1.72 mm, the first refractive zone 20 will have an outside diameter of about 2.90 mm, the next diffractive zone will have an outside diameter of about 4.60 mm and the second refractive zone will have an outside diameter of about 7.00 mm. As will be understood by those of ordinary skill, the design dimensions may be varied somewhat to achieve particular corrective effects. It will also be understood that the order of placement of the diffractive and refractive zones may be reversed, i.e., the central zone may be refractive, etc.

Another embodiment of a lens having similar properties to that shown in FIG. 2 is depicted in FIG. 3. The lens design shown has a centrally disposed first refractive zone 30, preferably of about 1.3 mm diameter if used in a 7.00 mm intraocular lens. Surrounding the first refractive zone 30 is a diffractive zone 40, which preferably has an outer diameter of about 3.36 mm. A second refractive zone 32 surrounds the refractive zone 40 and has an outer diameter of about 7.00 mm. As set forth above, in certain embodiments it may be desirable to alter the dimensions given or to reverse the arrangement of the zones.

Referring now to FIG. 4, an embodiment of a high efficiency lens utilizing both diffractive and refractive elements over its entire surface to achieve bifocal vision is shown. The lens depicted in FIG. 4 has two zones of a first diffractive power 110,112 for distance vision and two zones of a second diffractive power 120,122 for near vision. Although the layout of the zones shown places the zones in a series of annular rings, it should be understood that numerous other layouts are comprehended by the present invention. Also, as demonstrated with reference to FIGS. 2–3, the number of zones may be expanded or reduced. In this embodiment of the present invention, two zones of different diffractive powers are placed in an additive manner relative to a lens having a basic power to achieve multiple focal points. As will be readily understood by those of ordinary skill, the layout, shape and relative size of the zones is dependent upon the specific correction required.

In a preferred embodiment of the lens depicted in FIG. 4, a lens preferably provides a basic refractive power of about 10 diopters, achieved using a bi-convex lens or other lens designs known to those of ordinary skill. An additional 10 diopters of a first diffractive power is added by two diffractive zones 110,112, thereby providing a total power of 20 diopters for distance vision. Two near vision diffractive zones 120,122 which have a second diffractive power of about 14 diopters are also provided, resulting in a total near vision power of 24 diopters.

Referring now to FIGS. 5–6, intraocular lenses 200 made in accordance with the present invention are shown. The lenses 200 have haptics 210 for holding the lens in place. As shown, each lens has near vision N and far vision F zones. In accordance with one aspect of the present invention, either the near of the far zone may comprise a high efficiency diffractive element while the other zone comprises a refractive element of the basic lens. Alternatively, as discussed with reference to FIG. 4, in certain embodiments of the present invention, both the near and far zones will comprise diffractive elements, each respectively of a different diffractive power.

The lenses depicted in FIGS. 5–6 also illustrate further variations of the geometries of the zones of different focal lengths created on the basic lens. As shown in FIGS. 2–4, it will be desirable in certain instances to create one or more circular or annular diffractive zones. As shown in FIGS. 5–6, it is also possible to divide the lens diametrically in halves or quarters, alternating the near and far vision zones accordingly. As will be readily understood by those of ordinary skill, the same zone layouts depicted in FIGS. 2–6 may be applied to contact lenses and other forms of lenses and are not limited to intraocular lenses.

The operation of an intraocular lens 200 within the eye 250 is shown in FIG. 7. Light from a near object N is focused on the retina R by the near vision zone. Light from a far object F is focused on the retina R by the far vision zone of the lens. Therefore, all of the light both the near and far objects is focused by the near or far zone respectively, resulting in a nearly 100% efficient lens.

Similarly, FIG. 8 depicts a contact lens 100 made in accordance with the present invention disposed on the cornea of an eye 250. Unlike the example of FIG. 7, the patient wearing a corrective contact lens also has a natural crystalline lens 260 within the eye.

As will be understood by those of ordinary skill the lenses discussed above may have a basic refractive power provided by the shape of the lens. The present invention may be applied to bi-convex or plano convex lenses, as well as to meniscus lenses, such as contact lenses.

Although certain embodiments of the present invention have be set forth in detail, these examples are not meant to be limiting. Numerous other embodiments and variations to the embodiments set forth will immediately present themselves to those of ordinary skill. Accordingly, reference should be made to the appended claims in order to determine the scope of the present invention.

What is claimed is:

1. A multifocal lens for correcting vision comprising:

a basic lens element having a basic lens power and a basic focal length;

one or more diffractive elements covering one or more zones of said basic lens element arranged as alternate semi-circular area and having a diffractive power,

whereby a portion of the light travelling through said lens is focused at said basic focal length by said basic lens power, and another portion of the light travelling through said lens is focused t a different focal length by the combined power of said basic lens element and said diffractive elements.

2. A multifocal lens for correcting vision comprising:

a basic lens element having a basic lens power and a basic focal length; and

one of more diffractive elements covering one or more zones of said basic lens element arrayed as alternate quarter circular areas and having a diffractive power,

whereby a portion of the light travelling through said lens is focused at said basic focal length by said basic lens power, and another portion of the light travelling through said lens is focused at a different focal length by the combined power of said basic lens element and said diffractive elements.

3. A multifocal lens for correcting vision comprising:

a basic lens element having a basic lens power and a basic focal length;