A light distribution system

FIELD OF THE INVENTION

This invention relates to a light distribution system and, in particular, to one that distributes light using optical fibres.

BACKGROUND TO THE INVENTION

Computers used for data processing, such as mainframes and servers, within data centres, often generate a large amount of heat during their operation. Adequate cooling is required for their stable operation. In a building, or data centre, where such computers are located, sunlight may enter the building through windows as a natural light source for illumination. However, this may further heat up the space surrounding these computers, thereby exacerbating the heat generation problem and increasing the cooling requirement.

Housing these computers in a building with no or few windows is one way to mitigate the heat generation problem. However, the inability to utilise natural light means that electric power is necessarily consumed for electric lighting. Therefore, it would make the running of these computers more cost-effective and environmentally friendly if they are housed in a windowless building (or a building with fewer windows) that utilises natural light for illumination.

There are attempts to illuminate a windowless building while still utilising natural light source. These include an arrangement where a curved mirror or reflector is placed, for example, on a rooftop to collect sunlight outside a building and distributing it to the interior of the building via optical fibres. In this prior art arrangement, the amount of light collected is primarily dictated by the area of the reflector. In order to collect more light, a reflector with a larger reflector area will have to be used. The mechanical requirements to support a large curved reflector become more stringent when a larger reflector is used.

In this prior art arrangement, therefore, the amount of light collected is not easily scalable without also substantially strengthening its mechanical support. Furthermore, this arrangement also requires two curved reflectors separated by a distance in the order of the focal length of the system. Since this distance scales roughly with the reflector area, using a larger reflector for collecting more light further increases the dimension of the system (in the direction along the optic axis of the reflector) and compromises the compactness or flatness of the system.

SUMMARY OF THE INVENTION

According to one aspect of the present invention there is provided a light distribution system comprising

a plurality of light converging elements for concentrating light; and

a plurality of wavelength selective optical conduits each being operatively coupled to respective of the light converging elements, and configured to receive converged light from the respective light converging element and transport at least a portion of the converged light in the wavelength selective optical conduits.

Preferably the plurality of wavelength selective optical conduits include a wavelength selective optical fibre. More preferably the plurality of wavelength selective optical conduits include a plastic or polymer optical fibre. Alternatively the plurality of wavelength selective optical conduits include a photonic crystal fibre or holey fibre. Still alternatively the plurality of wavelength selective conduits include an optical fibre doped with dopants having wavelength dependent absorption.

Preferably the plurality of wavelength selective optical conduits are adapted to transmit substantially light of visible wavelengths. More preferably the plurality of wavelength selective optical conduits are adapted to transmit substantially light of visible wavelengths while blocking light of a selected range or ranges of wavelengths.

Preferably the plurality of light converging elements form a one or two dimensional array of light converging elements. More preferably the plurality of light converging elements are arranged in a hexagonal or triangular pattern.

Preferably the system further comprises a light dispersing module operatively coupled to at least one of the plurality of wavelength selective optical conduits for dispersing light transported in the optical conduits. More preferably the light dispersing module is one of a plurality of light dispersing modules.

Preferably the plurality of light converging elements includes a first set of lenses. More preferably the plurality of light converging elements includes a first set of ball, or half ball lenses.

Preferably the plurality of light converging elements or the light dispersing module include a plurality of Fresnel lenses. More preferably the plurality of Fresnel lenses include a plurality of bulk Fresnel lenses. Additionally or alternatively, the plurality of Fresnel lenses are stamped at one or both ends of the respective wavelength selective optical fibres. Even more preferably the plurality of optical fibres stamped with Fresnel lenses are wide-tapered plastic optical fibres.

Preferably the plurality of Fresnel lenses may be superstructured. More preferably the plurality of superstructured Fresnel lenses are stamped into one of the plurality of converging elements for coupling light into or out of the plurality of wavelength selective optical fibres.

Preferably the plurality of light converging elements each include a wavelength selective element for substantially blocking light of a selected range or ranges of wavelengths.

Preferably the plurality of wavelength selective optical conduits each have a smaller cross-sectional area than that of the respective light converging element.

Preferably the plurality of light converging elements are each formed integrally with the respective wavelength selective optical fibre. More preferably the plurality of light converging elements are each formed at a taper extending into the respective wavelength selective optical fibre. Alternatively the light converging elements are each formed within the respective wavelength selective optical fibre which includes a graded refractive index profile for converging light.

Preferably the light dispersing module includes a second set of lenses. More preferably the light dispersing module includes a second set of ball, or half ball lenses. Alternatively or additionally the light dispersing module includes a diffuser.

Preferably the second set of lenses form a one or two dimensional array of lenses.

Preferably the plurality of wavelength selective optical conduits are each coupled to the respective light converging element using index matching epoxy

Preferably the system further comprises a solar panel for receiving light energy. More preferably the solar panel includes photovoltaic materials for generating electricity from the received light energy.

Preferably the light dispersing module is one of a plurality of dispersing modules. More preferably the plurality of dispersing modules are located separately.

Preferably the plurality of wavelength selective optical conduits are bundled into an optical fibre bundle. More preferably the optical fibre bundle is one of a plurality of optical fibre bundles. Even more preferably the plurality of optical fibre bundles are each operatively coupled to respective of the plurality of light dispersing modules.

Preferably the optical fibre bundle is a fused optical fibre bundle. More preferably the fused optical fibre bundle is drawn and/or annealed.

According to another aspect of the present invention there is provided a light distribution system comprising

a plurality of light converging elements for concentrating light;

a plurality of optical conduits each being operatively coupled to respective of the light converging elements, and configured to receive converged light from the respective light

converging element and transport at least a portion of the converged light in the optical conduits; and

a first frame including a first set of alignment holes for holding the plurality of light converging elements.

Preferably the first set of alignment holes are each aligned with respective of the plurality of optical conduits.

Preferably the system further comprises a second frame for holding the plurality of optical conduits. More preferably the second frame includes a second set of alignment holes for holding the plurality of optical conduits. Even more preferably the second set of alignment holes are each aligned with respective of the plurality of light converging elements. Alternatively or additionally the second set of alignment holes are aligned with the first set of alignment holes.

Preferably the system further comprises a third frame for holding the light dispersing module. More preferably the third frame includes a third set of alignment holes for holding the second set of lenses. Even more preferably the third set of alignment holes are each aligned with respective of the plurality of optical conduits. Alternatively or additionally the third set of alignment holes are aligned with the second set of alignment holes.

BRIEF DESCRIPTION OF THE ACCOMPANYING FIGURES

Figure 1 shows a schematic diagram of an embodiment of a light distribution system according to the present invention.

Figure 2 shows a schematic diagram of a light distribution system installed in a building.

Figure 3 shows a schematic diagram of a light distribution system installed in another building.

Figure 4 shows an example of a square array of converging lenses.

Figure 5 shows examples of one or two dimensional arrays of dispersing lenses.

Figure 6 shows a schematic diagram of a converging lens and an optical fibre aligned by index matching epoxy.

Figure 7 shows a plan view of a frame with drilled holes for aligning lenses with optical fibres.

Figure 8 shows a plan view of another frame with drilled holes for aligning lenses with optical fibres.

Figure 9 shows a cross-sectional view of two frames, with one holding an optical fibre and the other holding a half ball lens.

Figure 10 shows a schematic drawing of a partially drawn optical fibre preform.

Figure 11 shows a schematic drawing of a partially drawn optical fibre preform with a moulded lens.

Figure 12 shows a schematic drawing of an array of partially drawn optical fibre preforms held by a frame.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Figure 1 shows a schematic diagram of an embodiment of a light distribution system **1** according to the present invention. The light distribution system **1** generally comprises a plurality of light converging elements, such as converging lenses **10**, and a plurality of wavelength selective optical conduits, such as wavelength selective optical fibres **12**, having wavelength-dependent transmission. The converging lenses **10** and the optical fibres **12** are so aligned that light **11** that is converged or concentrated by the converging lenses **10** is coupled into the optical fibres **12**. Once received into the optical fibres **12**, the converged light is transported in the optical fibres **12**. The converged light may be transported to another end of the optical fibres **12** and may leave the optical fibres **12** for illumination purposes. Although not necessary, it is preferable that the system **1** further comprises a light dispersing module **14**, which may include dispersing lenses **16**, for dispersing light transported in the optical fibres **12**. This may be achieved by aligning the light dispersing module **14** with the optical fibres **12** to disperse light through the light dispersing module **14**. At the dispersing side of the system, a piece of roughened glass or Perspex may be used as a diffuser to diffuse the light, which may improve the appearance of the lighting system, but also for security purposes.

In a preferred embodiment, the optical fibres **12** are plastic or polymer optical fibres. One of the reasons is that plastic or polymer optical fibres may be made more flexible than other types of fibres, such as glass or silica fibres, allowing light to be transported around tight corners within a building and thus reducing the chance of breakage of the optical fibres **12** during installation of the light distribution system **1**. The second reason is that plastic or polymer optical fibres can be installed and replaced at a much lower cost than that for standard silica fibre, which requires highly skilled operators to handle it. And yet another reason for using plastic or polymer fibre is the fact that it transmits light in the visible wavelength region of the electromagnetic spectrum. Additionally, the optical fibre may be engineered to exhibit a high transmission loss for either of both of infrared and ultraviolet light, thereby substantially inhibiting light of these wavelengths to be transmitted. In some embodiments, the optical fibres **12** are photonic crystal fibres or holey fibres. In further embodiments, the optical fibres **12** may be doped with dopants having wavelength dependent absorption (or wavelength dependent absorption cross section). Sections of the optical fibres **12** may be grouped together as optical fibre bundles **18** for ease of handling and installation.

Figure 2 shows a schematic diagram of how an embodiment of the light distribution system **1** may be installed in a building **2**. The embodiment shown in Figure 2 has the converging lenses **10** placed on a vertical outside surface **13** of the building **2**. Light collected by the converging

lenses **10** is transported in optical fibres (not shown) grouped in an optical fibre bundle **18**. The bundle 18 may be individual fibres, as shown in Fig. 1, or may be formed by fusing the individual fibres together into a single strand of fibre (not shown). In case of a fused fibre bundle, the bundle may be drawn and/or annealed to the desired length and shape to, for example, improve the stability of the fused material as well as to improve light transport characteristics such as light confinement and loss. The collected light is then dispersed in a room **15** inside the building **2** through a light dispersing module **14**, which in this embodiment includes dispersing lenses **16**. Near the dispersing module **14**, the bundle **18** (whether fused or not) may be split into individual fibres for dispersing light through the respective dispersing lenses **16**. In some embodiments, the individual fibres may be split and directed to different rooms, whereby light is dispersed through dispersing lenses in different dispersing modules located in different rooms.

The lack of window (or providing only few windows) in the building **2** provides for thermal isolation while allowing natural light as the light source for the room **15**. The converging lens **10** may be additionally or alternatively placed on a horizontal or any other surface of a building, as shown in Fig. 3.

Concentrating collected light in optical fibres means that the energy density (energy flow per unit area) of the light when transported in the optical fibre is higher than that before the light is collected by the converging lenses. The increased higher energy density allows for the reduction in cross-sectional area required of the optical conduits to transport the same amount of light. This may be desirable because some dwellings may have limited space for laying the optical conduits or installing a light distribution system.

Both the converging lenses **10** and dispersing lenses **16** may be ball lenses, or half ball lenses. The use of ball lenses, or half ball lenses, assists in aligning the lenses **10** and **16** with the optical fibres **12**. This is because the spherical symmetry of ball lenses means that the lenses need not be tilted in any way (as there is no tilt orientation of a sphere) with respect to the longitudinal axis of the optical fibre, thereby eliminating the need for tilt alignment. The use of ball or half-ball lenses provide a relatively large acceptance angle for collecting light, such that light coming from different directions may be collected.

The light converging elements can be either simple optical lenses or Fresnel lenses. For optical lenses, we propose the use of bulk optical lenses, including double concave and plano-concave lenses, but also ball and half-ball lenses as mentioned above. For Fresnel lenses, we propose to use bulk Fresnel lenses, or to manufacture the Fresnel lenses directly in the light collecting area by stamping a master into a deformable substance that forms the light converging elements. These lenses may be adapted to couple light into or out of, for example, the respective plastic optical fibres mounted behind the lenses, and/or at the focal point of the respective lens. Additionally or alternatively, we suggest stamping Fresnel lenses in the end or ends of wide-tapered plastic optical fibres. In other embodiments, the Fresnel lenses may be superstructured, with two or more different Fresnel lenses stamped into the same light

collecting area , and/or stamped into an end of the same optical fibre, to form a single light converging element. The performance of each lens may be degraded, but allows the same light capture area or optical element to focus or couple light into or out of two or more different optical fibres.

The converging lenses **10** may each include a wavelength selective element such as a wavelength-selective filter or a thin-flim coating to substantially block specific wavelengths (for example, infrared and ultraviolet light) while allowing light of other wavelengths (for example, visible light) to pass. This and/or the use of wavelength selective optical conduits may be desirable since exposure of ultraviolet light to optical fibres may degrade the optical fibres. Also, infrared light may carry a certain amount of heat energy. Blocking infrared light thus further reduces heat energy being delivered to the inside of the building.

In some embodiments, as shown in Figure 4, the converging lenses **10** form a two-dimensional array **20** of lenses. The array may form a square as shown in Figure 4 or any other shape so as to be fitted to an opening in the building. In other embodiments, the converging lenses may form a one-dimensional array of lenses. The converging lenses may also form a three-dimensional (that is, providing a contour surface) array of lenses. This may aid the aesthetics of the array. However, care may be taken to ensure some converging lenses are not obstructed by others for the collection of light.

Similarly, in some embodiments, the dispersing lenses **16** as shown in Figure 5 may form a one-dimensional array **30** of lenses, or two-dimensional array (designated **32**, **34** or **36)** of lenses. The dispersing lenses 16 may be so arranged that it gives a functional purpose or an aesthetic appearance. The dispersing lenses **16** may be grouped into more than one arrays, as shown in designation **36**. The dispersing lenses may be grouped inside the building together, but with light collected from different outside surfaces or sides, of the building, as shown in Fig. 3. This allows light to be collected when the sun illuminates different surfaces or sides of the building, allowing distribution of light to the same room at different times of the day.

In some embodiments, the light converging elements may be integrally formed with the optical conduits. For example, referring to Fig. 10, the light converging element may be formed at a taper region **82** of an optical fibre preform **80** that is partially drawn. More specifically when an optical fibre is drawn from an optical fibre preform, a taper region **82** may exist to form a smooth transition between the non-drawn portion **84** and the drawn portion **86** of the optical fibre preform, with the drawn portion being the optical fibre. The taper region **82,** which acts as the light converging element therefore extends into the optical fibre **86**. The smooth transition of the taper **82** assists in guiding and concentrating light from the non-drawn portion **84** to the optical fibre **86**. Figure 11 shows that a moulded lens **92** may be additionally coupled to the non-drawn portion **84** of the of the optical fibre preform **80** to further assist in collecting light into the non-drawn portion **84**, and into the optical fibre **86** via the taper region **82**. Figure 10 illustrated schematically an array of eight partially drawn optical fibre preforms held by a frame **102**. Within each partially drawn optical fibre preform in the array there exists a taper region

104 acting as the converging element, formed integrally with the respective optical fibre **106** (shown only schematically as a single solid line and disconnected from the integrally formed converging element for the sake of simplicity), which is the drawn portion of the optical fibre preform. Each partially drawn optical fibre preform may include a taper (**104** and **108**) at each of its ends, as illustrated in Fig. 12, with the drawn portion **106** located between the two ends. For the sake of simplicity, Fig. 12 only shows one of the eight partially drawn optical fibre preforms as having a corresponding end. In practice, each partially drawn optical fibre preform in the array should have a corresponding end.

As another example, the light converging element may be formed at the tip of an optical fibre, where the tip has a gradually changing refractive index profile, or a graded refractive index profile, in the radial direction of the optical fibre (as opposed to a step index profile) to create a lens effect or light converging effect. This arrangement is akin to a fibre pigtailed with a GRIN (graded-index) lens. Similarly the dispersing lenses may be formed integrally with the optical conduits or fibres.

Figure 6 shows an example of one of the converging lenses **40** and the respective optical fibre **42**. Ideally the position of the converging lens **40** relative to the optical fibre **42** is such that the amount of light converged and coupled into the optical fibre **42** is maximised. In order to maintain this relative position, the converging lens **40** may be adhered to the optical fibre **42** using index matching epoxy **44**. The use of an index matching epoxy, as opposed to a non-index matching one, helps minimising Fresnel reflections at the interface between the converging lens **40** and the epoxy **44**, and at the interface between the optical fibre **42** and the epoxy **44**, thereby maximising the light coupled and transported in the optical fibre **42**.

To assist the process of aligning a plurality of converging lenses with a plurality of optical fibres, a frame or frames with alignment holes may be used. As shown in Figure 7, such a frame **50** may be made up of Perspex® (a registered trade mark of Lucite International UK Limited) with drilled holes **52** for holding lenses (not shown). A corresponding frame (not shown) with a corresponding set of alignment holes for holding optical fibres may be used to bring the optical fibres in proximity to the lenses. The frames may then be positioned relative to each other to align the lenses and the optical fibres before an epoxy **44** is applied for adhesion. Similarly the dispersing lenses may also be held in a similar frame to assist alignment between the dispersing lenses and the optical fibres. Furthermore, the frame **50** may be made up of any one or more of the following materials: Perspex, wood, glass and metal. The material making up of the frame **50** may also be chosen to match or dependent on the outside or inside wall of the building, for example, to create an aesthetic effect.

Fig. 8 shows another frame **60** with alignment holes **62** in a hexagonal pattern for holding lenses (not shown) so that the converging lens and the dispersing lenses may be arranged in a hexagonal pattern. For example, six alignment holes (**64a**, **64b**, **64c**, **64d, 64e** and **64f**) form a hexagon surrounding a central alignment hole **66**. Compared to the arrangement of the holes shown in Fig. 7, a hexagonal or triangular pattern increases the packing density of

lenses in a given area. A hexagonal pattern can be considered equivalent to a triangular pattern formed by, for example, alignment holes **64a**, **64b** and **66**, which achieves a similar packing density but not requiring the alignment holes forming of a hexagon.

Fig. 9 shows a frame **70** holding an optical fibre **12** brought in proximity of frame **72** holding a half ball lens **74**. Aligning the frames **70** and **72** assists in aligning the optical fibre **12** and the half ball lens **74**.

To more fully utilise energy from the sun, solar panels may be installed or supported on the frame holding the converging lenses for receiving light energy from the sun. The solar panels may include photovoltaic materials to generate electricity with the received light energy. The generated electricity can then be used, for example, to power electric light sources such as light bulbs or fluorescent lamp for illumination.

In some embodiments, light can be collected using a single array of converging lenses **10** (one or two dimensional) and transported to multiple locations. In one embodiment, the optical fibres **12** can be grouped into a number of optical fibre bundles **18**, where each bundle is operatively coupled to a different light dispersing module **14**. This allows distributing light to different parts in the interior of a building from a single array. An illustrative example is shown in Fig. 3 where an array **80** of six converging lenses are adapted to collect light to be transported in six optical fibres grouped in a bundle **18**. Each of the six optical fibres terminate with a dispersing lens, wherein dispersing lenses **16a**, **16b** and **16c** are located in a room **82** and dispersing lenses **16d**, **16e** and **16f** are located in another room **84**.

Now that several preferred embodiments of the present invention have been described in some detail, it will be apparent to those skilled in the art that the light distribution system has at least the following advantages over the admitted prior art:

- The amount of collected light is scalable by using more light converging elements and optical fibres.
- The ability to placing the light converging elements in a one or two dimensional array ensures the compactness or flatness of the light distribution system even when a multitude of light converging elements are to be used.
- The ability to tailor the shape the array of lenses allows the array to be installed in places of a building with shape restriction.
- The use of converging lenses with a diameter larger than the diameter of the transporting fibre allows for significant reduction in light gathering area during transmission than other prior art
- The use of passive (hemi-)spherical lenses for collection of light relaxes the requirement for active tracking of the light source (the sun).

- Installing converging lens on different outside surfaces or sides of a building allows for light collection at different times of the day when the sun illuminates different outside surfaces or sides of a building.

It will be appreciated by persons skilled in the art that numerous variations and/or modifications may be made to the invention as shown in the specific embodiments without departing from the spirit or scope of the invention as broadly described. For example, the alignment holes may be arranged to form shapes such as a circle or an oval, or to outline the shape of a object, or even positioned in a random manner to mimic the distribution of stars on a night sky. The frame may be of a circular or any other shape.

The present embodiments are, therefore, to be considered in all respects as illustrative and not restrictive.

CLAIMS

1. A light distribution system comprising
a plurality of light converging elements for concentrating light; and
a plurality of wavelength selective optical conduits each being operatively coupled to respective of the light converging elements, and configured to receive converged light from the respective light converging element and transport at least a portion of the converged light in the wavelength selective optical conduits.

2. A light distribution system as claimed in claim 1 wherein the plurality of wavelength selective optical conduits include a wavelength selective optical fibre.

3. A light distribution system as claimed in claim 2 wherein the plurality of wavelength selective optical conduits include a plastic or polymer optical fibre.

4. A light distribution system as claimed in claim 2 wherein the plurality of wavelength selective optical conduits include a photonic crystal fibre or holey fibre.

5. A light distribution system as claimed in claim 2 wherein the plurality of wavelength selective conduits include an optical fibre doped with dopants having wavelength dependent absorption.

6. A light distribution system as claimed in any one of the preceding claims wherein the plurality of wavelength selective optical conduits are adapted to transmit substantially light of visible wavelengths.

7. A light distribution system as claimed in claim 6 wherein the plurality of wavelength selective optical conduits are adapted to transmit substantially light of visible wavelengths while blocking light of a selected range or ranges of wavelengths.

8. A light distribution system as claimed in any one of the preceding claims wherein the plurality of light converging elements form a one or two dimensional array of light converging elements.

9. A light distribution system as claimed in claim 8 wherein the plurality of light converging elements are arranged in a hexagonal or triangular pattern.

10. A light distribution system as claimed in any one of the preceding claims wherein the system further comprises a light dispersing module operatively coupled to at least one of the plurality of wavelength selective optical conduits for dispersing light transported in the optical conduits.

11. A light distribution system as claimed in claim 10 wherein the light dispersing module is one of a plurality of light dispersing modules.

12. A light distribution system as claimed in any one of the preceding claims wherein the plurality of light converging elements includes a first set of lenses.

13. A light distribution system as claimed in claim 12 wherein the plurality of light converging elements includes a first set of ball, or half ball lenses.

14. A light distribution system as claimed in any one of the preceding claims wherein the plurality of light converging elements or the light dispersing module include a plurality of Fresnel lenses.

15. A light distribution system as claimed in claim 14 wherein the plurality of Fresnel lenses include a plurality of bulk Fresnel lenses.

16. A light distribution system as claimed in either of claims 14 or 15 wherein the plurality of Fresnel lenses are stamped at one or both ends of the respective optical fibres.

17. A light distribution system as claimed in claim 16 wherein the plurality of optical fibres stamped with Fresnel lenses are wide-tapered plastic optical fibres.

18. A light distribution system as claimed in any one of claims 14-17 wherein the plurality of Fresnel lenses may be superstructured.

19. A light distribution system as claimed in claim 18 wherein the plurality of superstructured Fresnel lenses are stamped into one of the plurality of converging elements for coupling light into or out of the plurality of wavelength selective optical fibres.

20. A light distribution system as claimed in any one of the preceding claims wherein the plurality of light converging elements each include a wavelength selective element for substantially blocking light of a selected range or ranges of wavelengths.

21. A light distribution system as claimed in any one of the preceding claims wherein the plurality of wavelength selective optical conduits each have a smaller cross-sectional area than that of the respective light converging element.

22. A light distribution system as claimed in any one of the preceding claims wherein the plurality of light converging elements are each formed integrally with the respective optical fibre.

23. A light distribution system as claimed in claim 22 wherein the plurality of light converging elements are each formed at a taper extending into the respective wavelength selective optical fibre.

24. A light distribution system as claimed in claim 22 wherein the light converging elements are each formed within the respective wavelength selective optical fibre which includes a graded refractive index profile for converging light.

25. A light distribution system as claimed in any one of claims 10 to 24 wherein the light dispersing module includes a second set of lenses.

26. A light distribution system as claimed in claim 25 wherein the light dispersing module includes a second set of ball, or half ball lenses.

27. A light distribution system as claimed in either of claims 25 or 26 wherein the light dispersing module includes a diffuser.

28. A light distribution system as claimed any one of claims 25 to 27 wherein the second set of lenses form a one or two dimensional array of lenses.

29. A light distribution system as claimed in any one of the preceding claims wherein the plurality of wavelength selective optical conduits are each coupled to the respective light converging element using index matching epoxy

30. A light distribution system as claimed in any one of the preceding claims wherein the system further comprises a solar panel for receiving light energy.

31. A light distribution system as claimed in claim 30 wherein the solar panel includes photovoltaic materials for generating electricity from the received light energy.

32. A light distribution system as claimed in any one of claims 10 to 31 wherein the light dispersing module is one of a plurality of dispersing modules.

33. A light distribution system as claimed in claim 32 wherein the plurality of dispersing modules are located separately.

34. A light distribution system as claimed in any one of the preceding claims wherein the plurality of wavelength selective optical conduits are bundled into an optical fibre bundle.

35. A light distribution system as claimed in claim 34 wherein the optical fibre bundle is one of a plurality of optical fibre bundles.

36. A light distribution system as claimed in claim 35 wherein the plurality of optical fibre bundles are each operatively coupled to respective of the plurality of light dispersing modules.

37. A light distribution system as claimed in either of claims 35 or 36 wherein the optical fibre bundle is a fused optical fibre bundle.

38. A light distribution system as claimed in claim 37 wherein the fused optical fibre bundle is drawn and/or annealed.

39. A light distribution system comprising

a plurality of light converging elements for concentrating light;

a plurality of optical conduits each being operatively coupled to respective of the light converging elements, and configured to receive converged light from the respective light

converging element and transport at least a portion of the converged light in the optical conduits; and

a first frame including a first set of alignment holes for holding the plurality of light converging elements.

40. A light distribution system as claimed in claim 39 wherein the first set of alignment holes are each aligned with respective of the plurality of optical conduits.

41. A light distribution system as claimed in either of claims 39 or 40 wherein the system further comprises a second frame for holding the plurality of optical conduits.

42. A light distribution system as claimed in claim 41 wherein the second frame includes a second set of alignment holes for holding the plurality of optical conduits.

43. A light distribution system as claimed in claim 42 wherein the second set of alignment holes are each aligned with respective of the plurality of light converging elements.

44. A light distribution system as claimed in either of claims 42 or 43 wherein the second set of alignment holes are aligned with the first set of alignment holes.

45. A light distribution system as claimed in any one of claims 39 to 44 wherein the system further comprises a third frame for holding the light dispersing module.

46. A light distribution system as claimed in claim 45 wherein the third frame includes a third set of alignment holes for holding the second set of lenses.

47. A light distribution system as claimed in claim 46 wherein the third set of alignment holes are each aligned with respective of the plurality of optical conduits.

48. A light distribution system as claimed in either of claims 46 or 47 wherein the third set of alignment holes are aligned with the second set of alignment holes.