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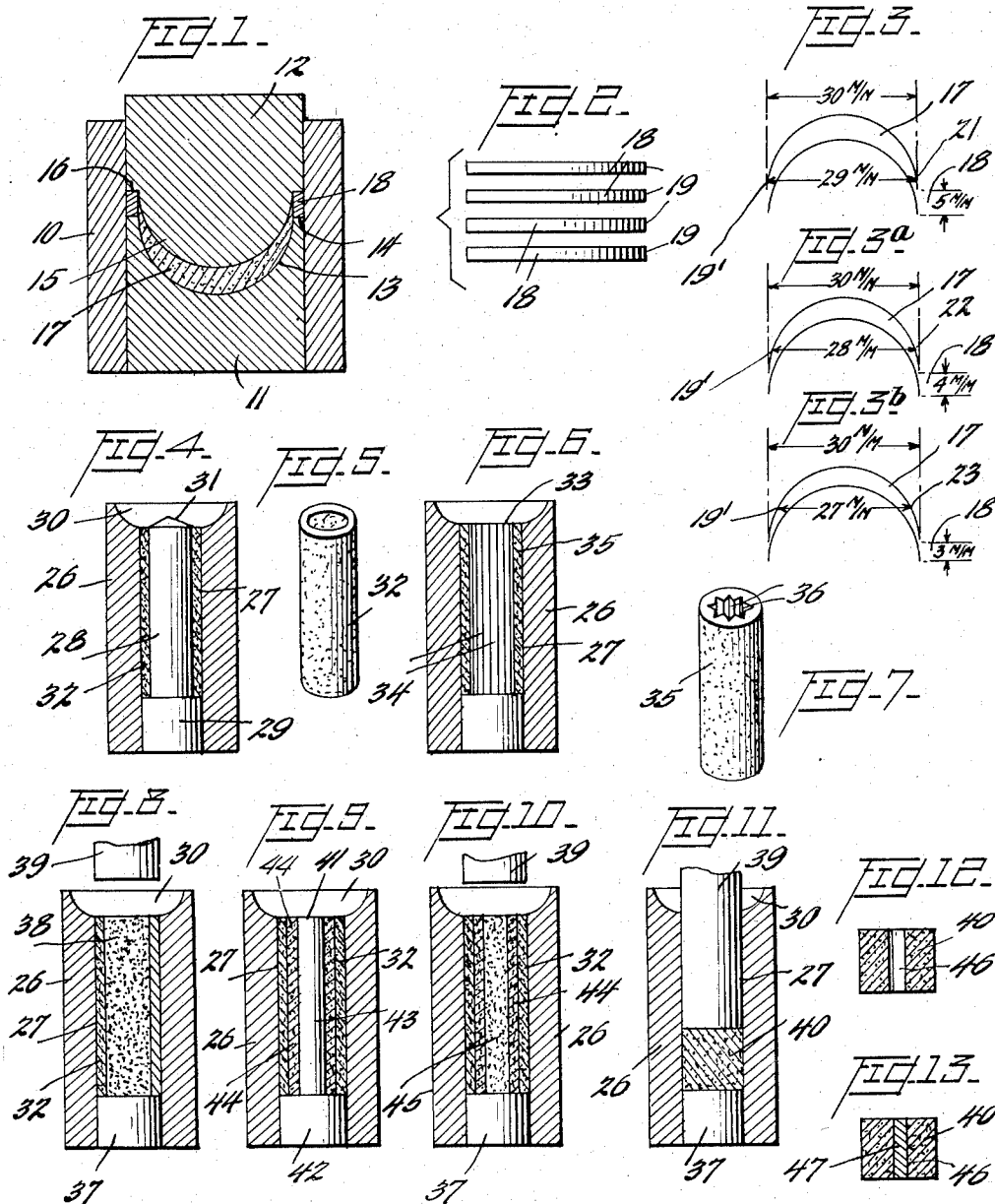
J. S. GALESKI

2,563,462

ARTIFICIAL EYE AND METHOD OF FORMING THE SAME

Filed June 25, 1946

3 Sheets-Sheet 1



Inventor

Joseph S. Galeski,

By *Leushman Dwyer Leushman*

Attorneys

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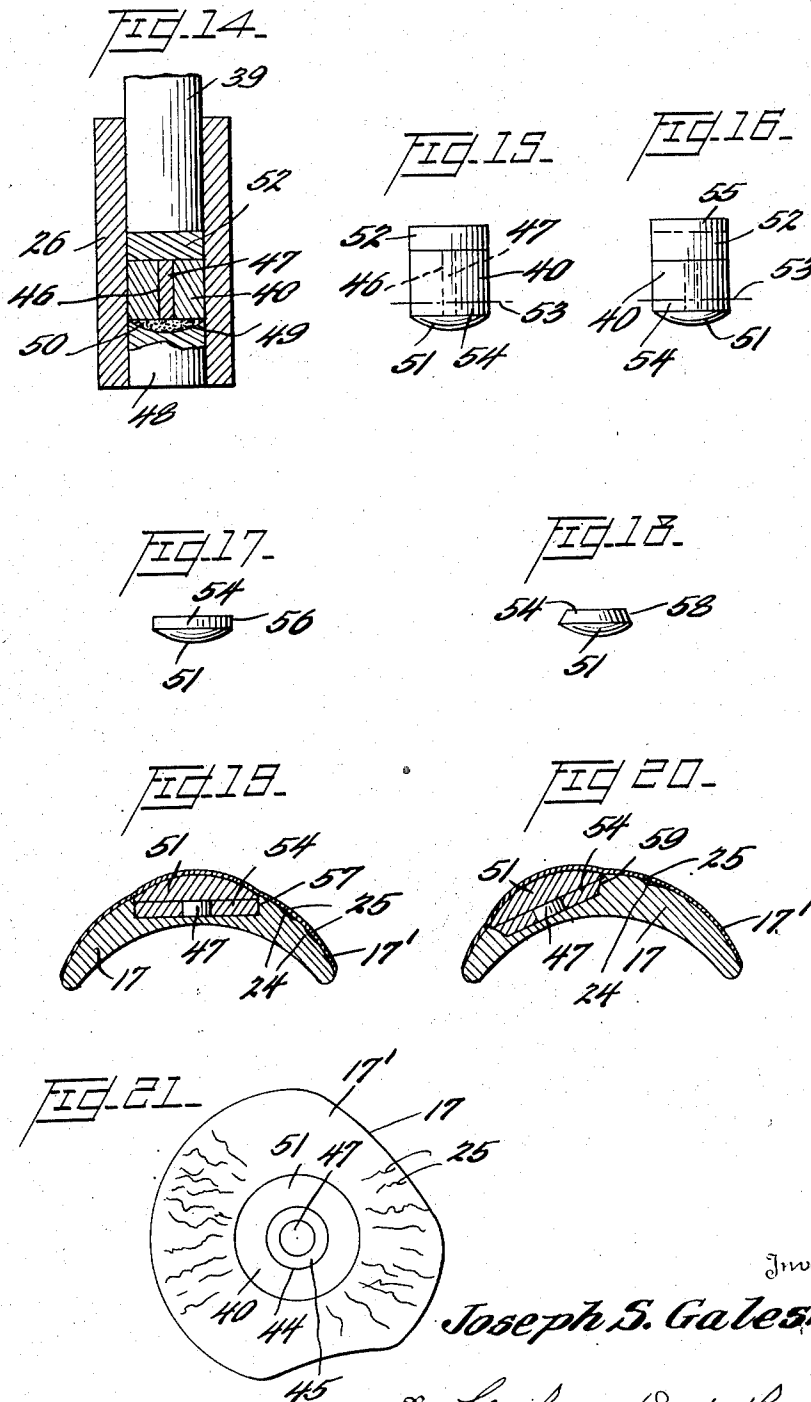
J. S. GALESKI

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ARTIFICIAL EYE AND METHOD OF FORMING THE SAME

Filed June 25, 1946

3 Sheets-Sheet 2



Inventor

Joseph S. Galeski,

By *Cushman Darby & Cushman*

Attorneys

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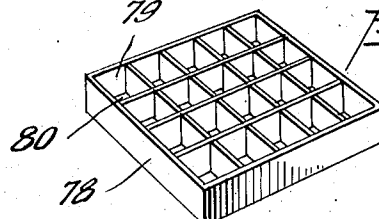
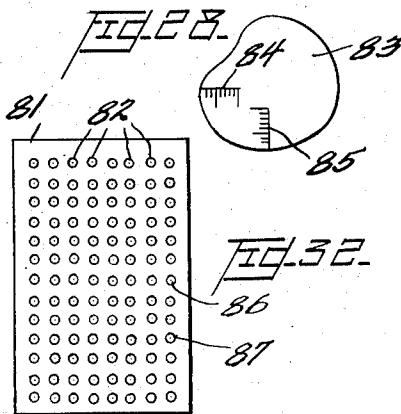
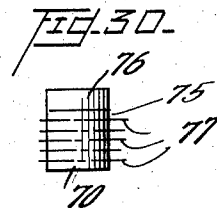
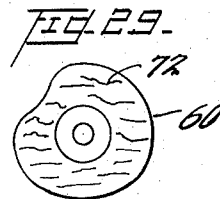
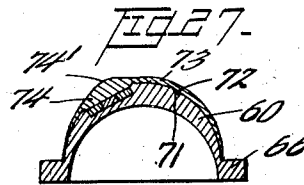
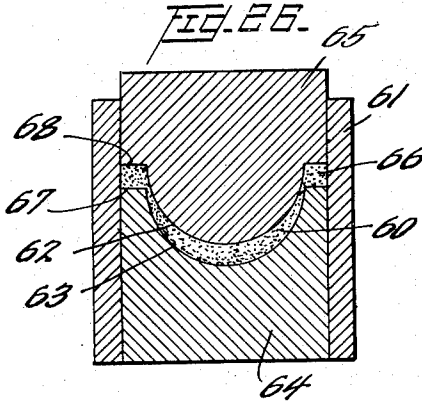
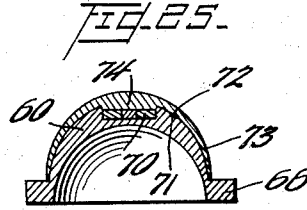
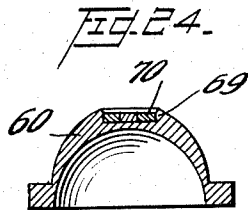
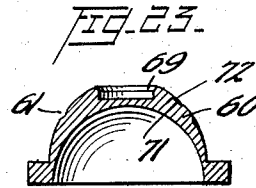
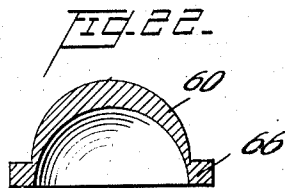
J. S. GALESKI

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ARTIFICIAL EYE AND METHOD OF FORMING THE SAME

Filed June 25, 1946

3 Sheets-Sheet 3



Inventor

Joseph S. Galeski,

By *Cushman, Durbin & Cushman*
Attorneys

UNITED STATES PATENT OFFICE

2,563,462

ARTIFICIAL EYE AND METHOD OF FORMING
THE SAMEJoseph S. Galeski, Richmond, Va., assignor to
Galeski Laboratory, Inc., Richmond, Va., a cor-
poration of Virginia

Application June 25, 1946, Serial No. 679,040

8 Claims. (Cl. 3—13)

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The present invention relates to a new method and apparatus for making a prosthesis or artificial eye of granulated plastic material. This application is a continuation-in-part of my co-pending application Serial No. 607,732 filed July 30, 1945, now abandoned.

An important object of the invention consists in forming an artificial eye body or sclera and the iris of the eye of bonded, granular, plastic material.

At the present time there is no standardization in making artificial eyes. No two natural eyes are exactly alike nor can they be perfectly duplicated. Artificial eyes are fitted usually either from a large selection of stock-eyes or are made to order by trained and skilled experts. An important feature of the invention consists in an improved artificial eye and method of making the same, so as to give to artificial eyes a high degree of standardization qualities that such eyes at the present time do not possess, and in which the parts of the eye are formed to match in color, shape and appearance a human eye.

By the present method anyone who can properly fit a glass eye, can measure, order and furnish to a user, an artificial eye fully equal in appearance and comfort to the finest made to order glass artificial eye. The plastic material used in making the artificial eye in accordance with the present invention is practically unaffected by the acid or tear solution of the eye and is, therefore, more durable than glass eyes.

Heretofore, in the art of making artificial eyes, the sclera or white portion of the eye has been made of glass, rubber, plastic or other material, but no means have been provided whereby individual eyes to match natural eyes can be ordered in substantially the same manner that an eye specialist prescribes lenses for eye glasses.

Accordingly, a further object of the invention consists in providing an apparatus for forming the bodies of an artificial eye in which interchangeable means are provided, whereby a single mold may be utilized to form a number of scleras of different horizontal dimensions and center thicknesses, but each having substantially the same edge thickness.

It has also been the custom in making artificial irises: (1) to form both the body of the artificial eye and the iris of colored glass mixed to the desired shade to match the good eye; (2) to make the body of plastic material and embed a colored glass iris; (3) to make a body of plastic material and form the iris disk by a colored photographic process and (4) to paint a thin washer or member to form the colored part of the iris. The use of different materials to form the artificial eye are

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objectionable since these materials have different coefficients of expansion and dimensional stability, and therefore, do not form an integral, homogeneous unit. Painting the iris to match a good iris is an extremely laborious process requiring the services of a trained expert and also occasions considerable delay, since it is necessary for the paint to dry before another coating of a different color or shade can be applied. As the completed artificial eye is made of solid plastic material, it may be handled without being broken if dropped, and thus overcome a serious defect present in the use of glass artificial eyes.

Another object, therefore, of the invention is to provide a new and improved method and apparatus for forming different colored or shades of irises from a mixture of selectively colored, bonded, granular, plastic material, in which the various colors or shades are blended in varying percentage and treated to simulate in shape, color and appearance any natural iris. This simple, efficient and economic method of forming the iris eliminates the expensive and highly skilled method of painting the artificial iris to simulate a human iris, or making individual irises from different colored glass in a molten state or by an elaborate color-photographic process, and also provides a novel means whereby a number of these artificial irises can be formed from a single colored body or plug at a minimum expenditure of time and effort.

Referring to the drawings in which are shown for the purpose of illustration preferred means for forming an artificial plastic eye and iris in accordance with the present invention:

Figure 1 is a detailed sectional view of a mold cylinder for forming the plastic eye body or sclera;

Figure 2 is a detailed side view showing interchangeable rings of different thicknesses arranged to be interposed between the die members of the mold;

Figures 3, 3a and 3b are diagrammatic detailed sectional views illustrating the formation of the eye bodies with different separating rings and in which the eye bodies have different center thicknesses and different horizontal dimensions but the same edge thicknesses;

Figure 4 is a vertical, sectional view of the iris mold cylinder for initially forming the granular, plastic material into tubular uncompressed form;

Figure 5 is a detailed side view of the uncompressed plastic tube formed by the iris mold shown in Figure 4;

Figure 6 is a vertical, sectional view of a modification of the iris mold shown in Figure 4;

Figure 7 is a detailed side view of a plastic tube formed by the mold shown in Figure 6;

Figure 8 is a side view with parts in section of the iris mold modified to form a two-tone colored iris button;

Figure 9 is a side view with parts in section of the iris mold shown in Figure 8 for forming a three-tone colored iris button;

Figure 10 is a side view with parts in section of the iris mold shown in Figure 8, showing a third color or shade therein and preparatory to the heating and compression operation;

Figure 11 is a side view with the parts in section of the iris mold shown in either Figures 8 or 10, having the plunger inserted therein for compressing and forming the material into a solid homogeneous body.

Figure 12 is a sectional view of the iris button formed by the mold in Figure 10 and having an axial central opening drilled therein;

Figure 13 is a view similar to Figure 12, showing the pupil plug inserted in the central opening;

Figure 14 is a side view with parts in section of the iris compression mold modified to form the cornea;

Figure 15 is a detailed side view of the completed, solid, colored iris body or plug;

Figure 16 is a view similar to Figure 15, showing the iris plug provided with a lengthened handle portion;

Figure 17 is a side view of a colored iris button and cornea cut from the plug shown in Figure 15;

Figure 18 is a detailed side view of a modified form of iris button;

Figure 19 is a sectional view of a plastic eye body having an iris and cornea such as shown in Figure 17 embedded therein;

Figure 20 is a sectional view of a plastic eye body having an iris button and cornea such as shown in Figure 18 attached thereto;

Figure 21 is a front view of an artificial eye made in accordance with the present invention and having a three-tone iris button embedded therein;

Figures 22 to 25, inclusive, are sectional views of a modified form of an artificial eye body and method for inserting the iris and applying a transparent coating to the outer surface of the eye body and iris.

Figure 26 is a sectional view of a mold cylinder for forming the artificial eye body shown in Figure 22;

Figure 27 is a sectional view of a formed artificial eye body showing the cornea, shaped or ground to the desired configuration and with the optical center of the iris offset.

Figure 28 is a plan view of an eye body that constitutes a part of the fitter's set.

Figure 29 is a plan view of a complete artificial plastic eye made in accordance with the modified form of the invention;

Figure 30 is a side view of an iris plug from which the iris wafers are formed;

Figure 31 is a perspective view of a box in which one set of different sizes and shapes of sample eye bodies used by the fitter are carried, and

Figure 32 is a front view of a card containing different colored iris wafers from which the fitter selects the iris to match the natural eye.

The artificial eye body or sclera formed in accordance with the present invention is composed of granular plastic material, such as "Lucite," "Plexiglas," i. e., polymethacrylic acid ester

or polymethacrylic acid ester resins. As shown in Figure 1, the mold for forming the body of the artificial eye includes a cylinder 10 of such size and shape as to receive a pair of co-acting removable die members 11 and 12, respectively, one of which, such as the die 11, has a recess or cavity 13 at one end that terminates in an annular shoulder 14 and is arranged to receive a complementary formed curved projection 15 on the adjacent end of the die 12 which is also provided with an annular shoulder 16 that may abut the shoulder 14 to limit inward movement of the die members. To form the hollow plastic eye body of the desired shape and size to fit the eye socket and match the natural eye with which it is to be used, the die 12 is removed from the mold and transparent or suitably colored, dry, granular, acrylic, plastic material is introduced into the recess 13, and the die 12 is then inserted in the mold and the parts subjected to heat and pressure, in a heated press not shown, so as to fuse the grains of material into a homogeneous curved plastic body or sclera 17 of concave-convex shape to form a hollow shell. The bodies 17 of the eyes are made in several shades of "off-white" to match the good eye of the wearer.

In order that a single mold may be used to form eye bodies of predetermined desired centers, and having the same edge thicknesses, there is associated with the mold a series of separating rings 18, each of which has a different edge thickness 19 (Figure 2). These rings are arranged to be interchangeably positioned between the shoulders 14 and 16 of the die members to form the plastic eye bodies with different center thicknesses and different horizontal dimensions but with substantially the same edge thicknesses. As diagrammatically illustrated in Figures 3, 3a and 3b, it will be seen that, assuming it is desired to form an eye body 17 with a 15 mm. radius, a 5 mm. separating ring 18 is interposed between the die members 11 and 12 to form an eye body that has a transverse dimension or length of 29 mm. (Figure 3). For an artificial eye body that is to have a finish or length of 28 mm. a separating ring of 4 mm. is used (Figure 3a). If the eye body 17 is to have a 27 mm. length, then a separating ring 18 of 3 mm. is positioned between the die members 11 and 12 (Figure 3b). The center thickness of each of the bodies 17 is substantially the same as the width of the separating ring used to form the particular eye body, so that if a 5 mm. ring is used, the center thickness of the body will be substantially 5 mm., while a 3 mm. separating ring will form an eye body having a center thickness of 3 mm. The metric measurement herein used is illustrative and is not necessarily restrictive or actual. In other words, should the radial curvature of the die members 11 and 12 be fractionally different, as they may be, the dimensions would be correspondingly different. It will be noted from Figures 3, 3a and 3b that as the cord subtending the arc because shorter the curved shape of the body 17 tends to gradually straighten out. Further, these three figures illustrate the use of curves of the same radii, but each having greater portions of the arc used for the convex curve than that for the concave curve so that by varying the differences in the lengths of the arcs to vary the outer curve of the eye bodies and their longitudinal lengths, so that the plastic eye bodies

may have different horizontal diameters and center thicknesses but substantially the same edge thicknesses, in order that a single mold cylinder can be used to form plastic eye bodies of different sizes, shapes and dimensions and thus effect a substantial saving in making the plastic eye bodies.

The interchangeable use of the separating rings with the mold 10 give approximately the same edge thicknesses 19' at the points 21, 22 and 23, as indicated in Figures 3, 3a and 3b, respectively, despite the fact that these eye bodies may have different center thicknesses and different horizontal or transverse dimensions. Eye bodies formed of these radii of curvature necessarily require rings of different thicknesses to obtain the desired results. Their use may be facilitated by reference to a prepared chart which will accurately show the dimensions of an artificial eye body and the particular ring to be used to form the same. The unfinished eye body 17, after being pressed in the mold 10 under high pressure and reasonably high temperature, is removed from the mold and then veined by engraving minute channels or irregular shaped grooves 24 (Figure 19) on the outer surface of the body 17 and filling these channels with plastic red ink or suitable coloring material to form vein lines 25 (Figure 21). The surface of the body is then wiped off so that it is absolutely clean except for the coloring material in the veins or channels 24. A thin layer of fine granulated, plastic material is then deposited in the recess 13 of the die 11 and the formed body 17 is placed back into the mold between the dies 11 and 12 and the mold positioned in the press, so as to cover the whole front surface of the eye body with a transparent, protective or polished coated surface 17' of about one-half mm. thickness.

If it is desired to form an eye body such as 17, having a center thickness of 5 mm., the body is first formed by using a separating ring of $4\frac{1}{2}$ mm., then properly veining the outer surface of the body and returning the same to the cylinder 10, to which has previously been added $\frac{1}{2}$ mm. of transparent or clear plastic material. A 5 mm. separating ring is now interposed between the members 11 and 12 and the parts subjected to heat and pressure, to form the eye body of the proper size. In other words, a separating ring $\frac{1}{2}$ mm. thicker than the initial ring is used in the second molding operation, in order to give $\frac{1}{2}$ mm. thickness to the transparent outer coating or surface. Several different molds having different curvatures formed on the members 11 and 12 are used to form the artificial bodies 17 of the desired sizes and shapes.

It will be noted that the vein lines 25 are positioned well below the finished coated surface 17' of the eye body so as not to be detrimentally affected by wearing, handling or cleaning of the same. When withdrawn from the mold 10, the body 17 will have the unfinished edge thereon removed by a milling cutter or similar means to produce smooth edges and the desired shape to the body of the eye. This operation may be carried out in a manner similar to that used in shaping the edges of spectacle lenses. The completely polymerized, acrylic, plastic eye body 17 is much denser, harder and less porous and more durable than similar bodies made by the dental process of molding, previously used in the construction of plastic artificial eyes. "Dental molding," as it is commonly understood, consists of using a polymer

and monomer mixed to the approximate consistency of putty and is then polymerized in a mold made of plaster or some similar material. Since the mold does not fully confine the material, the surplus being squeezed out as "flash," high pressures are not possible.

It will be seen that the eye body mold 10 and its associated parts can, by reason of the interchangeable rings 18 be utilized to form a number of artificial eye bodies having different center thicknesses and different horizontal dimensions, but all with substantially the same edge thicknesses, so that these eye bodies may be kept in stock and be available for use when desired.

The colored iris which is embedded in the eye body so as to match the natural eye, is preferably made of the same plastic, granular material used to form the eye body or sclera. This plastic material is colored and then may be ground in a machine that reduces it without heating to the desired degree of fineness. This machine is provided with suitable means for obtaining either a fine or coarse granulated, plastic material, so that the different colored batches of plastics of coarse or fine grains may be selectively blended or mixed in desired proportions to produce an artificial iris that matches in color shades any natural iris. Thus, it will be seen that the artificial iris comprises completely polymerized, fused, acrylic, fine and coarse granules of different shades which are blended together so that the finished iris is provided with sharply defined colored areas harmonizing with the original colors of the granules, so as to simulate a natural iris in size, shape, pattern and appearance, and in which adjacent fine granules are blended with the areas defined by the large granules to form blended edges with the different shades arranged in juxtaposition so as to be free from sharp dividing lines and simulate a natural iris.

The mold for making the colored or shaded irises may be of any desired shape and size and preferably one size iris mold is used and the formed iris turned to any desired diameter before being cut from the iris plug. As shown, the iris mold is formed with a cylindrical body 26 (Figure 4), having a center and axial opening 27 of uniform diameter therethrough, and arranged to receive a removable cylindrical rod or plunger 28, the lower end of which is formed with an enlarged shoulder or base portion 29 of substantially the same diameter as the opening 27, so as to properly center the rod 28 in the cylinder 26. The rod or stem 28 extends upwardly from the base 29 and is of such a diameter as to form an annular clearance with the inner wall of the opening 27. The upper end of the cylinder 26 may be recessed or dish-shaped, as at 30, and the rod 28 may be formed with a tapered end 31 which extends into the recess 30 when the parts are assembled so as to facilitate the pouring of the dry, granular plastic into the cylinder 26. The desired color or shade of plastic material which constitutes the outer periphery of the artificial iris is then introduced in granular form of the proper fineness into the cylinder 26, to fill the space between the wall of the opening 27 and the rod 28, and the parts are then heated without being subjected to pressure to form the uncompressed tubular colored or shaded body 32 (Figure 5) having smooth cylindrical inner and outer surfaces.

Instead of forming the tubular body 32 with an inner smooth surface, it is often desired, in order that the iris simulate in appearance the natural iris, that it be provided with longitudinal ribs or

serrations on its inner surface, in such a case, instead of using a smooth cylindrical rod such as 28, a rod or member 33 having circumferentially disposed, spaced projections or ribs 34 (Figure 6), is arranged to be inserted within the cylinder 26, to form a clearance between the wall of the axial opening 27 and the rod 33, so that the desired colored or shaded material in granular form may be introduced into the mold and, upon being subjected to heat, forms an uncompressed tubular body 35 (Figure 7), having inwardly disposed ribs 36, for the purposes which will subsequently be described. The diameter of each of the rods 28 and 33 determines the thickness of the tubular body 32 and may be varied as conditions require or may be omitted if a single color or shade is to form the iris plug.

Thus, it will be seen that the plastic body or sclera 17 comprises a translucent, completely polymerized, acrylic, plastic body, and that the colored iris 54 is formed from similar material including completely polymerized, fused, acrylic, dry granules. The granules in the finished iris constitute or form sharply defined colored areas that harmonize with the original colors of the granules so as to simulate a natural iris in size, color, shape, pattern and appearance, and in which the colored areas are blended at their edges with adjacent colored areas. Additionally, the adjacent fine granules are blended with the area defined by the large granules so that the different shades are arranged in juxtaposition and are free from sharp dividing lines. Moreover, a portion of the iris may be tinged any desired shade by the addition of a minute quantity of the desired tinging color of transparent, acrylic, dry plastic.

The color of human irises which usually are composed of different shades of brown, gray or blue or a mixture of any one or more of these colors, can be accurately reproduced to form an artificial iris by selectively blending these three colors and subjecting the mixture to proper heat and pressure in a heated press or the like. Accordingly, separate batches of fine and coarse gray, blue and brown dry, granular material are reduced to the desired degree of fineness by being passed through a grinding machine, so as to be available for immediate use. Assuming two colors or shades, such as a blue and brown, are required to form an artificial iris corresponding to a human iris and that a light shade of blue is required to form the outer periphery of the artificial iris, then this particular shade is first made up by properly blending the necessary colors and the same is introduced into the iris cylinder 26 to form the tubular uncompressed body 32 (Figure 5). Similarly, the desired shade of granular brown plastic of the proper fineness is mixed and the rod 28 is removed from the cylinder 26 and a plug 37 (Figure 8) is inserted in the lower end of the opening 27, so as to close the same. The pre-formed tubular body 32 now rests on the top of the plug 37 and the space or opening in the tube 32 is filled with the desired shade of brown plastic 38. A press head or plunger 39, of substantially the same diameter as the opening 27, is then inserted into the cylinder 26 under sufficient heat and pressure to compress and reduce the two color shades into a solid cylindrical body 40, substantially of the size as shown in Figure 11. During this operation the different colors or shades of the granular plastic materials are fused or bonded together under heat and pressure to cause the lines of demarcation to be very irregular, so as to simulate in appearance the color of the

human iris with which the artificial iris is to be used.

Instead of forming the outer periphery of the iris of cylindrical form, it may be desired, in order to simulate the natural iris, to provide ribs between the two colors, in which event tube 35 of the desired color or shade (Figure 7) is substituted for the tube 32 in the cylinder 26 (Figure 8), so that in its final form the compressed solid body 40 will be provided with longitudinal ribs or serrations between the two colors. Should it be desired to add a third color or shade to simulate the natural iris, then the outer periphery of the artificial iris is first formed in the manner as shown in Figure 4 and upon removal of the rod 28, a rod or member 41 (Figure 9), of smaller diameter than the tubular member 32 is inserted in the cylinder 26. The rod 41 has a base 42 of substantially the same diameter as the opening 27 and has its reduced stem portion 43 extending upwardly through the opening in the tubular member 32 to a point adjacent the recess 30. The desired color or shade which is to form a portion of the iris between its outer and inner peripheries, is then introduced between the inner wall of the tubular member 32 and the rod 41 to form, when the parts are subjected to heat and pressure, an uncompressed intermediate tubular portion 44. The rod 41 is then removed from the cylinder 26 and the plug 37 (Figure 10) again inserted in the bottom of the opening 27 and the color or shade 45, which is to form the inner periphery or part of the iris, is then poured in dry, granular form into the cylinder 26, to fill the opening in the tubular body 44. The press head 39 under sufficient heat and pressure is then introduced into the cylinder 26 to compress and fuse the different colored or shaded plastic materials into a solid cylindrical homogeneous body 40. It will, of course, be manifest, that the thickness of either the tubular plastic body 32 or 35 may be varied as desired by the simple expedient of using rods of different diameters. Moreover, instead of the smooth cylindrical rod 41 (Figure 9) a rod of the same diameter having ribs thereon may be provided, so that the iris plug in its final form will have radial ribs formed therein to simulate in appearance a natural iris.

The completed iris plug 40 upon removal from the cylinder 26 (Figure 11), is drilled to form a central opening 46 (Figure 12) into which is inserted a black rod 47 (Figure 13) that forms the pupil of the eye. The iris plug 40 with the pupil running through it is then placed back into the mold 26, so as preferably to have fused thereon at the same time, a cornea at one end and a handle portion at its opposite end. For this purpose, a plug 48 (Figure 14), having an upper concave surface 49, is inserted in the bottom of the cylinder 26 upon removal of the plug 37, and a sufficient amount of transparent, granular material is poured into the concave portion 49 of the plug 48 to fill the same. The solid iris body 40 is then inserted in the cylinder 26 so that the lower end thereof engages the material 50 and a few grams of granular, transparent material are poured on top of the body 40. The heated head 39 under proper pressure is now introduced into the cylinder 26, to simultaneously fuse the transparent convex cornea 51 and a handle portion 52 (Figure 15) on opposite ends of the solid body 40. The body 40, upon removal from the cylinder 26, is then chucked in a lathe so as to be held firmly in position by the handle 52 and the portion of the

body adjacent thereto. The iris body is then cut transversely to the desired thickness such as at the point 53 (Figure 15) to form a complete iris 54 of the desired shade or color to match a natural iris.

The operation of forming a cornea 51 on the end of the iris plug 40 is repeated by returning the plug 40 to the cylinder 26, until the entire plug 40 is used. Each time the plug 40 is returned to the cylinder 26, an additional amount of transparent material is added, so as to lengthen the handle 52, as clearly illustrated at 55 in Figure 16. In other words, substantially the same amount of plastic material is added to the handle as is removed from the body to form each of the irises 54. The lengthening of the handle 52, as the body is reduced to form the several irises, insures a proper gripping means for holding the body 40 in a fixed position in the lathe during each cutting operation. It will be seen that the length of the plug 40 is such that a number of iris buttons and corneas may be formed from a single iris plug. However, the handle portion 52 may, if desirable, be omitted.

The differently colored or shaded granular plastic material in either fine or coarse form when introduced into the iris mold 26 to form the solid iris plug 40, is subjected to a temperature of about 300° F., in order to heat the grains to a point where the individual grains fuse or melt into each other without materially affecting the size, shape or volume of the grains and without changing the molecular structure of the material. During the compression and heating operation, the material in the iris cylinder 26 is subjected to a pressure of two tons or more per square inch, as contrasted to the slight pressure used in molding by the dental process. The iris plug or button 54 may be formed of a single color or color combination, two colors with either a different color periphery or a different color around the pupil, or three colors or shades with different colors around the pupil and a different colored or shaded periphery. The circumferentially disposed spaced ribs or projections formed in the body of the iris by the rod 33 (Figure 6) preferably are located between the outer periphery and the portion of the iris surrounding the pupil, and may be associated with either a two or three-tone or shaded iris and may vary in size and location, in order that the completed iris will simulate in appearance the natural iris with which it is to be used.

The colored iris 54 and transparent cornea 51, when removed from the plug 40, are of the shape shown in Figure 17 and the iris may have a straight annular edge 56 arranged to fit in a complementary formed recess or socket 57, previously formed in the outer surface of the body of the eye 17 and located at the proper optical center to match the human eye (Figure 19). The outer surface of the cornea has a greater curvature than that of the eye body (Figures 19 and 20).

In order to make the outer edge of the iris appear slightly darker as is the case in most human eyes, it is found by scientifically and correctly tapering the side 58 of the iris button 54 and forming the outer surface of the eye body 17 with a complementary formed recess 59 (Figure 20) that the iris, by refraction and reflection, when inserted in the body 17, is provided with a shaded portion around its periphery which very closely simulates a natural iris in size, shape, color and

appearance. The iris button 54, either with a straight edge or a beveled edge, is firmly secured into the counterbore of the eye body 17 by being fused therein or by a cement composed of the same plastic as the material of which the body of the eye and the iris are made. The pupil rod 47 is inserted after the iris plug 40 is formed and before the cornea is attached, and a portion of the rod 47 is removed when forming each of the iris buttons 54 and corneas 51.

It will be seen that an artificial eye constructed in accordance with the present invention can be made and reproduced in substantially the same manner that a doctor or optician orders lenses for glasses. Briefly, the initial fitting of an artificial eye to match a human eye would be selected from a trial set kept in stock. This fitting set would contain approximately 120 blanks, that is artificial eyes without irises or corneas, rights and lefts, as specified in different shapes, sizes, or curve depths, and properly numbered or classified, so as to be easily selected. From these blanks or sets practically 99% of all artificial eye cases could be correctly fitted for size, shape and appearance, and the bodies of the eyes or scleras would be made in several shades of "off white" to match the wearer's good eye. This stock set of fitting may also contain about 130 unmounted irises of different shades and standardized percentage mixtures of blue, gray and brown, all definitely numbered. To match varied colored eyes, the fitter may specify one color around the pupil, another color for the main part of iris, and still a third color for the outer periphery of the iris, or a one or two color or shade of iris may be selected to match the natural iris.

Eyes of most white Americans and others of the Caucasian race are almost never a true, single color, but composed of different shades of blue, gray and brown, almost invariably a combination of two or three of these colors. The present method and means of making irises of several shades of each color blended together in fixed predetermined percentage quantities enables the matching of the color effect of practically every human eye. The exact design of the color formation in the human eye and the artificial eye is of little importance, for if the color effect is the same, the design difference can only be detected by a minute inspection to which the wearer is not ordinarily subjected.

The fitting procedure for artificial eyes may be illustrated as follows: The fitter selects the proper blank to match the good eye and, in this connection it may be mentioned, that in a percentage of cases where an eye is lost by accident, the upper lid muscles are affected and it is not unusual that a flatter eye must be used to permit proper lid action. In other cases, an eye with a greater curvature may be needed to prevent the lid from dropping. Since the fitting set of artificial eyes contains the same size blank in several radii of curvature, it is only a matter of trial to select the most desirable curve for each particular case. The proper colors for the iris would be selected and the diameter of each iris and pupil specified. The blank may then be marked with a waterproof, China-marking, wax pencil or by other means to show the exact position desired for the iris and for the center of the eye. This position or fit would also be measured and recorded.

In the modification shown in Figures 22 to 30, inclusive, the eye body 60 is formed of a suitable plastic material in a mold cylinder 61 (Figure 26) by introducing into the cylinder an accurately

measured quantity of dry granulated plastic material 62 that is received by the concave recess 63 of the lower die member 64. The upper contacting die member 65, which has been previously removed from the cylinder 61 so as to allow the granulated material 62 to be introduced therein, is then inserted in the mold 61 and the parts subjected to heat and pressure to form the solid eye body 60 having the annular outer extending flange 66. It will be noted that the mold 61 is substantially similar in construction and operation to the mold 10, but that the interchangeable separating rings 18 are omitted, and the annular flange 66 is formed by the opposed shoulder portions 67 and 68 on the die members 64 and 65 respectively, and the inner wall of the cylinder 61 which serves to confine the extruded material within the cylinder. The desired shape and dimensions are imparted to the body 60 by accurately determining by weighing the amount of granulated plastic material to be introduced into the mold 61 for the particular size of the plastic body 60 to be formed. Thus it will be seen that by accurately controlling the measured quantities of plastic material introduced into the mold cylinder, that simple, efficient, and economical means are provided for varying the arcs formed by the opposed concave and convex die members as diagrammatically illustrated in Figures 3, 3a and 3b, so that a single mold cylinder may be used to form eye bodies having different horizontal diameters, center thicknesses and curvatures, but the same edge thicknesses.

The plastic eye body or sclera 60 is then removed from the mold 61 and at the proper position or optical center of the body in which the iris wafer is to be inserted, there is formed in the outer surface of the eye body, an annular recess 69 of substantially the same diameter as the iris wafer 70 which fits within the recess 69 and below the outer surface of the body (Figure 24). The outer surface of the eye body is then grooved as at 71 to form irregular channels which receive plastic red ink or other suitable colored material in order to form the vein lines 72 (Figure 29). The surface of the eye body is then wiped off so that it is absolutely clean with the exception that the colored material is embedded in the channels. The eye body 60 with the iris wafer 70 and vein lines 72 therein is then returned to the mold 61, to which has previously been added a small quantity of transparent granular plastic material, and the mold is subjected to heat and pressure to form the transparent coating 73 on the outer surface of the eye body and the cornea 74 which extends over the iris wafer 70, so as to cover the same as particularly shown in Figure 25. In other words, the outer transparent coating 73 constitutes a covering for the eye body 60, the iris wafer 70 and the veined lines 72.

The eye body 60 and its associated parts are then clamped in a suitable cutting or grinding machine so as to shape the outer contour of the cornea 74 to the desired configuration such as indicated at 74' (Figure 27) in order to conform in appearance to the natural cornea. The formed eye body in Figure 27 is substantially similar to that disclosed in Figure 25 and differs therefrom in that the optical center of the iris is offset as contrasted to the central position shown in Figure 25. The annular flange 66 is then removed from the eye body 60 and the outer edge of the body cut transversely and shaped to the desired contour to properly fit in the eye socket with which it is to be used, and in substantially the same

manner as shown in Figure 3. It will be seen that different lengths of the same arc obtain different shapes in order that the eye body may readily conform to the size and shape of the eye socket with which it is to be used. Upon removal of the surplus material the outer coating 73 is polished to give to the eye a high gloss and a reflective convex surface.

In Figure 30, there is shown an iris plug 75 formed similarly to the plug 40 previously described, and which may be provided with a transparent handle portion 76 for securing the plug in a lathe during the cutting operation. The iris plug 75 is drilled centrally and axially to receive a pupil rod similar to the rod 47. A number of iris wafers or buttons 70 are formed from the plug 75 by cutting the latter along the transverse dot and dash lines 77. Each of the iris wafers, when removed from the plug, has a dull exposed surface and is inserted in the recess 69 of the body 60 without being polished, since the application of the transparent coating 71 over the same, when it forms the cornea 74, serves to impart a high polish or gloss to the iris wafer.

The artificial eye fitter may be provided with a complete set of sample plastic eye bodies and irises for accurately fitting and matching artificial eyes with the natural eye of the user, and this fitting set may include preferably six sets of boxes or receptacles, one of which is indicated 78 (Figure 31) and is divided into separate compartments 79 for receiving artificial eye bodies of different sizes, shapes and colors, and which is suitably marked as at 80 so that the fitter may conveniently remove from the proper compartment the desired eye body 60. Each fitter is also provided with a sample card 81 (Figure 32) which contains a number of different colored iris wafers or buttons 82. Each of these differently colored or shaded wafers is provided with a transparent cornea, and numbered according to a standardizing formula. Additionally, the sample artificial eye bodies may be marked with graduated divided lines extending about 12 mm. from the inner canthus or inner corner of the eye and approximately the same distance from the bottom of the eye. In Figure 28 there is shown one of the marked eye bodies 83 provided with a horizontal dividing line 84 and a vertical dividing line 85, each of which is graduated in millimeters and is used to determine the correct position of the iris on the body of the eye.

As an example of operating the fitting set in accordance with the present invention, it might be assumed that the box 78 is arranged to carry a set of artificial eye bodies having an outer radius of 14 mm. This set would include eye bodies 23, 27, 26, 25, 24 and 23 mm. long. These eye bodies would further be divided into two sets, one shape of which would have the vertical dimension substantially 92% of the horizontal dimension, and the other set 77% of the horizontal dimension. Another set or series of artificial eyes would have the same outside dimensions, but with an inner radial curve a little less so as to make the eye thicker at the center, and consequently position it a bit further forward than the first mentioned set. The markings 80 on each compartment 79 indicate the length, proportion, and inner and outer curves of the eye bodies therein so that the fitter may conveniently remove by inspection the desired size and shape of the eye body. Another box similar to the box 80 of the fitting set may contain eye bodies of 13 mm. radius with the largest eye in the series 26 mm. and the smaller

eyes similar in number and proportion to those contained in the 14 mm. set. There may also be a separate box of 15 mm. outside radius bodies which would start with an eye 30 mm. in its longitudinal dimension and other small sizes to be used with this particular radius of eye body. As an example of fitting an artificial eye from this fitting set and without requiring the presence of the maker of the eye, the method of procedure would be substantially as follows:

Assuming that an artificial right eye is wanted to match the natural eye in color, shade and shape, the fitter would select from the right eye set of sample fittings, such as the box 78, an eye body of the proper length. Assuming that he tried a 25 mm. eye, and this appeared to be a little small he would then select a 26 mm. eye. Probably the 26 mm. eye appears satisfactory, but he would also, as a precautionary measure, try a 27 mm. eye and find the latter a little too large for comfort. He would therefore select and use the 26 mm. eye body. He would then notice the palpebral opening or how the distance between the upper and lower lids of the artificial eye compares with the patient's natural eye. If the 26 mm. eye allowed the lid to drop a little too much, he would use the same length eye from his fitting set which has a little greater bulge caused by the shorter radial curve. If this were correct and he selected then a 26 mm. with a 13 mm. outer radius, this would be the artificial eye body 60 to be used. With the eye body inserted in the eye, he would notice the metric marks 84 and 85 on the fitting eye body and specify from these marks the number of millimeters the inner edge of the iris should be set from the inner canthus. This can readily be determined since the fitter desires to leave the same amount of white showing from the colored portion of the eye to the corner of the eye as the patient's natural eye. In the same manner, he would determine from the vertical line of the fitting body, the correct height of the iris. With these measurements correct, the eye must look natural in its most important essential features. That is, the lid of both eyes should be opened the same amount and both eyes should look straight ahead when the patient looks in this direction.

The next step is the selection of an iris 82 from the card 81 that matches the iris of the natural eye. If the card 81 contains an iris of the desired color and shade, the fitter will simply specify the number. If, on the other hand, detail changes are necessary in order to match the natural iris, he might specify from the card 81 an iris having the color and shades such as 86, but if he wanted a smaller pupil than shown in this particular iris wafer, he might select the size of pupil shown in iris wafer 87 and would specify in this order that he wanted an iris of the color and shade in 86 but with the size of pupil the same as in 87. He might also want this iris $\frac{3}{8}$ " greater or less in diameter than the $\frac{1}{2}$ " iris shown on the sample card 81, and if so, he would so specify. In ordering the eye body, he would also mention whether he wants a sclera of the eye to match any one of the different shades shown in this fitting set and whether the eye should be veined light, medium or heavy. The fitter would then fill out a prescription or order blank to be sent to the maker of the artificial eye reading substantially as follows:

Body #13—26, full regular, shade #3, medium veined. Iris #86, with pupil as in #87, $\frac{1}{2}$ "

diameter. Set: 11 mm. from inner canthus, 7 mm. from bottom.

This prescription is then sent to the eye maker's laboratory and the artificial eye is made up in accordance therewith so that when the fitter delivers the artificial eye to his patient, the artificial eye will match in every detailed respect the natural eye of the user. A duplicate copy of the order blank or prescription is retained by the fitter as a permanent record so as to be readily available should a new artificial eye have to be formed to the same size, color, shade and dimensions. This method of fitting and furnishing artificial eyes has the further advantage that it does not require the eye maker to personally be present to see that the artificial eye is made up to simulate in size, color, shape and appearance the natural eye of the patient.

While the formation of the eye bodies and irises from dry plastic material are shown being molded in cylindrical molds, it will be manifest that other types of molding and heating means may be employed.

It will be seen that by reasons of the present system of fitting and making artificial eyes, it is not necessary to have the eye wearer and the eye maker together any more than the spectacle maker and the spectacle wearer are together at the time of the fitting. The novel construction and arrangement of the fitting set is such that the whole fitting is systematized, and anyone familiar with the fitting of stock glass artificial eyes may fit a patient with an artificial eye equal in every respect to that obtained by the best artificial eye maker under the old method. In other words, the fitter may be in one city and the eye maker in another, yet the artificial eye is as accurately made as if the maker obtained his information directly from seeing the patient.

Thus, simple efficient and economical means are provided for forming an artificial eye body, colored iris and cornea that will simulate in every detailed respect the natural eye of the wearer and which may be ordered or duplicated in the same manner as eye glasses are made and without requiring the presence of the eye maker. The parts of the artificial eye are preferably formed from the same plastic material so that the composite eye is light and durable and readily shaped to fit the eye socket of the wearer. Moreover, the transparent, protective, plastic coating over the vein lines and the iris prevents human tissues from being detrimentally affected by toxicity, or the tear solution in the eye or by handling, so that the wearing qualities of the artificial eye are materially enhanced.

It is to be understood that the methods and apparatus disclosed for forming the artificial eye bodies and irises are merely illustrative and that such other means may be employed as fall within the purview of one skilled in the art without departing from the spirit of the invention and the scope of the claims.

I claim:

1. An artificial iris formed of polymerized, fused, acrylic, dry granules blended together to simulate in size, shape, pattern and appearance, a natural iris, the granules in the finished iris forming sharply defined colored areas harmonizing with the original colors of the granules to simulate a natural iris, and said colored areas blending at their edges with adjacent colored areas.

2. An artificial iris comprising completely polymerized, fused, acrylic, fine and coarse gran-

ules of different shades blended together to simulate in size, shape, pattern and appearance, a natural iris, the granules in the finished iris being blended into each other to form colored areas into which adjacent fine granules are blended with the area defined by the coarse granules and the different shades are arranged in juxtaposition so as to be free from sharp dividing lines.

3. An artificial iris formed of completely polymerized, fused, acrylic, dry granules blended together to simulate in size, shape, pattern and appearance, a natural iris, said iris having a tingling portion formed of a minute quantity of transparent acrylic, dry, plastic granules, the granules in the finished iris constituting sharply defined colored areas harmonizing with the original colors of the granules to simulate a natural iris, and said colored areas blending at their edges with adjacent colored areas to simulate a natural iris.

4. An artificial iris formed of completely polymerized, fused, acrylic, dry granules blended together to simulate in size, shape, pattern and appearance, a natural iris, said iris having circumferentially spaced colored plastic ribs extending radially and outwardly from the center thereof, the granules in the finished iris constituting sharply defined colored areas harmonizing with the original colors of the granules to simulate a natural iris, and said colored areas blending at their edges with adjacent colored areas to simulate a natural iris.

5. An artificial eye having a sclera comprising a translucent, polymerized, acrylic, plastic body, a colored iris incorporated in the sclera, said iris including polymerized, fused, acrylic, dry granules blended together to simulate in size, shape, pattern and appearance, a natural iris, the granules in the finished iris forming sharply defined colored areas harmonizing with the original colors of the granules to simulate a natural iris, and said colored areas blending at their edges with adjacent colored areas.

6. An artificial eye having a sclera comprising a translucent, completely polymerized, acrylic, plastic body, a colored iris incorporated in the sclera, said iris including completely polymerized, fused, acrylic, dry granules, fine and coarse gran-

ules of different shades blended together to simulate in size, shape, pattern and appearance, a natural iris, the granules in the finished iris being blended into each other to form colored areas into which adjacent fine granules are blended with the area defined by the large granules and the different shades are arranged in juxtaposition so as to be free from sharp dividing lines.

7. An artificial eye as called for in claim 5 having a transparent, acrylic coating covering the front surface of the eye, the solidity of the acrylic material forming the sclera and iris substantially reducing the possibility of toxicity.

8. An artificial eye as called for in claim 5 in which the sclera has grooves in its outer surface filled with coloring material to form vein lines corresponding with the veins of a natural eye, and a transparent, acrylic, plastic coating covering the front surface of the sclera, iris and vein lines.

JOSEPH S. GALESKI.

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