May 21, 1957 E. D. CLARKE ET AL 2,792,573

ARTIFICIAL EYE

Filed Oct. 5, 1950

3 Sheets-Sheet 1

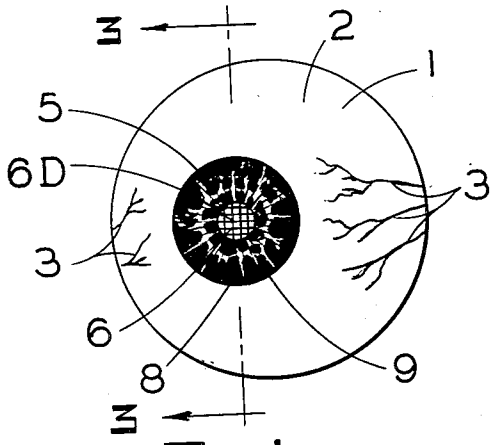


FIG. 1

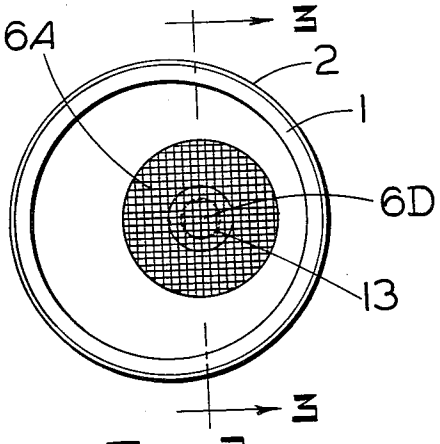


FIG. 2

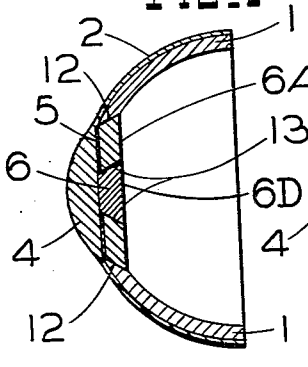


FIG. 3

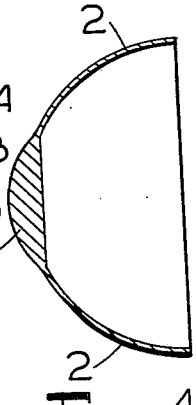


FIG. 4

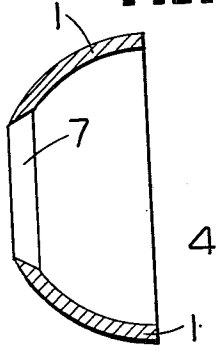


FIG. 5

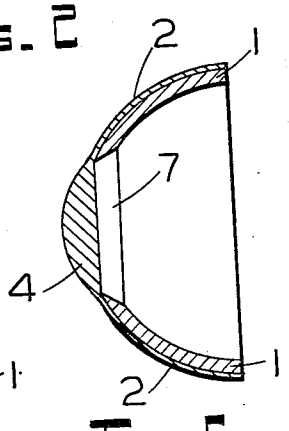


FIG 6

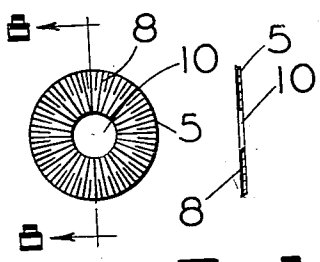


FIG. 7

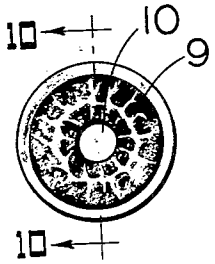


FIG 8

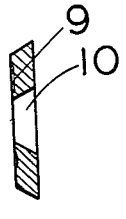


FIG 9

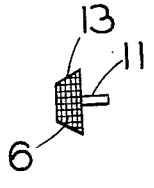


FIG 10

FIG 11

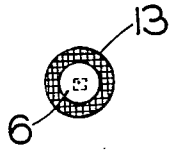


FIG 12

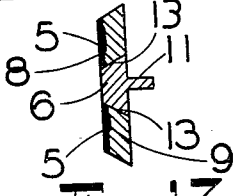


FIG 13

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May 21, 1957 E. D. CLARKE ET AL 2,792,573

ARTIFICIAL EYE

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3 Sheets-Sheet 2

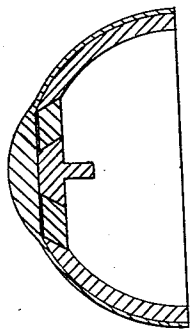


FIG. 14

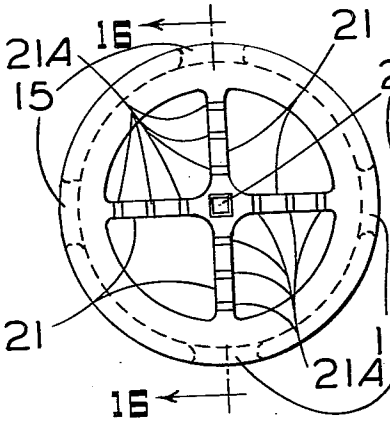


FIG. 15

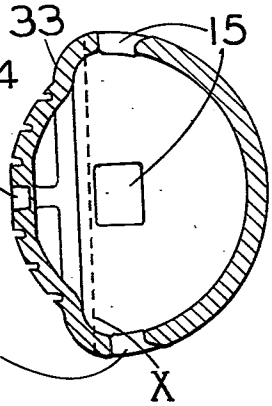


FIG 16

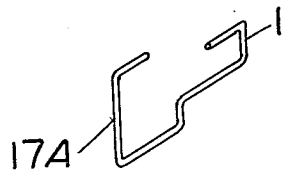


FIG 17

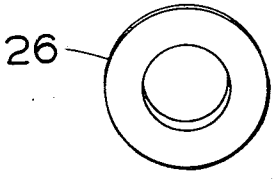


FIG. 18

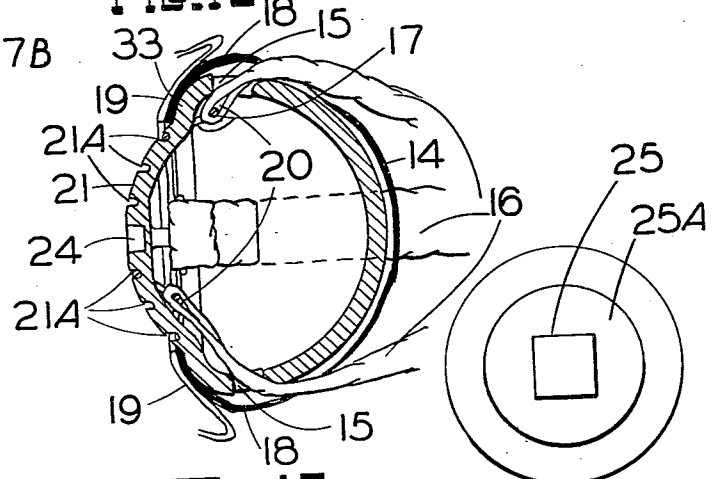


FIG. 19

FIG. 20

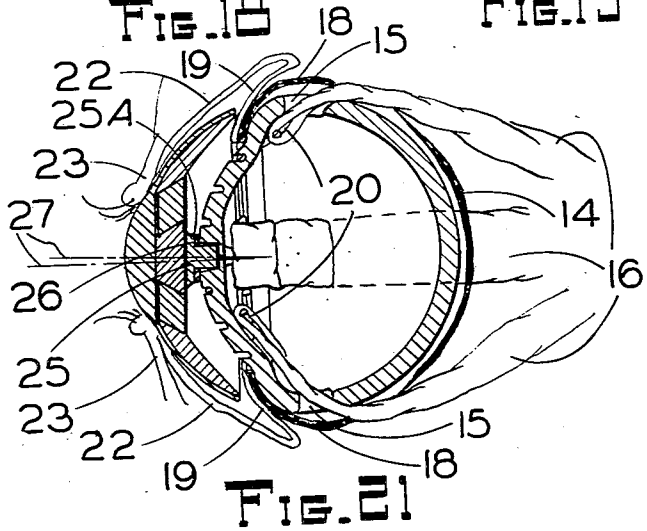


FIG. 21

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May 21, 1957 E. D. CLARKE ET AL 2,792,573

ARTIFICIAL EYE

Filed Oct. 5, 1950

3 Sheets-Sheet 3

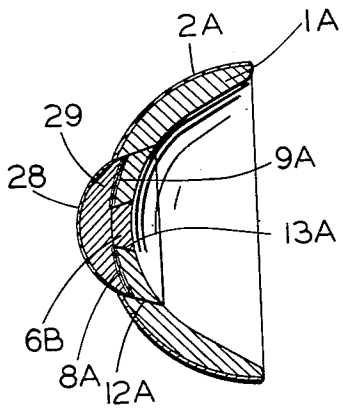


FIG. 22

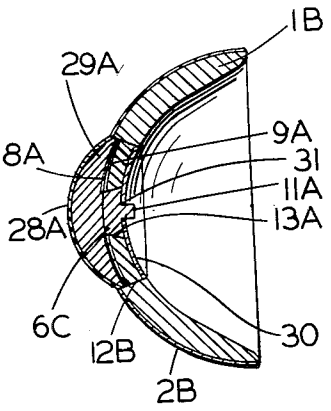


FIG. 23

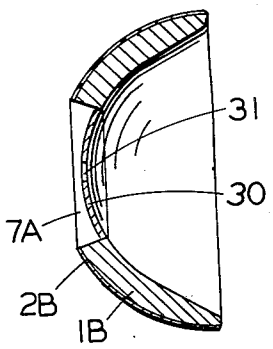


FIG. 24

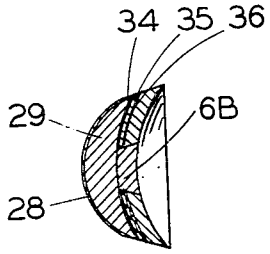


FIG. 25

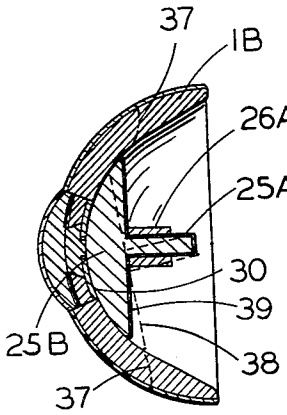


FIG. 26

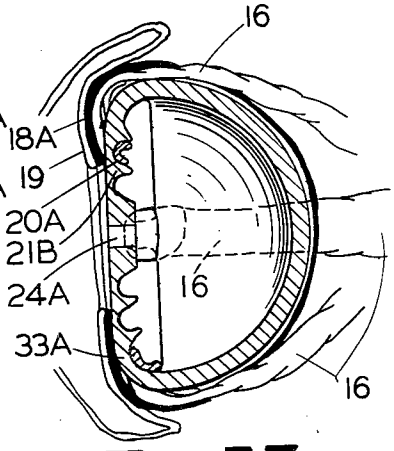


FIG. 27

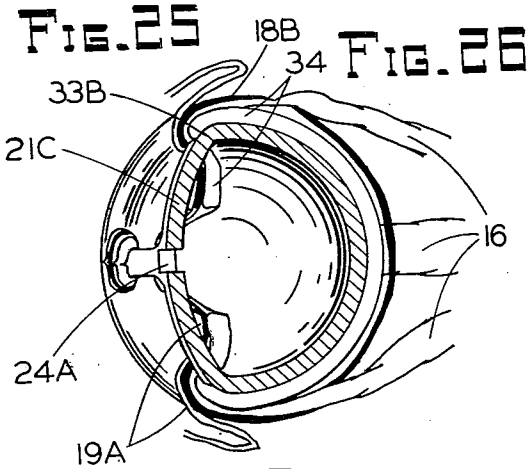


FIG. 28

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United States Patent Office 2,792,573 Patented May 21, 1957

2,792,573

ARTIFICIAL EYE

Eric D. Clarke and Robert B. Clarke, Cleveland, Ohio

Application October 5, 1950, Serial No. 188,602

12 Claims. (Cl. 3—13)

This invention relates to improvements in artificial eyes, and more particularly to those used by humans to replace one lost eye, under which condition the artificial eye must match in every detail the remaining human eye in respect to appearance and movement that corresponds with that of said human eye.

This application is a carrying forward by way of improvements in the subject matter of copending applications of previous applications of Eric D. Clarke, Ser. No. 546,763, filed July 27, 1944 (now Patent No. 2,673,984, issued April 6, 1954); Ser. No. 678,975, filed June 24, 1946 (now Patent No. 2,634,423, issued April 14, 1953) and Ser. No. 737,816, filed March 28, 1947 (now Patent No. 2,675,561, issued April 20, 1954), all relating to artificial eyes and methods pertaining to making such eyes and matching them with remaining human eyes.

The last two of the applications hereinbefore referred to are partly directed to the employment of an artificial eye constructed to afford the optical illusion of a dilating pupil member. In all of the said applications depth of iris and pupil have been striven for.

In artificial eye technique, the matching of the iris of the eye is an intricate task, because the addition of the customarily used transparent member in front of the iris creates changes of appearance of the iris color when viewed from different angles; also the effect of the iris color is changed to a certain extent by the iris being placed in a recess of the sclera, and likewise the action of the eyelids which partly cover the iris tends to cause different shadings of the coloring of the iris when the artificial eye is disposed in the eye socket, as distinguished from the coloring of the iris when the eye is held in the hand. The shading action of the eyelid is different in different people due to the extent to which the iris may be covered by the lid, the action being somewhat similar to that of window shades in a room, when open or partly drawn, effecting a change in the color shades of decoration of the room, dependent upon the extent of opening of such shades. In the development of our present invention the foregoing problems of difficulty in the production of the iris part of the artificial eye are taken especially into consideration with a view to overcoming such difficulty as has been experienced in the past in the production and emplacement of the artificial eye in the human eye socket.

In the carrying out of the present invention we have endeavored to improve the technique of a muscle attachment phase of the use of artificial eyes, especially in regard to the saving of unreplaceable tissue so that the latter will not be lost in subsequent operations for effecting other muscle attachment, should they later become necessary.

Our invention of this application is a carrying forward of the inventions and development of the previously identified applications, by utilizing certain improvements and effectuating certain objects that will appear more fully hereinafter when pointed out.

A further object of our invention is to produce an

individual eye or custom-made artificial eye from standardized, separate precision made units, which latter are adapted to be manufactured on a production basis, thereby lowering the cost when produced at a centralized plant under the direction of those skilled in the art, the foregoing enabling wide distribution of the standardized separately made units to persons who need only skill in the art of fitting and color matching an artificial eye with a natural eye, with the actual eye parts or units assembled and disposed in the eye socket of the lost eye of a customer. The above method of producttion and distribution of eye units for artificial eyes of our invention is such that a customer who requires an artificial eye can go to a city or place in or near his home and obtain a complete artificial eye made up of carefully selected parts taken from a relatively small amount of stock, the eye parts being interchangeable incident to connecting and assembly or detachment operations. The person who performs the fitting and color matching of the eye therefore does not have to be an artist or plastic expert and requires for his particular work no molds or heat and pressure machinery. In fact the eye fitter and matcher requires little technical knowledge and skill in plastics, having in mind that the parts or units of the artificial eye proposed by our invention are preferably made from acrylic resins, and a fast-acting solvent makes it feasible to laminate without the application of heat or use of molds.

Another object of our invention hereof has been to place in the hands of the surgeon performing the operation a novel form of implant that can be inserted into the socket for the suturing of the rectus muscles, whereby the surgeon has more room to work in his operative procedure in the very restricted area established by the ordinary eye socket of a human being.

Another object of our present invention is to place in the hands of the operating surgeon for artificial eye procedure an implant having provisions whereby the tension of the rectus muscle connected to the implant can be adjusted after performance of the original operation.

Still another object of our present invention has been to produce a construction of implant for the operating surgeon, which implant enables the rectus muscles to be attached on the anterior side of the implant, thus affording the surgeon more room for his operative procedure in the very restricted area in which he has to work, and also enabling the muscles connected to the implant to be adjusted in respect to their tension, after the operation, as well as at the time of such operation.

Another object of our invention has been to produce a novel construction of implant, for emplacement in the sclera, the implant permitting the suturing to be performed on the anterior side thereof.

A further object of our present invention has been to provide a form of implant enabling the surgeon employing the same to suture the Tenon's capsule and bulbar conjunctiva on the anterior side of the implant.

Another object of our invention has been to produce an implant for artificial eyes which, when in place, enables the anterior part of the Tenon's capsule to be sutured inwardly over the outer rim of the implant, to prevent the implant from being extruded.

A further object of our invention hereof has been to produce a novel construction of an implant formed of a main posterior body of somewhat or partial ball form, the same provided with an open front portion of skeleton-like structure, which enables surgical procedure to be performed within the body of the implant by instruments to be introduced through the front skeleton-like portion of said implant.

Another object of our present invention has been to produce an implant for artificial eyes adapted to carry

an eye prosthesis and which implant is made up of a body section and a front separate rim and spoke section, the latter providing a skeleton-like structure. The said rim and spoke section is especially designed with provisions whereby it may be connected to the eye prosthesis, and peculiar features are provided for enabling special adjustment of the eye prosthesis upon the anterior rim and spoke section referred to, all as will be more fully disclosed hereinafter.

Still another feature of our invention resides in supplying on a production basis a simplified three-dimensional iris and pupil member or unit that will not cast shadows, and wherein radial iris color lines and concentric folds or ruffles are provided in suitable depth of various color tints, all to the end of providing for perfect or naturalistic appearance of the artificial eye utilizing the unit, especially as respects the matching of a remaining human eye.

Another object of our invention has been to produce a simplified form of prosthesis affording an optical illusion of a dilating pupil member which operates to afford a varying dilating effect under different degrees of light, and in which an opaque pupil is placed considerably in rear of the translucent colored iris, or omitted, the said dilating pupil being so made that it apparently increases in size when light is diminished, and vice versa.

Another object of the present invention has been to produce an artificial eye eliminating the forming of a contrasting color ring appearing at the point of the joinder of the iris with the sclera, and instead effecting the blending of the color areas of the iris and sclera for effective matching of the natural eye by the artificial eye being fitted and color matched at the particular time.

Still another object of the present invention is to provide a sclera unit having a recess therein for receiving a selectable detachably interchangeable iris unit which is positioned behind a transparent outer member in such a manner that there is no appearance of color change in the iris produced by the magnification of the outer member after the sclera and iris units are unified with the transparent member.

Still another object of the invention is to provide an iris unit for an eye prosthesis in which there will be no fogging lines or area due to the employment of separate composite portions or members or materials such as glass, paint, printed sections, decalcomania elements, or photographic film, and one in which plastic material covers the iris unit and coloring material is employed integral with the said plastic material.

Another object of the invention is to provide an iris unit affording depth of iris color wherein the light absorption and reflections are balanced as in the natural eye, by providing each successive posterior layer of material of such unit of lesser transparency, thus blending the light absorption and reflection.

Another object of the invention lies in the provision of a simplified method of protruding and aligning the artificial eye with the natural eye of the person using the artificial eye.

Another object of the invention is to provide an eye prosthesis in which the pupil member has the closest possible simulation with respect to the pupil of the natural eye, wherein the pupil is a transparent hole in the iris and appears black due to the lack of color and light in the back of the eyeball.

Another object of the invention is the provision of an artificial eye that can be used as an ordinary artificial eye which is usually not movable simultaneously with the natural eye, or which may be associated with another standardized unit manufactured by precision methods of the invention, so as to be movable in the same manner as incident to the movement of the natural eye.

Still another object of the invention hereof is the provision of an implant having substantially the size and shape of the posterior part of the ocular structure which

it is to replace, with provisions whereby the said implant, along with the prosthesis mounted thereon may be made more or less protuberant when the complete artificial eye is mounted in the natural eye socket in which it is held. Thus having in mind that the implant is connected to the muscles of the natural eye, in the case of adhesion failure developing the abnormal protrusion of the prosthesis due to such failure may be rectified from the anterior face of the implant, and, in addition, inspections of the adhesions can be made in like manner.

Another object of this invention is to provide an implant that is simple in design, in different sizes and forms, with slight modifications, whereby the implant may be used after enucleation or after evisceration by employing many different methods of operative procedure of implantation, whereby the eye tissues, after suturing, lie in a plane such that the severed tissues can heal with adhesion in order to hold the implant in place. If for any reason the implant does not have good static and dynamic balance, provisions are made according to this invention for adjustment in reference to such balance without surgery, a matter of tangible advantage to the patient and the surgeon who has performed the operative surgery previously.

Still another object of this invention is the provision of a shell implant that is structurally strong but light in weight, so that no undue strains are placed on the connective eye tissues, which might cause a failure in the suturing, or fatigue on the attached eye muscles.

For the purpose of disclosing our invention as clearly as possible, in the accompanying drawings certain figures are shown which are exaggerated or enlarged more than others in order to bring out the structural characteristics of the units making up the prosthesis, and the implant members of the artificial eye. The term lens as used in this specification refers to a structure simulating the cornea and aqueous humor of the natural eye when said lens simulating structure is molded as a single unit, but, by reason of its shape, acts as a magnifying lens. Also, in the drawings, the eye socket and muscles and associated portions of the eye anatomy are not depicted with absolute accuracy and are primarily shown for illustrative purposes only.

No precise technique of operative surgery employed for the purposes of our invention is intended to be presented herein, for, in respect to may phases, such surgery is beyond our knowledge or province, being within the knowledge and skill of surgeons practicing in the particular field of eye surgery. Therefore, to a large extent, the surgical technique must necessarily depend upon and vary according to the skill, knowledge and experience of the particular surgeon performing the optical surgery, our main objective being to place in the hands of the surgeon certain artificial eye parts which may be available to constitute parts of the new artificial eye at the time of enucleation or evisceration, or at a later date when the eye socket containing such artificial eye may again be required to be opened.

For a full understanding of our present invention, as respects the details of construction and the method of use proposed, reference is made to the following specification describing different modifications, in conjunction with the acompanying drawings, in which latter:

Figure 1 is a front elevation of a complete artificial eye according to our invention.

Figure 2 is a rear view of the eye structure of Figure 1.

Figure 3 is a vertical sectional view taken about on the line 3—3 of Figures 1 and 2.

Figure 4 is a vertical sectional view of the outer transparent member shown in the previously mentioned figures.

Figure 5 is a vertical sectional view of the translucent sclera member.

Figure 6 is a vertical sectional view of the combined members shown in Figures 4 and 5 forming a sclera unit, in its condition ready to receive the iris unit as shown

in Figure 13, for detachable connection in the recess of the sclera unit, as used for color matching.

Figure 7 is a posterior view of the anterior iris member, showing the radially extending identations formed in the colored transparent plastic body of the iris member, which indentations are filled with a darker colored plastic.

Figure 8 is a vertical sectional view of the iris member as shown in Figure 7, taken on the line **8—8** of Figure 7.

Figure 9 is a front view of the posterior iris member showing the irregular concentric folds or ruffles which are depressions or indentations formed in the colored translucent plastic, said ruffles being filled with a lighter colored plastic.

Figure 10 is a vertical sectional view of the iris member shown in Figure 9, taken on the line **10—10** of Figure 9.

Figure 11 is a vertical sectional view of the transparent pupil member, adapted to fit in the pupil opening as shown in Figures 7, 8, 9, and 10.

Figure 12 is a front elevation of the transparent pupil member of Figure 11.

Figure 13 is a vertical sectional view of the combined iris and pupil unit and composed of the parts of Figures 7 to 12 inclusive.

Figure 14 is a vertical sectional view of the temporarily combined parts of the artificial eye, as used for color matching, employing the units shown in Figures 6 and 13.

Figure 15 is a view in front elevation of an artificial eye shell implant showing details of its construction.

Figure 16 is a vertical sectional view taken on the line **16—16** of Figure 15, showing the shell implant construction more clearly.

Figure 17 is an enlarged perspective view of the muscle pin hook.

Figure 18 is an enlarged perspective view of the aligning and protuberant control washer, such as used between the artificial eye or prosthesis, and the implant unit or shell.

Figure 19 is a vertical sectional view of the shell implant unit showing the implant in the Tenon's capsule of the eye socket, with the rectus muscles looped around the muscle pin hook and sutured upon themselves for adhesion to themselves, the muscle pin hook being detachably hooked to the spokes of the anterior part of the implant for adjusting the tension of the muscles, dependent upon the particular grooved portion or portions of the implant spokes with which the pin hooks may be interengaged. Also in this figure, the bulbar conjunctiva, and the anterior part of the Tenon's capsule, are sutured in place for adhesion to themselves.

Figure 20 is a rear elevation of the prosthesis unit showing the mounting or connecting pin by which the prosthesis is detachably mounted on the implant unit at the anterior section or portion of the latter.

Figure 21 is a vertical sectional view of the artificial eye, as when cut down to fit in front of the implant, with the connecting pin extending from the said eye unit, and the aligning and protuberance controlling washer shown in Figure 18 disposed in a position surrounding the mounting pin. In this figure there is also depicted the manner in which the eyelids partly cover and shade the iris in the natural eye sockets.

Figure 22 is a vertical sectional view of a modification of combined members.

Figure 23 is a vertical sectional view of a modification of combined members.

Figure 24 is a vertical sectional view of the sclera unit as seen in Figure 23.

Figure 25 is a vertical sectional view of another modification of iris unit adapted to be detachably connected in a sclera unit such as shown in Figure 22.

Figure 26 is a vertical sectional view of the combined units of Figure 23, with a modification of the form of the mounting or connecting pin as shown in Figures 20 and 21.

Figure 27 is a vertical sectional view of a modification of the implant shell, showing the implant in the Tenon's capsule of the eye socket, with the rectus muscles extending over the anterior rim of the implant and looped around the graduated spoke members and sutured upon themselves for natural healing by adhesion.

Figure 28 is a vertical sectional and perspective view of a modification of the shell implant showing the implant in the sclera of the eye socket, with the anterior parts of the sclera and Tenon's capsule bent or extending over the anterior rim of the implant, with the bulbar conjunctiva extending inwardly of said outer rim of the implant and sutured together under the spokes of the implant for adhesion to themselves.

As outlined in the fore part of this specification, this invention is directed, in one of its primary phases, to the making of artificial eyes on a production basis, into units, for later assembly and combining by persons who may not be skilled in the art of eye making, or may not be artists of color technique, but who are skilled in the art of fitting, altering, and color matching artificial eyes. The invention is also, of course, designed to place in the hands of a surgeon an implant that will make his operation more successful and more easily performed with the likelihood of superior results as compared with techniques employing artificial eye parts heretofore proposed.

The drawings comprising Figures 1 to 28 annexed hereto show the standardized precision made parts of our invention, and while no particular materials will necessarily have to be used in the carrying out of the invention, it has been found that thermoplastic materials have proved superior in most respects for the purposes of our invention. Such materials are especially adapted to precision molding on a production basis. Furthermore, while this invention is not limited to any certain molding methods, it is contemplated, according to the invention, that the injection and compression molding techniques shall preferably be utilized, especially because the injection method is a process of molding thermoplastic material at a production rate seldom equalled by any other method used in the plastic industry. Also, in general, the materials used, those of a plastic nature, in the injection or compression processing, undergo no chemical change during molding, and this advantage is necessary and desirable, having in view the construction of the artificial eye provisions that form our invention, since the slightest of chemical changes might undesirably affect the appearance factors which are desired to be obtained in securing the utmost faithfulness in the simulation of the colors of the natural eye in producing the artificial eye parts of our invention. Compression molding techniques, as known in the art today, may be utilized alternatively with the injection molding method within the contemplation of this invention.

The various parts of the artificial eye prosthesis and implant unit or units of different modifications as proposed herein are intended to be made in different sizes and colors, also different color patterns, and then assembled into the units that are to be finally employed for the purposes thereof, all of which will be more fully described hereinafter.

The prosthesis shown in Figures 1, 2, and 3 of the drawings comprises an off-white translucent or opaque sclera **1** which can be made of various tints to match those of the sclera of the human eye, and a transparent covering **2**, and these parts, as a unit, may be cut down so as to alter the shape to fit a particular individual eye socket, somewhat after the manner which is illustrated in Figure 21.

The sclera **1** is provided with suitable vein lines **3** which may be in the form of rayon fibers embedded between the sclera **1** and the transparent covering **2**. The vein lines **3** are formed into different patterns in the different sizes

and different color units comprising the parts **1** and **2** kept in stock. It will be noted that the transparent covering **2** is thickened on the anterior side, and centrally or slightly eccentrically in order to form the lens **4**, thus making a continuous covering without any joint. On the posterior side of the lens **4** is located the iris member **5**, which has an opening for a pupil member **6** and which may be provided with a black coating **6A** on its posterior side to simulate the pupil. The oblique joint between the pupil opening of the iris member **5** and the pupil member **6**, or in other words the surface of the joint portion, may be provided with a black coating **13** to better effectuate the obtaining of a dilating pupil illusion of action in darker colored iris or iris members, this depending somewhat upon the degree of transparency of the iris member **5**.

Figures 4, 5 and 6 disclose the manner in which the combined sclera **1** and its covering **2** having the lens portion **4** are formed as individual members and combined into a single unit. These units will preferably be made in about four sizes so as to avoid much alteration. The iris varies in size, and about five sizes of the iris members would normally be sufficient to be kept in stock. The foregoing phases of construction would afford certain variations in the size of the lens **4** circumference, and also of the iris recess **7** in the sclera **1**. Thus it will be seen that we have many patterns of vein lines **3**, with many off-white tints of sclera **1**, and also five different iris sizes altogether, thus making available many hundreds of sclera units to provide a large selection for the person doing the fitting and matching work, to chose from.

The members shown in Figures 4 and 5 are preferably precision molded in polished molds by the injection method as previously referred to, and then the sclera member, as shown in Figure 5, has the vein lines **3** placed thereon, whereupon the transparent covering member **2** may be placed over the member **1** and the two members united by compression molding as previously described. Or, in the alternative, a solvent for the plastic can be applied between the members **1** and **2**–**4** after which these members may be united by weight or pressure applied thereto to provide the unit of Figure 6.

The above described unit is now ready for shipment and color matching with respect to the natural sclera of a human eye, and, as previously indicated, it may be cut down to fit the natural eye socket, an operation which can be performed, obviously, without any special degree of eye making skill or the employment of molds or the like.

It is to be noted that the two members **1** and **2**, if desired, could be shipped in separated condition, and the vein lines **3** applied to the member **1** at the time of the fitting and matching, and then the members **1** and **2** united by a solvent in the manner previously outlined. According to the last plan of use, the number of sclera members **1** required to be kept in stock would be cut down materially.

The parts which are shown in Figures 7, 8, 9 and 10, also Figure 11, are preferably precision molded in polished molds by the injection method, previously referred to. The iris member **5** is made of preferably transparent, integrally pre-colored plastic and is a thin disc-like part. Said member is provided with radial indentations **8** on its posterior side, which indentations are filled with a darker, transparent or translucent integrally pre-colored plastic. The members like that shown in Figures 7 and 8 are made in various color combinations, and the indentations **8** can be filled by mixing a suitable solvent with a pre-colored plastic to about the consistency of paint, and wiping such plastic into the indentation **8**, and, if desired, wiping said plastic over the posterior face of the iris member being described. This method of making the iris member of Figures 7 and 8 would not require much skill and could be rapidly done, or, if desired, the pre-colored material wiped onto the posterior surface of the said member may be omitted until a later stage or time as will be hereinafter explained.

The iris member of Figures 7 and 8 is the anterior member of the iris unit and is transparent, as stated, so that depth of iris color can be seen in the indentations **8**. The material wiped into the indentations **8** of the anterior iris member described will blend into the body color of the iris disc or member structure so that there will not be much contrast of color tint at adjacent edges because the solvent will contain coloring which will penetrate the pre-formed body member or disc structure.

In Figures 9 and 10 of the drawings we have illustrated the posterior member of the iris unit **5**, and this member is molded in the manner previously indicated, using translucent pre-colored plastic. It is formed with an irregular anterior surface providing concentric folds or ruffles **9**, which are depressions or indentations, and which are filled with lighter colored translucent or opaque integrally pre-colored plastic. The posterior member of Figures 9 and 10, for the iris unit, is made in various colored combinations, from pre-colored translucent plastic, the folds or ruffles **9** being filled by mixing a solvent with a lighter colored translucent or opaque pre-colored plastic to about the consistency of paint, and again using the technique, previously mentioned, of wiping such material into the folds or ruffles **9**. On the other hand, if desired, the application to or filling of the pre-colored plastic in paint condition respecting the indentations or ruffles **9** is a step which may be omitted until a later time, as will be explained hereinafter.

It will be apparent from the foregoing that we have, in respect to the iris unit, two pre-formed iris members of different color tints, having indentations and different color tinted material in the indentations of both of them, which iris members can be combined to make iris units of different color combinations, and which said iris members may also be made on a production basis. Moreover, the depth of the different iris colors of the unit provide for a blending effect because the iris coloring material is disposed in substantially a single plane whereby to avoid the possibility of shadows being cast when the parts are combined.

It will be understood that color, plus thickness of material, changes transparency to translucency, and translucency to opaqueness, in articles of the nature of the present invention. Thus an integrally pre-colored transparent plastic can become translucent if thickness is increased enough, and a translucent plastic body can become opaque under like conditions. This principle of color variation will generally apply in reverse, although it may not have sufficient stability in itself, but, by combining with other plastics of greater transparency, stability may be obtained. The reversal can be obtained also by light or color on the posterior side of the member, the absence of color or light on the posterior side having an opposite optical effect. All of the above combinations are used in this invention, as will be pointed out later.

The iris members or parts shown in Figures 7, 8, 9, and 10 will preferably be made in about four sizes, and these sizes will vary according to the size of the iris hole **7** in the sclera **1**, see Figure 6. The pupil member **6** also varies in size so the pupil hole or opening **10** of the iris unit will preferably be made in about four sizes somewhat corresponding in size to the size of the entire iris unit **5** as found in the eyes of different human beings.

Figures 11, 12, and 13 illustrate how the iris unit **5** and transparent pupil member **6** are made and assembled into a unit, and the member **6** will be observed to be in the form of the frustrum of a cone, having the handle portion **11** to aid in the manipulation of the iris unit **5** when the parts are being assembled or disassembled, or when the iris and pupil units are being handled as a combined unit. The member **6** is molded by the injection molding method previously referred to, and made in about

four sizes, corresponding with the sizes of the opening **10** of the iris member as shown in Figures 9 and 10.

The iris unit **5** can be combined with the transparent pupil member **6** by assembling the members as shown in Figures 7 to 12 inclusive, into the unit structure disclosed in Figure 13, by compression molding, or with solvent applied to the joint portions between the parts, then assembling them and then applying a weight or pressure to obtain the proper effective adhesion. Also such members may be joined by applying pre-colored plastic after the manner of use described in the filling of the indentations or depressions **8** and **9**, and, in the alternative, the transparent pupil member **6** may have a black or other colored plastic **13**, see Figure 11, such as used to fill the indentations **8** and **9**, as a means for forming a joint between the annular surface of the member **6** and the wall of the opening **10**, where the member **6** joins to the iris unit.

Figure 13 illustrates the iris unit **5** and the pupil member **6** ready for shipment and color matching with the iris and pupil parts of a natural eye when suitably combined with the prepared sclera **1** as shown in Figure 6. As previously stated, the parts are adapted to be shipped to remote places where they can be assembled into a complete artificial eye, after the following manner: When a customer comes in to obtain an artificial eye, a sclera member **1** of suitable size and color assembled with its covering parts **2** and **3**, as shown in Figure 6, with proper vein lines and an iris unit of suitable size, are selected. The sclera unit can be cut down to alter it to fit the eye socket, then the iris and pupil members, as shown in Figure 13, of a size to fit the iris recess **7**, will be selected for color. It will be noted that the iris unit **5** will be either more or less intense in color effect when placed in back of the lens **4**, due to magnification. It is detachably inserted into the opening **7** by using the handle **11** for manipulation, and it will be found that the molded parts, being precision made, will fit snugly enough for color matching. The combined artificial eye will now be in the condition somewhat as illustrated in Figure 14 and is ready to be placed in the natural eye socket for color matching under natural conditions of artificial eye use. It may be found that when the artificial eye is in the eye socket, a color change in the iris unit may take place due to the amount of shading in the eyelids which cover a portion of the iris unit **5**, thus tending to darken the color of the latter. This shading or darkening of color effect is different in different people, and it must be dealt with in order to obtain a true matching of the color parts of the eye when placed in the eye socket alongside the natural remaining human eye. If the first selection of parts in the color matching operation of the iris unit **5** and the sclera **1** is not satisfactory, another iris unit **5**, or sclera unit **1** may be selected and the handle **11** of the pupil member **6** forms a ready means for facilitating separation of the first combined unit and inserting and assembling other combinations of such units to be used in the color matching operation. If a suitable sized sclera **1** is not available, a larger one can be cut down and altered to fit the eye socket. After proper matching and fitting has been achieved so that the person doing the fitting and matching is satisfied that he has obtained an assembly of parts of an artificial eye which will practically duplicate in color effect the appearance of the natural eye, the several parts of the obtained and finally selected artificial eye may be joined together by using a solvent for the plastic, placed around the oblique joint **12**, see Figure 3, between the sclera **1** and the iris unit **5**. It will be noted that a merging of the colors of the iris **5** and the sclera **1** takes place due to the oblique disposition of the joint portion designated at **12**, and the different colors in the iris unit **5** over which the sclera **1** and members **2** and **4** lie. The handle **11** can be twisted to better seat and assist in the blending of the color areas after the said solvent is applied to the parts for their final joining. This is due to the slight softening of the two bodies by the solvent to such an extent at their inter-face portions where they slightly intermix, to secure color blending.

At times a better matching iris unit can be obtained by the addition of a circular sheet of black or other colored plastic designated **6A**, as seen in Figure 2, the same having a central opening for the transparent pupil **6** and being adapted to be temporarily applied to the posterior side of the iris unit for color matching according to Figures 2 and 3. If such a sheet member **6A** is found to be satisfactory and desirable for the color matching, the same may be permanently joined to the posterior side of the iris unit by means of a suitable solvent.

The color matching operation completed, the handle **11** can be cut off because no longer necessary, and a weight or pressure can be applied to the iris and sclera unit to complete the artificial eye in its final condition by assisting in obtaining a better adhesion of the two units incident to the use of the solvent for uniting the same. Generally speaking, it is contemplated that no black coloring shall be in back of the transparent pupil member **6** if the prosthesis can be used without employing such black coloring and is found satisfactory in its absence. When and if it is found required that black coloring be employed at the inner end of the pupil member **6**, a small circular sheet of black plastic material **6D** of a size to cover the posterior side of the member **6** can be added by the use of solvent.

Figure 22 is a vertical sectional view of a modification of a combined prosthesis unit wherein the translucent sclera **1A** has a transparent covering **2A** and formed with a hole having outwardly tapered side walls **12A**, constituting the sclera unit. The other unit of the prosthesis of this modification is composed of a transparent cornea member **28** and a transparent lens member **29**, the latter having on its posterior face the simulation of an iris **8A** and there being also provided a transparent pupil member **6B** with a translucent iris member **9A** similar to that shown and described with respect to Figures 7 to 13 of the drawings. The described members are combined into a unit and made so as to be detachably connected to the sclera unit from the posterior side of the latter, for color matching.

It will be noted that in this last modification of our construction of iris, the anterior colored member as shown in Figures 7 and 8 has been eliminated, and the filled indentations **8A** are similar to the identations **8** of Figures 7 and 8 and have been formed in the transparent humor member **29**, which may contain a small amount of iris coloring, to better effect a blending of the coloring in the indentations **8A**.

Another modification of our invention will be found in Figure 23 of the drawings disclosing combined sclera and iris units, wherein the translucent sclera **1B** has a transparent outer covering **2B** with a transparent inner covering **30** closing or over the hole or recess **7A** formed in the sclera member **1B**. The inner covering **30** has a centralized hole **31**. While this inner covering part **30** is preferably transparent, as pointed out later, it could be translucent and made of the same material as the sclera **1B** itself, or it could be some other color to merge with the colors of the iris. The recess **7A** has tapered side walls **12B**, tapering inwardly however in this instance. The above described parts form the sclera unit.

The iris unit in this construction is composed of a transparent cornea member **28A** and a transparent lens member **29A**, the latter having on its posterior face the simulation of an iris **8A** and having a transparent pupil member **6B** formed with a transparent handle **11A** as shown and described in reference to Figures 7 to 13 inclusive.

The above so called sclera and iris units are combined into a unit and may be detachably connected together by

emplacing the iris unit on the sclera unit from the anterior side of the sclera unit for color matching. Detachment of the iris and sclera unit in the color matching operation, including selecting and putting together different ones of these parts, is performed by pressure on the handle 11A and pushing the iris unit outwardly in the direction of the anterior side of the sclera unit. In this construction it will be observed that no coloring has been applied in back of the transparent pupil members in Figures 22, 23 and 24, for purposes to be later explained. the iris member being made like the one explained in reference to the construction of Figure 22 as to colored parts.

Figure 24 illustrates the sclera unit of Figure 23, alone. In Figure 25 there is illustrated in cross section a modification of construction of iris unit adapted to be used with a sclera unit such as illustrated in Figure 22. In the unit of Figure 25 a colored transparent or translucent disc 35 is used, having the color areas in simulation of an iris, on the anterior side 34 and the posterior side 36. The color simulation, or simulations, of said sides may be indented, painted, or printed, that on the anterior side 34 being intentionally more transparent than the colored disc 35 plastic structure itself, whereby shadows will not be cast through the colored disc 35 upon the color simulation applied or carried by the posterior side 36; otherwise the iris unit is similar to the one described in Figure 22. The color simulations may be effected in the same manner as those shown in Figures 7 and 9, or could be reversed.

Looking from the front of a completed eye prosthesis as seen in Figure 1, and likewise in respect to the many modifications of the prosthesis constructions as before set forth, it will be seen that there is a merging of the sclera 1 color with the iris 5 colors, and additionally there will be a dark band of iris color with an intermediate band of lighter iris color, and then an inner band of dark iris color merging and blending the iris color with the small pupil member 6. There will also be seen radial lines 8 and folds or ruffles 9 with depth of iris color in the lines 8 and folds or ruffles 9, thereby producing symmetrical radiating and irregular concentric gleaming color effects obtained by reflected color rays given off at different angles of the indentations 8 and 9 and originating from an irregular plane and blended by other colors lying in another plane, thereby blending the light absorption and reflection with depth of various iris colors as seen in the iris of the human eye.

It will be understood that in every instance we contemplate that each visible posterior layer of coloring shall be less transparent than its next anterior layer, and that all the colors shall originate from substantially the same plane and do not have material between them that is more transparent than the anterior layer, wherefore all possible shadows on the posterior layers are eliminated.

The above explains how the iris 5 will appear in a bright light, but as light is reduced, the color rays are reduced and gradually the pupil member 6 appears to enlarge or dilate due to the black color of the pupil 6D in back of the iris 5 and on the oblique joint 13 of the transparent pupil member 6 and translucent iris 5. In some light colored eyes the oblique joint need not have black color thereon as the optical illusion is quite good the nearer the translucent iris 5 comes to being transparent, though it never becomes actually fully transparent.

As previously explained, a colored transparent member can become translucent if thickness is increased regarding its structure, and also a translucent member can become opaque if thickness thereof is increased. This is true when there is light on both sides, but the effect is increased as light is decreased on the posterior side. It is in the above manner and by the above action of color effects that we obtain different color changes by light rays in front and back of the iris 5 under different conditions, and these can be checked in the natural eye socket for color matching under different degrees of light prior to the unification of the iris unit with the sclera unit, something not heretofore achieved prior to our present invention. It will be readily apparent from the foregoing that a person having little experience in plastic construction or formation, without machinery, molds, or heating appliances, and who would not necessarily have to be an artist in any way, can select for size and color, assemble temporarily, match for color in the natural eye socket, alter by cutting down, and finally unite permanently properly selected parts of the eye prosthesis, so as to produce a custom-made artificial eye. If a customer or patient to whom the eye is to be fitted, is not satisfied, none of the parts used in the above procedural method would have to be destroyed, and only the time of the procedure would be lost. Moreover, the procedure can be followed employing a small stock of artificial eye parts and would in no way involve the large amount of guess-work that is necessarily practiced at the present time by the usual methods employed.

Should the iris parts shown in Figure 7 and in Figure 9 be originally supplied without the coloring material applied thereto in the manner hereinbefore described, it is quite evident that it would be within the skill of an ordinary person to apply the coloring material in the indentations 8 and 9 having only a knowledge of color mixing or matching the eye coloring and using a suitable solvent with different kinds of colored plastic. Likewise, as previously intimated herein, it is possible to supply to the eye fitter and matching person the sclera parts 1 and 2 in separated condition as distinguished from the preferable mode of supplying same as a unit, so that the vein lines 3, see Figure 1, could readily be applied by the person fitting the artificial eye, to match the vein lines of the natural eye of the person fitted, at the actual time when the fitting and matching operation is to be performed. We know of no eye prosthesis constructions heretofore proposed in the art having the facility for handling and capacity for accurate matching such as above referred to.

Figures 19, 21 and 27 show implant constructions forming a part of our present invention, the implant illustrated being adapted to fit into the posterior part of the Tenon's capsule 14 of the natural eye socket. For the performance of its required movements, it is necessary for the eyeball, or artificial eye implant, to rotate as freely and precisely as if it were mounted on bearings. Axle means, however, cannot well be used, of course, and, accordingly, the principle of mounting the eyeball or artificial eye implant of our invention for supporting the same in an eye socket is analogous to that of the use of the gimbal by which a ship's compass is mounted, allowing rotation of the compass in any plane about a single central point. Generally speaking, the eyeball or artificial eye impant and its surroundings, when disposed in a natural eye socket, may be compared with a ball and socket joint. The suspensions, according to our invention, are provided by the muscles 16, and to a greater extent by a complicated system of ligaments and membranes carrying fat in the interstices thereof, forming a "packing." The artificial eye implant hereof is surrounded by a fibrous membrane, the capsule of Tenon's 14 and 18. Except for its anterior part around the cornea, the capsule of Tenon 18 on its anterior portion, forms with the bulbar conjunctiva 19 a cover for the cornea in the natural eye. This part of the bulbar conjunctiva is not salvaged for the artificial eye implant of our invention. The eyeball or artificial eye implant of our invention may be mounted so as to be susceptible of movement slightly within the capsule of Tenon 14 and 18, but during movement of any great extent the capsule moves with the eyeball or artificial eye implant. The orbital connective tissue is, in places, so intimately connected with the capsule of Tenon 14 and 18 that it can-

not remain perfectly still or immovable during eye movement of any material extent. The movements are caused by the contraction of one muscle and the expansion of an opposite muscle. In order to secure movement by a muscle, one end of the muscle must be attached to the implant and movable, and the other end will, of course, be fixed; also the tension on the muscles connected with the implant must be equal in all practical respects when the eye prosthesis or the implant connected therewith are in what may be called the neutral or normal position.

The foregoing description of how the artificial eye implant is suspended, supported, and operates, is supplied for a better understanding to the layman and artificial eye fitter of the objectives of our present invention. It is contemplated that the surgical technique required in carrying out our invention will involve the freeing of the bulbar conjunctiva **19** around the cornea of the eyeball, then slitting thereof to the extent that the eyeball can be passed through the slit portion, whereupon the anterior part of the Tenon's capsule **18** is opened. Then the recti tendons of the eye muscles **16** are slit from the eyeball out into the cornea, and the superior and inferior oblique muscles are severed from their attachments to the eyeball on the posterior side of the latter, referring to the original natural eyeball of the human being. The eyeball is then removed in the usual manner.

The artificial eyeball or implant of our invention is of unique and novel construction. As seen best in Figures 15 and 16, this implant comprises an anterior member or portion **33** largely consisting of a rim open at the front portion, or, in other words, over the large central area, and having spokes **21** extending across said open portion and radiating from a central axis or hub portion having mounting provision for supporting the eye prosthesis in a detachable manner, as will later be set forth. Each of the spokes **21** is formed with a series of transverse grooves. In addition to the rim, spoke, and hub elements of the anterior portion of the implant, the implant includes a semi-spheroidal posterior hollow body having top, bottom, and side openings formed therein, designated **15**, at a point adjacent that at which the posterior body joins the rim part of the implant. For facilitating its manufacture, the implant may originally be made in two parts, one comprising the anterior section referred to as including the elements **33**, **21**, and the central hub having the polysided recess **24**, and the other composed of the semi-spheroidal posterior body. When these two main portions of the implant are suitably molded they are connected together by employing a suitable solvent for the plastic material, preferably used to connect them, the point of joinder being designated in Figure 16 by the dotted line "X." In the above way the two main sections or portions of the implant are rendered integral, and, when employed for the purposes of the invention, the entire implant is a single unit. It is noted also that the spoke and hub formation, including the spokes **21**, protrudes forwardly from the rim section **33** of the implant so that the spokes **21** are actually curved or arc-shaped in cross section, as seen best in connection with Figure 16, Figure 19, and Figure 21.

Having in mind the procedure previously described in regard to the removal of the natural eyeball and its contents, for the purpose of mounting an eye prosthesis and implant of our present invention in the natural eye socket, the implant of Figures 15 and 16 can be introduced into the natural eye socket after the manner depicted in Figures 19 and 21 by the following surgical steps, which are suggested, allowing the surgeon more room to work, in a restricted area. The outer extremities of the four rectus muscles **16**, where they have been severed from the eyeball are folded inwardly and sutured so as to provide the loops **20** at the outer extremities thereof where they have been severed from the eyeball. Each of the four rectus muscles **16** is, therefore, provided with the loop portion **20**, the extremities of the muscles **16** being designed to be united to adjacent portions thereof by natural healing and forming the required adhesions incident to such healing. Thus it will be seen that the suturing of the muscles **16** is done before the implant is in place, allowing more room for the surgeon to do this work.

Next, by tying a thread to each of the four loops **20** of the muscles **16** and running said threads through the four holes **15** of the implant, said threads may be pulled upon as the implant is placed in the posterior part of the Tenon's capsule **14**, pulling the muscles **16** over the outer periphery of the semi-spheroidal body of the implant and through the holes **15**. Then the loop portions **20** of the muscles **16** are anchored by means of the pin hooks **17** which comprise a shank or stem member formed at its opposite ends with the hooks **17A** and **17B**, see Figure 17, the hook **17B** being smaller than the hook **17A**. Each muscle loop **20** is anchored by its individual pin hook **17** after the muscle loop **20** is drawn through the openings **15** into the hollow body portion of the implant. The wider hook **17A** is engaged with the muscle loop **20** after the manner depicted in Figures 19 and 21, and the narrower hook **17B** of the pin hook **17** is engaged preferably in the outer grooves **21A** of the more adjacent one of the spokes **21** of the implant. After the four muscles **16** have been engaged by the pin hooks **17** to the outer grooves **21A** they can be later adjusted to better equalize the muscle **16** tension.

The anterior part of the Tenon's capsule **18** and the central part of the remaining conjunctiva **19**, which will overlie the anterior part of the implant, may have small wedge-shaped segments thereof removed so that by suitable suturing they can be drawn together tight against the anterior face of the implant, for adhesions to themselves, thus partly enclosing the implant, as shown in Figures 19, 21, and 27, so that it cannot be extruded because the Tenon's capsule **18** and the conjunctiva **19** are sutured together for adhesions and to a great extent overlie the anterior part of the implant and are not mechanically held in place by suturing alone. An eye prosthesis somewhat larger than shown in Figure 21 can be temporarily attached to the implant to support the eyelids **23** and the conjunctiva **19** and **22** during healing. The eye prosthesis need not color match the other eye as it acts only as a temporary support and form.

The foregoing described operative procedure having been followed, a suitable dressing can be applied and removed upon the surgeon's orders, for inspection of the adhesions and for the adjustment of the eye muscles **16** for proper tension thereon. The latter adjustments being accomplished by moving the muscle pin hooks **17** to different positions on the spokes **21** as respects the engagement of the hooks **17B** in the grooves **21A** of the spokes **21**, thus to give the implant static and dynamic balance, which is very difficult to obtain in an operation.

Some of the advantages of this new implant of our invention are: (A) Suturing of the eye muscles **16** is done before implantation so these is no added obstruction while this operation is performed. (B) Means for adjustment of the tautness of the muscles, after the operation, are supplied, thus eliminating any miscalculating that the surgeon might make in the operation, and avoiding the problem of possible slippage that might take place in the suturing. (C) If, at a date later than the time of completion of the surgical operation described, and healing of the muscles, it develops that one muscle has a greater stretch than another one, it is possible to change the tension of the muscles so as to ensure that the implant will move the same distance in opposite directions. This may be accomplished by removal of the eye prosthesis mounted on the implant as hereinafter described, such removal giving full access to the location of the pin hooks **17** for the adjustments required. (D) The dispositions of the rectus muscles **16** and the anterior part of the capsule of Tenon **18** are substantially that of their original disposition in the natural eye, thus

allowing limited movement of the implant as in the natural eye.

It is notable in regard to the openings **15** in the semi-spheroidal body of the implant that these openings may be provided somewhat posteriorly of the positions in which they are shown in Figure 16 and other figures of the drawings, to deal with the problem of interengaging loops of shorter muscles than as depicted in the present drawings. Or again, there may be provided in the implant construction of Figure 16, an additional set of openings such as **15** but located rearwardly of the latter so that either set of openings, those forward or those disposed rearward, may be availed of by the surgeon at the time of the operation, depending upon the particular muscles that are being handled respecting the length of the latter.

It has been found that fairly good eye movement for artificial eye purposes, can be obtained without utilizing the oblique muscles and heretofore they have been very difficult to attach to an implant due to the fact that they are located on the posterior side of the eyeball. However, with a hollow shell implant as shown in this application, open almost completely on its anterior side, the oblique muscles may be attached through the holes or openings at the front of the implant, between the spokes **21** at or near the points of natural attachment of said muscles, and for this purpose pin hooks like those heretofore described and designated **17** may be utilized for adjustment of the oblique muscles after the manner of the technique employed in regard to the rectus muscles and presented fully above. The oblique muscles help hold the eye or implant forward more than they aid in eye movement and it would be advantageous to a better operation if they were attached and adjusted properly. The facility for the above handling of the muscle attachment is obviously due to the peculiar open formation of the anterior section of the implant. The above described method of utilizing our implant construction in conjunction with the oblique muscles is not illustrated in the drawings but is contemplated within the purview of our invention.

A special advantage in respect to our invention lies in the fact that where a patient has already been operated on for enucleation, the eye socket can be reopened and the muscles separated where they have been sutured and partly grown together and a new implant selected and disposed in the eye socket and thereafter reconnected with the rectus muscles. Under such condition, since the muscles generally have grown shorter, the implant selected would be one in which the holes **15** are somewhat rearward of the locations of the holes **15** according to the illustration of the implant of Figure 16 of the drawings. When employing the implant having the holes **15** posterior to those shown in Figure 16, the axis of the implant is shortened in relation to the shortened muscles and since eye movement depends upon muscle contraction, the shorter the muscle **16** the shorter the contraction and this is a means of compensation for the employment of the shortened muscles in the procedure described.

Figure 27 is a vertical sectional view of a modification of our implant construction, showing the implant in the Tenon's capsule **18A** of the eye-socket, with the rectus muscles **16** bent over the anterior rim **33A** of the implant and looped at **20**–A around the graduated grooved spokes **21B**. Then the said muscles are sutured upon themselves for natural healing with required adhesion, various muscle adjustments being obtainable by reason of the formation of the spokes **21B** with a series of outwardly or radially situated relatively large grooves or notches on their inner or rear sides. Figure 27 illustrates the feature of muscle adjustment facility because the upper muscle is looped around the middle notch of the upper spoke **21B** and the lower muscle is looped around the outermost notch portion of the lower spoke **21B**. This muscle adjustment can be accomplished by an instrument such as a shoe button hook, or the like, inserted into the sutured loop **20B** of the muscle **16**, along side the spokes **21B** and pulled into new position for greater tension. With the anterior portion of the Tenon's capsule **18A** bent over the anterior rim **33A** of the implant, and with the bulbar conjunctiva **19** extending inwardly of said outer rim **33A** as shown in Figure 27, the mounting of the implant in the eye-socket, as to the general procedure, is depicted completely by Figure 27, it being understood that according to this modification of our invention the holes **15** as shown in Figure 16 on the posterior portion of the implant are dispensed with.

Now in reference to our implant unit construction, it is notable that the same can be made smaller so as to fit inside the sclera instead of the Tenon's capsule, thus utilizing the sclera and its connective tissues. The bulbar conjunctiva, cornea and iris, of the natural eye, can be removed at about the cornea-sclera border for evisceration of the sclera contents. Then the anterior parts of the sclera and Tenon's capsule also the bulbar conjunctiva, can be slit into four parts and the implant inserted into the sclera, see Figure 28 which is a sectional perspective view of a modification of the implant, showing the implant in the sclera **34** of the eyesocket, with the anterior portion of the sclera **34** and Tenon's capsule **18B** bent over the anterior rim **33B** of the implant. In this view the bulbar conjunctiva **19A** extending inwardly of the said outer rim **33B** of the implant and sutured together under the spokes **21C**, will heal with adhesions to themselves. The implant so sutured cannot rotate in the sclera socket.

In Figure 21 showing an artificial eye implant of our invention, as heretofore described, it will be noted how the palpebral conjunctiva **22** connects with the bulbar conjunctiva **19** and the eye lids **23** partly cover the iris **5**, thus shading the same differently in different persons. This shading of this iris **5** has a darkening effect on the iris **5** dependent upon the position of the eyelids **23**, as previously pointed out herein.

The artificial eye show in Figure 21 has been altered by cutting off the outer edges so as to fit properly in the eye socket and has a polyhedrous pin **25** as shown in Figure 20 more clearly. The anterior face of the pin **25** is black in order to simulate the pupil **6A** or **6B**, heretofore referred to and said pin is attached to the posterior side of the transparent pupil **6** forming a part of the iris pupil unit of the construction hereinbefore set forth. A solvent may be used for connecting the members **6** and the pin **25** and unifying the same, employing weight or pressure for such purpose. The artificial eye or prosthesis, as shown in Figure 21, is, of course, detachably connected to the implant, the latter having a polyhedrous tapering recess **24**, as shown in Figures 19 and 21. The extent of protrusion of the artificial eye or prosthesis, and its alignment with the natural eye of the person to whom the artificial eye is being fitted, are controlled by means of a washer **26**, shown in Figure 18 and Figure 21, which washer is made wedge-shaped by being thickened in one direction from its axis as compared with its thickness in the opposite direction toward its periphery. In lieu of the washer shown in Figure 18 a flat washer may be employed if the protruding effect of the prosthesis is only required to be used for obtaining best results. As shown in Figure 21, the thin part of the washer **26** is uppermost and the thicker part is lowermost. This adjustment will tend to turn the axis of the prosthesis upwardly as is shown by the dot and dash lines **27** in Figure 21, the same originating at the inner end of the pin **25**. Or the washer **26** may be rotated to any other desired position for effecting the proper alignment of the prosthesis with the natural eye, by turning the washer around the polyhedrous pin **25**. Also within the purview of our invention it is contemplated that one or more of the washers **26** may be employed whereby to increase the degree of protrusion of the prosthesis and also to obtain the proper artificial eye alignment with the natural eye. Many artificial eyes have a shrunken appearance, especially after

they have been worn for some time, partly due to the pressure of the eyelids **23** against the prosthesis. If this condition should arise in an eye made according to our invention, all that is necessary is to add washers **26** at a later date, thereby to restore the natural appearance mounting of the eye as carried by the implant, so it will protrude exactly to the extent of protrusion of the natural eye, thereby restoring the natural appearance that may have originally been obtained.

The polyhedrous pin **25** has a round flat shoulder **25A** adapted to engage the washer **26** after the washer **26** has been turned to its proper position for aligning or protruding the eye prosthesis of the invention. The washer **26** or washers **26**, as the case may be, can be attached to the shoulder **25A** of the pin **25** by utilizing a solvent applied to one or both or several members to unify them, or the washer can be attached to the implant in the same manner.

A modification of the construction of our invention in Figure 21 is shown in Figure 26, which is a vertical sectional view of the combined parts of Figure 23 wherein the extending handle **11A** has been removed. In Figure 26 modification the pin **25** is shown having an enlargement **25B** at its outer end, the anterior face of which is convex in order to fit against and conform to the concave posterior face of the artificial eye prosthesis of the types such as illustrated in Figures 22 and 23. The combined members shown in Figure 26 are adapted to be detachably secured to an implant as shown in Figures 27 and 28 by means of the pin **25A** seated in the hole **24A** of corresponding shape and positioned forwardly by means of a washer or washers **26A**; as seen in Figure 26, the washer **26A** is of long sleeve-like form. It may be made in different lengths so as to adjust the artificial eye properly against the eyelids **23** of the person, as shown in Figure 21. As shown in Figure 26, the washer **26A** is not used to align the artificial eye with the natural eye, though such action could be accomplished by providing on the outer or rear end of the washer **26A** a camming edge or end portion, if desired, or in the alternative using a thin wedge-shaped washer mountable on the posterior end of the pin **25A** similar to the washer construction of Figure 18. Another mehod of aligning the artificial eye with the natural eye is as follows:

After the proper size and colored units of the sclera and iris have been selected, the pin **25A** can be placed in the hole **24A** of the implant, and the sclera unit without the iris unit, as shown in Figure 24, can be placed in front of the implant and in front of the part **25B** of the pin **25A** and in contact with the latter and moved until the hole **31** or recess **7A**, which latter the iris is to occupy, is in alignment with the other eye. Then the outline of the hole **31** can be marked on the anterior side **25B** of the pin **25A**. If a sclera unit is used like that in Figure 22, the outline of the hole that the iris unit will occupy can be marked in like manner. Then the sclera unit and the pin **25A** can be removed. Then by placing the marked piece in its proper place a new marking can be made on the inner or posterior face of the sclera unit around the pin **25A**. The marking on the anterior face of the pin **25A** can now be removed and the unit may be united by cementing together with solvents, or heat and pressure.

It will be understood that the handle **11A** need not be used as shown in Figure **23** but may be omitted from the transparent member **30**. If the handle member **11A** does so protrude, it is cut off and made flush with the part **30** before combining the units with the pin **25A** as above described.

Another method of aligning the artificial eye with the natural eye is by combining the sclera unit with the iris unit, inserting the pin **25A** in the hole **24A** of the implant, applying a cementing solvent on the inner face of the sclera and iris units, forming an artificial eye as shown combined in Figure 22, inserting the artificial eye in the eye socket and against the anterior base **25B** of the pin **25A**, and moving the artificial eye into alignment with the natural eye. After a few minutes time the parts will become set or unified with the artificial eye in alignment with the natural eye.

It will be understood that in respect to the last described or third method of alignment, the same is adapted to be used with the conventional type of artificial eye that is now on the market.

The dotted lines **38** shown on Figure 26 disclose how the pin **25A** can be combined in a different position so as to align the artificial eye with the natural eye when the pin **25A** is inserted into the hole **24A** of Figures 27 and 28 implant construction. The combining referred to is, of course, between the pin **25A** at its enlarged portion **25B**, and the concave portion of the sclera and/or pupil, sclera and iris unit. Also in Figure 26 the two dotted line sections **37** disclose how the artificial eye can be altered by cutting down to fit the eye socket shown in Figures 27 and 28, or said artificial eye altered as shown in Figure 21.

In Figures 22, 23 and 25 no black coloring is shown in back of the transparent pupil member **6B** and **6C**. The coloring has been omitted so as to afford a pupil depth relatively far back away from the iris so as to render the eye more naturalistic, having in view that the pupil in a natural eye is not black, but transparent, and appears black due to depth and lack of light. It will be found that no color need be placed in back of the transparent pupil **6B** and **6C** members if light colored material is not used in making the hollow implant.

In Figure 26, a black coating **39** is shown applied on the posterior face of the enlargement **25B** of the pin **25A**. This affords a construction in which the black pupil area is still farther back from the iris and therefore at a greater depth than if the color matter were applied to the rear face of the pupil members **6** or **6B** as shown in certain of the unit constructions.

If desired the black coloring **39** seen at the back of the enlargement **24B** in Figure 26 may be extended or continued to surround the pin **25A**, as shown in heavy lines.

While we have set forth that the various parts of the units forming a part of our invention may be assembled and unified by solvents, other methods of unification are contemplated to be resorted to such as may be well known in the art to which our invention relates.

Acrylic resins are the common plastic used for artificial eyes, having many advantages over other plastics, but some patients are hypersensitive to its use, reportedly as high as 1 out of 100. Incomplete polymerization is believed to be of importance in the development of such hypersensitivity. Therefore a process of manufacture using only completely polymerized resins, where they come in contact with the eye tissues has been developed and where solvents have been used to unite the polymerized parts, they can be polymerized under the influence of heat, light, oxygen, and oxygen-yielding substances such as benzoyl peroxide. Such process would be one which may be employed by us for purposes of our invention herein set forth.

This invention is directed to an article of manufacture, and not to a surgical operation. As previously stated, we want only to aid the surgeon and not direct him. Our specification and drawings state and show the anterior part of the capsule of Tenon **18**, slit and sutured around the spokes **21** of the implant. Should it be desired that the Tenon's capsule not be slit, then only the conjunctiva **19** need be anchored around the spokes **21**.

Having thus described our invention, what we claim as new and desire to secure by Letters Patent of the United States is:

1. In a combined iris and pupil unit for an artificial eye, comprising a translucent iris colored disc in the form of a frustrum of a cone and a transparent pupil member of crusto-conical form centralized in said disc,

in the plane of the surrounding portion of the disk with the smaller end of the pupil member facing toward the front side of the iris disc.

2. In a combined iris and pupil unit for an artificial eye, comprising a translucent iris member having a transparent pupil member in the form of a frustum of a cone and a removable handle on said pupil member for facilitating engaging and disengaging the pupil member relative to the iris member.

3. In a combination iris and pupil unit for artificial eyes, comprising separable iris and pupil members, the improvement which consists of a handle member on the posterior side of the pupil member to facilitate combining and separation of the two said members.

4. An implant for artificial eyes, the same comprising a body having muscle connecting openings at its top, bottom and sides, the front part of which is largely open over most of the area thereof for facilitating surgery in the ocular cavity of a natural eye at the rear of the implant, said implant having a central hub portion, and an eye prosthesis having a pupil unit provided with a member for mounting same on said hub portion of the implant.

5. An implant as claimed in claim 4, in which the prosthesis mounting member is detachably mountable on the said hub portion, and wherein the hub portion is connected to the rim of the body by spokes spaced to form the open front part.

6. In a combination iris and pupil unit for artificial eyes, comprising separable iris and pupil members, the improvement which consists of a handle member on the posterior side of the pupil member to facilitate combining and separation of the two said members, the iris member being tapered at its edge portion, and a sclera member having a tapered opening therein conforming to, receiving, and in edge abutment with the iris member.

7. In an artificial eye, in combination, an implant comprising a hollow body emplaceable in a natural eye socket and provided with side openings through which muscles may pass into the body, said implant having most of the area of its front portion open so that access may be had to the said muscles, and cross members at said anterior portion to connect with said muscles, a prosthesis detachably mounted on the anterior portion of the implant, and means detachably connecting the prosthesis to the implant so the prosthesis may be removed to enable access through the body of the implant to the muscles connected to the latter.

8. The combination of claim 7, with separate connecting members on the anterior portion of the implant engaging the cross members for connection of said muscles thereto and in positions rendered accessible by detachment of the prosthesis.

9. An implant for artificial eyes, the same comprising a body, the anterior part of which is largely open for facilitating surgery in the ocular cavity of a natural eye at the rear of the implant, said implant having a central hub portion, and an eye prosthesis connected to the implant and having a pupil unit provided with a member for mounting same on said hub portion of the implant, in which the mounting member of the prosthesis is provided with surrounding black coloration posterior of the pupil unit to impart depth of color to the latter, and the pupil unit is transparent.

10. An implant for artificial eyes, the same comprising a body, the anterior part of which is largely open for facilitating surgery in the ocular cavity of a natural eye at the rear of the implant, said implant having a central hub portion, and an eye prosthesis connected to the implant and having a pupil unit provided with a member for mounting same on said hub portion of the implant, in which the mounting member of the prosthesis is enrobed on its sides and rear end with black coloration and is seated within the hub portion of the implant, the pupil unit being transparent anterior to the mounting member.

11. In a combined iris and pupil unit for an artificial eye, comprising a colored thermoplastic disc simulating the color pattern of an iris, a pupil opening in the iris filled with a transparent thermoplastic, said opening being smaller on its anterior side than its posterior side, and pupil coloring on said transparent posterior side.

12. A combined iris and pupil unit for an artificial eye, comprising a plastic translucent disc simulating an iris, said disc having a transparent pupil in the form of a frustum of a cone, with pupil coloring material on the bottom of said transparent cone, and pupil coloring material on the sides of the cone.

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