a stereoprojector or a number of stereoprojectors have a light-splitting system that comprises a number of pairs of projection lens systems for division of the common projection into a number of separate full-screen stereoscopic projections to be viewed by a corresponding number of viewers. Each pair of the projection lens systems for projecting, on a sterescreen, one pair of interfaced left and right images is positioned in a predetermined aspect angle, which is the projection point in front of the stereoscreen, wherefrom the projected left and right images are focused by the stereoscreen into the left and right eyes of a predetermined viewer, respectively. The stereoscreen is made of three parallel layers of the lens raster, which layers focus images of the output apertures of projection lens systems into predetermined zones of selective viewing of the stereoscopic pair left and right images by viewers. Each pair of projection lens systems for projecting one stereoscopic image (viewed by a predetermined viewer) is coupled to an independent actuator for independent automatic

correction of this pair of lenses independently of other pairs. All actuators are coupled to an autocorrector. The autocorrector comprises a multi-position (matrix) sensor or a plurality of sensors for independent determination of position eyes of each of the viewers. For simultaneous viewing of different stereoscopic images in such stereoscopic projection system, two or more separate stereoprojectors for simultaneous parallel projection of different stereoscopic images are installed. These stereoscopic images can be simultaneously and comfortably, without viewing glasses, viewed by different viewers from respective viewing zones on a common viewing screen. Number of viewers (with any location or shifting of viewers within the sector of projection of these stereoscopic images) can amount to thousands persons.

According to claim 3 of the invention: a stereoscopic system comprises one stereoprojector having pair of projection lens systems or a stereoprojector having a light-splitting system with a plurality of pairs of projection lens systems to project a plurality of separate full-screen stereoscopic images on a common stereoscreen from different projection aspect angles. A novel feature of this system is a reflecting viewing stereoscreen of the retroreflection type with bead-shaped lens raster consisting of micro-spherical lenses having a mirror coating on the backside of these lenses. An autocorrector for registering the zones of selective viewing of the stereoscopic pair left and right images with the respective eyes of viewers has independent actuators coupled to each pair of the projection lens systems. A novel design of a stereoprojector or a system of stereoprojectors provides comfortable constant viewing, on a stereoscreen, of stereoscopic images by a great number of viewers from any aspect angle or in lateral shifting of any viewer within the viewing sector. A sensor or a plurality of sensors are adapted for simultaneous monitoring of coordinates of position of eyes of each viewer and for receiving the control signals for individual autocorrection of the optical interface of a pair of lens systems for registering the zones of viewing of stereoscopic pair images by each predetermined viewer, independently of other viewers.

A novel technical result of the use of such stereoscopic projection system is the possibility to project and view the stereoscopic images with a broad field of view on retroreflection stereoscreens of any sizes, geometrical shapes and formats, with any position of viewers in front of a stereoscreen at different distances from the stereoscreen. Another technical effect of the stereoscopic system according to claims 2 and 3 is improved coefficients of amplification of the image brightness by a screen up to thousand units owing to

narrowing of the light flux of each separate screen-focused left or right stereoscopic pair image in the zone of selective viewing within the area of the output pupil of a projection lens system (from 0.2 to 0.5 dm^2).

According to claim 4: the claimed stereoscopic system comprises one or several stereoprojectors, a translucent lens-raster screen with an autocorrector for automatic interface of projections with zones of viewing of the stereoscopic image by viewers. A novel feature is implementation of the system using a planar construction of the projection arrangement for the purpose to reduce overall sizes of the projection system (to reduce the projection portion behind the translucent stereoscreen). For that purpose, stereoprojectors, that are positioned on the end face of the viewing screen, have a light-splitting system having a minimal thickness of the projection portion behind the screen. Stereoprojectors have two or more pairs of projection lens systems to project, by each pair of the projection lens systems, a portion of the area of the stereoscopic pair left or right image. The light-splitting system provides the total full-screen projection of the stereoscopic pair left and right images. A novel technical result of such stereoscopic system is a substantial reduction of mass and overall sizes of the design and formation of the translucent stereoscopic projection systems and/or two-way projection for viewing the stereoscopic images from two sides.

According to claim 5: a stereoscopic system as claimed in any one of claims 1 - 4 is characterised in that each pair of the projection magnifying lens systems (that form projections of the stereoscopic pair left and right images for one viewer or a plurality of viewers) is provided with individual correcting optical elements. The optical correcting elements in the form of prisms, cylindrical, aspherical or spherical lenses are intended to transform images and/or correcting the linear magnification of images, eliminating the geometrical distortions and/or adjusting the viewing angles; and for adjusting the brightness or colour-correction across the image field – gray or colour filters are installed.

A novel additional technical result of said stereoscopic system is provision of the visual comfort in viewing the stereoscopic images by any viewer irrespective of his/her position within the viewing sector.

According to claim 6: a stereoprojection system is implemented according to any one of claims 1 – 5. A novel feature of the system is that, for the purpose to project the

stereoscopic images onto the wide-format or panoramic stereoscreens for viewing the stereoscopic images within a broad angle of view, area of the total projection on a screen is divided into several portions for separate projection of portions of stereoscopic pair frames onto a corresponding screen portion. For projection of these frame portions of the total image: the system is provided with additional projectors or additional pairs of projection lens systems. Additional projectors or projection lens systems are positioned according to the optical arrangement of separate projections on separate portions of a common lens-raster screen.

In the known analogs of stereoscopy with immovable lens rasters of a screen, without use of viewing glass, such projection arrangement cannot be implemented. The cause is that the optical interface of zones of viewing from extreme portions of a wide-format screen is not possible.

According to claim 7: a stereoscopic system comprises features of claim 6. A novel feature is that the optical positioning arrangement of projectors is adapted for separate projection of portions of the stereoscopic pair left and right images, where stereoprojection is possible only in the center of a stereoscreen for viewing of the stereoscopic image; the stereoscopic pair left and right images are projected as the monoscopic images in the extreme left and right portions of the screen area, respectively.

Brief Description of Drawings

Fig. 1 is a plan view of an optical diagram of a projection stereoscopic system with a translucent stereoscreen and movable projection lens systems;

Fig. 2 is a plan or front view of an optical diagram of a fragment of a translucent lens raster stereoscreen;

Fig. 3 is a plan view of an optical diagram of stereoscopic projection on a visualization stereoscreen with a movable lens raster;

Fig. 4 is a plan view of an optical diagram of stereoscopic projection on a reflecting mirror-lens retroreflection stereoscreen;

Fig. 5 is a plan or front view of an optical diagram of a stereoscopic system for projection on a reflecting mirror-spherical stereoscreen;

Figs. 6 and 7 are a right side view and a front view, respectively, of an optical diagram of a stereoscopic planar projection system with a translucent stereoscreen.

Embodiments of the Invention

In Fig. 1 – a stereoscopic system comprises two separate stereoprojectors 1(1) and 1(2) for simultaneous projection, by each stereoprojector, of a plurality of identical or different stereoscopic pair images onto common translucent viewing screen 2. The stereoscreen is interfaced with projection lens systems for focusing the stereoscopic pair left and right images into the zones of viewing by, respectively, the left eyes 3l and right eyes 3r. The stereoscreen is positioned in parallel with the spatial plane of position of all eyes of viewers (aspect angles of viewers' viewing) and the plane of positioning of projection lens systems 4l for projection of the stereoscopic pair left images, and that of projection lens systems 4l for projection of the right images.

In each of the stereoprojectors, for projection of the left of right one stereoscopic pair image used are two projection lens systems 1l and 4r (for projection of the left image), or 1r and 4r (for projection of the right image) with a mirror or prismal light-splitting system between such pair of lens system. Each projection lens system 1l or 1r (long-focus lens) is intended for projection in (a) direction, without magnifying an image, through the light-splitting system, of, respectively, one left or one right image into the input aperture of a corresponding projection short-focus (normal or broad-angle) lens system 4l or 4r. Lens systems 4l and 4r are positioned in different certain aspect angles of projection at the backside of the stereoscreen and for projection of the same images, with magnifying, in (b) direction onto stereoscreen (2). The lens raster of stereoscreen 2 is optically oriented for focusing (of the images projected onto the screen) in (c) direction of location of the corresponding zones of selective viewing of the stereoscopic pair left images – by left eyes 3l, and the right images – by right eyes 3r. The system has autocorrector 5 having automatic actuators coupled to each of projection lens systems 4l and 4r. The system has sensor 6 or a plurality of sensors 6 coupled to said autocorrector and providing determination (e.g. by optical signals (d)) coordinates of spatial position of each of the viewers' eyes, with subsequent generation of a control signal supplied to said autocorrector. The autocorrector is intended for an independent dynamic shifting in (e) direction of lens systems 4l and 4r, taking into account the registration of each of the zones of viewing of the stereoscopic pair left images - by left eye 3l of a

corresponding viewer, and the zone of viewing of the stereoscopic pair right image – by right eye 3r of said viewer. At that, for any viewer on any viewing point and during the lateral shift of a viewer, a clear stereoscopic effect is constantly viewed independently of other viewers.

Fig. 2 shows a fragment of an optical arrangement of translucent lens-raster stereoscreen 2 of the anharmonic type, having three layers of lens rasters made of spherical microlenses. Each of three lenses 7, 8 and 9 being co-axially interfaced and disposed in different raster layers are formed according to the optical arrangement of a direct-drawing lens microsystem, having the scale-one linear magnification. Distances A1 from the center of stereoscreen 2 to the output lens of each of the projection lens systems 4l and 4r are equal to distances A2 from the stereoscreen center to plane of the spatial positioning of each of left 3l and right 3r eyes of viewers.

In Fig. 3: a stereoscopic system comprises a stereprojector oriented to project, on a sterescreeen, by lens system (1r) the stereoscopic pair right image, and by lens system (1l) – the stereoscopic pair left image. In this system: a translucent lens-raster stereoscreen has central optical plane 10 for formation of an autostereogram image and two rasters disposed at the back and front sides of the screen. Raster 12 (at the backside) serves to form, on plane 10, the projected by lens systems 1l and 1r, a stereogram into an autostereogram. Front raster 13 that is movable in parallel with plane 10, is interfaced with the autostereogram and coupled to actuator of autocorrector 5. Autocorrector 5 having sensor 6 (to determine the spatial position of viewers' eyes) serves for dynamic interface of raster 13 with the autostereogram, which interfaces provides constant viewing of a stereoscopic image with a clear stereoscopic effect when a viewer shifts.

Fig. 4 shows a stereoprojector having projection lens systems 1l for projection of the stereoscopic pair left image and by lens system 1r for projection of the stereoscopic pair right image in (a) directions into the corresponding input apertures of projection lens systems 4l and 4r. A light-splitting system can be provided between lens systems 1l and 4l and lens systems 1l and 4k. Lens systems 4l and 4r are disposed near to head at the side of corresponding viewers' eyes 3l and 3r, and are oriented to lens-raster reflecting stereoscreen 13 for projection in (b) direction, with magnification of these stereoscopic pair images. On stereoscreen 13, at the viewers' size, positioned are beads made of retroreflecting micro-spherical lenses 14 having mirror coating 15 at the backside of said lenses. Each lens 14 has

the rated radius of the lens sphere and is oriented on the stereoscreen for focusing the stereoscopic pair images (reflected by lenses' mirror in (c) direction and projected onto the stereoscreen in (b) direction) to zones of viewing of the stereoscopic pair left image - by viewer's left eye 3l, and the right image – by right eye 3r. A system for independent correction of all projection lens systems is similar to that described referring to Fig. 1.

According to Fig. 5: a stereoscopic system comprises stereoprojectors with projection lens systems 4l for projection of the stereoscopic pair left image, and projection lens systems 4l for projection of the right image. Reflecting mirror-spherical stereoscreen 16 has spherical mirror 15 (at the side of projection and viewing of stereoscopic images), with radius R. Output apertures of each predetermined projection lens system 4l and 4r4 are automatically disposed in determined rated aspect angles symmetrically with coordinates of the spatial position of the corresponding left eyes 3l and right eyes 3r of viewers. The symmetry axis is the curvature radius of the stereoscreen mirror sphere. A system for independent correction of all projection lens systems is similar to that described referring to Fig. 1.

According to Figs. 6 and 7: a stereoscopic system of the planar design comprises monitors 1l (for formation of the stereoscopic pair left image) and 1r (for formation of the stereoscopic pair right image), having two or more projection telephoto lens systems 17 and broad-angle projection lens systems 18. Telephoto lens systems 17 are disposed on the endface of the stereoscreen and are oriented to project in (b) direction, without magnifying of images, along the stereoscreen plane into the input aperture of lens systems 18. The telephoto lens systems are intended for projection of local portions of the total area of the stereoscopic pair left and right images that are formed by videomonitors 1l or 1r. Lenses 18, interfaced with deflecting mirrors, are disposed in different aspect angles of projection and are oriented for projection in (c) direction, with magnification of images, to a certain localised portion 20 of the area of translucent stereoscreen 10. Stereoscreen 10 has two-way lens raster to form autostereogram stereoscopic images. One of the lens rasters is movable along (d) line across the stereoscreen plane and coupled to actuator of autocorrector 5. Sensor 6 is coupled to autocorrector 5 and is intended to receive signals (e) concerning coordinates of spatial positioning of the viewer's eyes.

The Claimed Stereoprojection System is Operated as Follows

According to Fig. 1: projector 1(1) and projector 1(2), by all lens systems' pairs, project, from different aspect angles, the stereoscopic pair left and right images that are interfaced on viewing screen 2 in the form autostereograms. A first layer of the stereoscreen (Figs. 1 and 2), at the side of projectors (having the raster consisting of lenses 7), forms – on the central (second) layer of the stereoscreen (having the raster consisting of lenses 8) – images in the form of an autostereogram of all images of the output apertures of projection lens systems 4l and 4r. A third layer (having the raster consisting of lenses 9) focuses each image of the output apertures of the projection lens systems systems in the aspectogram into the corresponding zones of viewing of theses images by the corresponding eyes 3l and 3r of the viewers. Sensor 6 or a plurality of independent sensors 6 receives the light signals (e) relating to coordinates of the spatial positioning of eyes of each of the viewers, then generates the autocorrection signals supplied to autocorrector 5. The corrector, in response to said signals, using separate actuators, shifts each predetermined pair of projection lens systems 4l and 4r in (d) direction in parallel to the path of shift the corresponding viewer's eyes, providing independent dynamic registration of each viewing zone with the corresponding viewer's eye. Autocorrection provides constancy of viewing by any viewer of a clear stereoscopic effect on any point of viewer's eye position, or when viewers shift laterally independently of one another.

According to Fig. 3, a stereoscopic projection system, using projection lens systems 1l and 1r, projects the left and right interfaced images of a stereogram onto lens raster 11 of a stereoscreen, thus forming an autostereogram or aspectogram on plane 10 (with simultaneous projection of a number of stereoscopic pairs). Second raster 12, at the side of viewers, using actuator of autocorrector 6, shifts dynamically in (d) direction, providing constant viewing by a viewer of a clear stereoscopic effect from any aspect angle and during lateral shift oif viewer within the stereoscopic image viewing sector. The stereoscopic system can be formed (without projection and backside raster 11) upon a screen (in plane 10) of a videomonitor, television set, computer monitor, as a stereoscopic photograph, stereoscopic illustration, shop window or advertisement panel.

Similarly to the embodiment of a stereoscopic projection system according to Fig. 1, the stereoscopic systems shown in Figs. 4 and 5 simultaneous project a plurality of stereoscopic pair images with independent autocorrection of zones of viewing of each stereoscopic pair image by the corresponding eyes of a predetermined viewer.

In the stereoscopic system according to Figs. 5 and 6, monitor 1l forms the stereoscopic pair left image, monitor 1r forms the right image. Each of a plurality of small-size projection telephoto lens systems 17 and broad-angle small-size lens systems 18 and deflection mirrors 19, projected is a portion of the area of full-screen images of a stereoscopic pair as stereograms. The lens raster of stereoscreen 10 (disposed on the backside of the stereoscreen) forms full-screen images in the form of an autostereogram. The movable front raster of stereoscreen 10 (disposed at the side of viewers), shifted by actuators of the autocorrector, provides dynamic registration of the zone of viewing of the stereoscopic pair left and right full-screen images by the viewer's left and right eyes during any lateral shift of a viewer.

Industrial Applicability

All claimed above-discussed stereoscopic systems can be produced on the commercial scale using the known manufacture techniques for producing lens-raster screens, stereoscopic projectors, and the known automatic correction systems can be used. Thus, the industrial applicability is obvious. These stereoscopic systems can become the mass-produced articles being far ahead of any known analogs in terms of competition, for the available analogs has not an active dynamic correction of a stereoscopic system to provide a constant clear stereoscopic effect in any aspect angle of viewing and during lateral shift of viewers. The claimed stereoscopic systems ensure maximally comfortable viewing of stereoscopic images.

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CLIAMS

1. A stereoscopic system for viewing stereogram images without glasses, comprising:

a plate having a stereoscopic image, or a stereoscreen to form a stereoscopic image,

an optical system for separating the left and right images of a sterescopic pair into the corresponding zones of viewing the left frame by the left eye and viewing the right frame by the right eye, in the form of the interfaced left and right images of the stereoscopic pair,

also comprising a projection system having a stereoscopic projector and stereoscreen,

characterized in that

the system is provided with an automatic corrector having actuators to displace the optical system relative to plane of an auto-stereogram, or elements of optical separation of the stereoscopic pair images, or elements of optical separation of the stereoscopic pair images, or projection objectives, or a spectator seat to effect the dynamic optical registration of the stereoscreen-formed zones of viewing the stereoscopic pair left image by the spectator's left eye and viewing the right image of said stereoscopic pair by the right eye with spectator's free comfortable resting or movement within a sector of viewing of said stereoscopic image;

the system further comprising:

coupled to the automatic corrector, a sensor for monitoring coordinates of spatial location of the spectators' eyes and for generating a controlling correction signal supplied to the automatic corrector;

the plate having a stereoscopic image or the screen to form a stereoscopoc image, or the viewing stereoscreen are

rotatable with respect to axes of spatial orientation of their plane, or a lens raster being movable along the stereoscopic image plane, or the stereoscopic projector having projection objectives that are movable along the stereoscreen, or the spectator seat being movable relative to the stereoscreen, for which purpose the automatic corrector comprises an actuator coupled to said movable parts of the stereoscopic system.

2. The stereoscopic system according to claim 1, comprising a plurality of stereoscopic projectors, or a stereoscopic projector having a light-splitting optical system adapted to provide, simultaneously from different projection aspect angles, a plurality of full-screen stereoscopic images on a common stereoscreen for simultaneous viewing each of the separately projected stereoscopic images as determined by a spectator,

characterised in that

the automatic corrector is provided with actuators, coupled to each of the projection objectives, for simultaneous autonomous dynamic registration of the corresponding zones of viewing of the left and right images of a separate stereoscopic pair by the spectator's left and right eyes, respectively,

characterised in that

the automatic corrector comprises autonomous actuators coupled to each of the separate projection objectives, or spectators' seats; and a sensor or a plurality of sensors being adapted to determine autonomously coordinates of spatial disposition of each of the spectators' eyes to generate signals supplied to the automatic corrector.

3. The stereoscopic system as claimed in claims 1 or 2, characterised in that the stereoscreen has a reflecting mirror-lens raster of the retroreflecting type made of

retroreflectors implemented in the form of spherical microlenses having a mirror coating at the rear side of said microlenses;

projection objectives of the stereoscopic projectors being positioned closer to spectator's head such that the objective for projecting the left images of the stereoscopic pair is disposed at the left side closer to the center of spectator's head, and the objective for projecting the right image of the stereoscopic pair is disposed at the right side of spectator's head;

an optical arrangement of the projection objectives and of the stereoscreen lens raster being designed to reflect, by the stereoscreen, the objective-projected image of the stereoscopic pair right image only to the spectator's right eye viewing zone, and the objective-projected left image - to the spectator's left eye viewing zone, respectively;

the automatic corrector being provided with autonomous actuators independently coupled to each of the projection objectives, having capability of synchronously shifting said objectives along the parallel path of each spectator's head movement, and

the sensor, or plurality of sensors being coupled to the automatic corrector and adapted to independently determine coordinates of the spatial disposition of each spectator's eyes.

4. The stereoscopic system as claimed in any one of claims 1, 2, characterised in that, for carrying out the stereoscopic projection onto a translucent viewing stereoscreen, the stereoscopic system has a stereoscopic projector for separate projection of portions of area of the stereoscopic pair left and right images, for which purpose the optical system comprises pairs of projection objectives having a deflecting mirror;

in each pair, a first projection objective being a telephoto lens disposed in the end face of the translucent screen and oriented to direct the projection into the input aperture of a second projection wide-angle objective for magnified projection onto the stereoscreen;

the deflecting mirror being positioned behind the exit pupil of the second objective to direct the projection onto a portion of the stereoscreen area;

all objectives, that have the deflecting mirrors, together forming the full-screen left and right stereoscopic pair images over the entire area of the stereoscreen;

the stereoscreen having a movable lens raster that is coupled to the automatic corrector actuator for dynamic registration of zones of selective viewing of the left and right stereoscopic pair images by the spectator's left and right eyes, respectively.

5. The stereoscopic system as claimed in any one of claims 1 - 3, characterised in that in each of the pairs of projection objectives that project the left and right stereoscopic pair images for one spectator, installed are individual correcting optical elements to correct geometric distortions, and/or installed are the semitone or color filters to equalize the brightness and chromaticity over the image field.

6. The stereoscopic system as claimed in any one of claims 1 - 3, or 5, characterised in that, for carrying out the stereoscopic projection onto the wide-format or panoramic stereoscreens, the stereoscopic projection system has projectors for separate projecting of portions of each of the left and right whole images of a stereoscopic pair in separate sectors of the stereoscreen using separate projectors or separate projection objectives disposed at the optimum projection points.

7. The stereoscopic system as claimed in claim 6, characterised in that the system of stereoscopic projectors is formed for separate projection of the central portion of the projected on-screen stereoscopic image in the form of interfaced left and right frames of a stereoscopic pair; in the leftmost portion of the screen - for projecting the monoscopic images of a portion of the left frame of said stereoscopic pair, and in the rightmost portion of the screen - for projecting the monoscopic image of a portion of the right frame of said stereoscopic pair.