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AUTOMATIC SELF-RECORDING VISUAL FIELD TESTER
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This is a continuation-in-part of application Serial No. 34,512, filed June 7, 1960, now abandoned.

This application relates to a visual field tester, and more particularly is directed to an automatic self-recording, visual field tester of the bowl perimeter type, which is used in connection with the practice of ophthalmology to determine the boundaries of the field of vision of a patient. This equipment is adapted for automatic self-recording but may be used also as a manual recorder.

This device is particularly adapted to provide a quick check of the field of vision of a patient and this may be accomplished either manually under the direction of an ophthalmologist or technician or automatically by the patient himself, in which case a record is made of his field of vision.

The patient fixes the eye to be tested at the geometric center of a bowl perimeter field tester and directs his eye at the apex of the bowl perimeter. Perhaps as many as eighteen lights on one axis will sequentially go on. As each light in turn comes on, the patient indicates that he sees it by pressing a switch button to automatically record on a recorder which is attached to the instrument. When the patient cannot see the test light, he does not press the button.

The device itself consists of an electrical pulsing mechanism, such as a thyatron tube or the like, which provides a short pulse, perhaps one-tenth of a second, at regular intervals which can be varied according to the requirements of the patient, to a degree stepper switch which steps off each 5 degrees, from 90 degrees to the apex or some other interval to the apex of the bowl perimeter. Upon completion of one sweep, the degree stepper switch is reset to its original position and a control device is actuated to operate the axis stepper to its next setting. Accordingly, the next radial segment is stepped through the same degree intervals.

At the same time as the patient sees a light, the device coordinates with a recorder to record the vision on a control instrument at the position where the light is seen, and it continues to record as each light is seen.

The visual field pattern is then available for observation and analysis by the ophthalmologist. Lights are positioned at the intersection of each of the concentric degree intervals and at each of the axes of the bowl perimeter as aforementioned.

An object of this invention is to provide a new and improved bowl perimeter, automatic self-recording, visual field tester having points of illumination at spaced axes and at spaced degrees along the perimeter of a bowl which is controlled by various circuits either manually or automatically by the pulsers and steppers, as indicated.

A further object of this invention is to provide a new and improved bowl perimeter that may be automatically or manually run to control a series of lights around the perimeter of a hemispheric bowl in order to check the visual field pattern of a patient.

A still further object of this invention is to incorporate control devices and circuits for the visual field pattern of a patient over the bowl of a perimeter and to coordinate these with a recording device for recording the corresponding position where the light is observed in a regular manner by the patient indicator switch.

Another object of this invention is to provide a new and improved visual field tester that may be either automatically or manually operated to develop and record a visual field pattern in a bowl perimeter, visual field tester by means of electrical impulses to a network of lights on the perimeter which shine through the perimeter of a non-transparent bowl having small apertures therein, and to coordinate the pulsing of these lights at timed intervals and at the same time having coordinated controls for the patient to indicate the appearance of the flashes of light in the bowl perimeter.

To the accomplishment of the foregoing and related ends, said invention, then, consists of the means hereinafter fully described and particularly pointed out in the claims; the following description setting forth in detail one approved means of carrying out the invention, such disclosed means, however, constituting but one of the various ways in which the principles of the invention may be used.

In the drawings:

FIG. 1 is a schematic perspective view of my new and improved bowl perimeter, visual field tester;
FIG. 2 is an enlarged cross-sectional view along the line 2—2 of FIG. 1 showing the fixation light and the bowl perimeter lights;
FIG. 3 is a fragmentary view along the line 3—3 of FIG. 2 showing the lights at the apex;
FIG. 4 is a fragmentary cross-sectional view of one of the lights in position showing a diode in the output of each of the lighting circuits;
FIG. 5 is a schematic diagrammatic view of the components of the apparatus showing the manner in which the pulsers, degree stepper, axis stepper, patient switch and recorder are integrated to produce the effect achieved;
FIG. 6 is a hypothetical diagram illustrating a patient's visual fields in a brain lesion; and
FIG. 7 illustrates in schematic diagram fashion some block diagram representations of FIG. 5.

Referring now more particularly to the drawings, 10 indicates a typical console cabinet having control means generally shown in the pedestal at 11 and support legs 12 therefor, a table top shown generally at 15 and a bowl perimeter as at 16 which is generally supported by means 17.

On the bowl perimeter 16 there is a flange 18 and mounted on the table top 15 is a pedestal 20 and a chin support or rest 21. This can be adjusted for height so that a patient's eye can be focused upon the fixation light at the apex of the bowl perimeter, which means that the eye being tested is as nearly as possible at the geometric center of the hemisphere and equidistant from the various perimeter lights.

Pedestal 11 houses a console and series of control devices for the lights, including a recorder section 23 of a type to be further described, automatic stepping means 24 and a manual control panel 25. A patient switch 27 is for the patient's use to indicate when he sees a light.

In the cross-sectional view of this invention, FIG. 2 there are shown the apex light 28 and the lights which are numbered serially 1 through 18 on the upper portion and 13 through 18 as far as they are visible in this view on the lower portion. The other axes of the bowl perimeter are also shown, for example, one axis at 29 and a further axis at 30. The eye of a patient will be at the geometric center, equidistant from the lights, as at 31. The adjustable pedestal 20 and the chin support 21 are also shown in this view.

The cluster of lights near the apex is shown in connection with FIG. 3 where the apex light is again at 28, and the various axes with all of the lights in a line are shown radiating from this point. As shown, each of the lights are equally spaced along each radial axis, such that corresponding lights in the radial axes define equally spaced concentric degree groups. Accordingly, the first
The second concentric group represents the 5 degree lights of each axis, the second concentric group represents 10 degree lights of each axis, etc.

A cross-sectional view of one of the lights is shown in FIG. 4 with one of the leads at 32 and a further lead at 33 to the lamp which is held by a spring clip 34 in socket 35 and cemented as at 36 to the bowl. There is an aperture for each light as at 37. A diode is in one lead of each of the lamps as at 38, and its function will be explained. As indicated by FIGS. 4 and 5, each light is connected to a suitable source of operating potential by way of a unidirectional current passing device 38 and an appropriate degree and axis stepper 41.

FIG. 7 shows a schematic view of the entire circuit. In this connection, the pulser 40 might be a 2D21 thyatron providing one-tenth of a second pulse at regular intervals. This interval may be adjusted between one second and ten seconds, depending upon the reaction time of a patient. Some patients are slow in responding to the light, in which event the pulse must be slowed down to meet their reactions. It is possible, of course, under certain circumstances, that alternate means of achieving the variable frequency pulse source may be used. For example, a motor driven disc with contacts or condensers having appropriate charging and discharging paths may be used.

Since the circuitry to provide a variable frequency pulser is well known in the art further discussion does not appear warranted.

The pulses developed by the thyatron pulser 40 are then fed to appropriate axes and concentric degree energization circuits to permit sequential energization of each radial light axis. It should be understood that the circuitry must be such to connect appropriate light energizing potential to the network of lights in a predetermined fashion. While any desired pattern of light ignition may have been utilized, it was felt that a sequential scanning of successive radial axes would be suitable to perform the test desired. Whereas various other circuitry all of which would, by necessity, have to be capable of performing the last mentioned desired end may have been designed, it was felt that the preferred embodiment is as disclosed in FIGS. 4, 5 and 7 of the drawings.

As shown in FIGS. 5 and 7 a plurality of leads, forming a plurality of energization circuits, connect the degree stepper with each concentric degree group. In this manner the 5 degree, 10 degree, . . . 90 degree groups are each connected to the degree stepper switch 41. It should be understood that each lead connects its particular concentric group to a different contact of the degree stepper. In turn the degree stepper switch has an appropriately movable scanning arm which connects one terminal of a suitable operating potential to each of the contacts in accordance with the setting of the scanning arm. The position of the scanning arm being, in turn, positioned in response to pulses received from pulser 40. The scanning arm is moved from one contact position to the next in response to pulses received from pulser 40.

Accordingly, assuming the scanning arm of degree stepper to be at the 90 degree contact, one terminal of the operating potential will be connected to appropriate light lead, such as 32 or 33, which are connected to the 90 degree group. Upon an appropriate signal from pulser 40 the scanning arm of degree stepper 41 will be stepped to the 85 degree contact for similar voltage application thereto. Upon the scanning arm of the degree stepper 41 receiving appropriate pulses from pulser 40 to thus permit sequential energization of each light in the particular radial axis, beginning at 90 degree and ending at the 5 degree concentric group, a suitable circuit means must be provided to automatically reset the scanning arm of degree scanner 41 to its initial position, and, as well, to step energization to the next desired radial axis.

To this end, a plurality of leads, forming a plurality of radial axes energization circuits connect the axis stepper switch, see FIG. 5, with each radial axes group. Each radial axis is connected to an individual contact of the axis stepper switch. In this case we have decided to form twelve individual radial axes and, accordingly, twelve leads form this last mentioned plurality of radial axes energization circuits.

Similar to the degree stepper switch, the axis stepper switch is provided with a scanning arm which automatically moves to the next successive contact upon receipt of an appropriate signal. While other particular arrangements for supplying scanning arm shifting pulses to the axis stepper may have been provided, it was felt that in order to coordinate the operation of the degree stepper with the axis stepper, that upward the degree stepper switch completing a sequential ignition of each light in a particular axis terminating with the ignition of the 5 degree concentric group, the automatic resetting of the degree stepper to its initial contact also would be the means to provide the shifting of the scanning arm of the axis stepper switch to the next desired radial axis contact.

Along these lines independent circuitry, such as a time delay shifting means, which will take into account the time needed for the degree stepper to scan each of its concentric degree contacts, with the delay being set for the longest frequency rate of pulses available from pulser 48, could have been used to automatically step the scanning arm of axis stepper 41. It was felt, however, that an embodiment as hereinabove described would be preferred. Along these lines, the degree stepper and axis stepper switch may be independent switching switches with suitable interconnecting circuits, or, as is well known in the art, a ganged switch having a plurality of cooperating stepping switches may be used. In the latter case a suitable contact and circuit is provided on the degree stepper to automatically reset the same upon a complete scan of the degree stepper, and concurrently step the scanning arm of the axis stepper.

More particularly, in this instance since it is contemplated to have 18 concentric groups, upon the degree stepper being pulsed to its 19th contact the degree stepper is automatically reset and simultaneously therewith a pulse is sent to the axis stepper for shifting the scanning arm thereof to the next desired radial axes contact, see FIG. 7.

The scanning arm with the axis stepper is operatively connected in circuit with the other terminals of a suitable source of light igniting potential. In this manner a series circuit consisting of the source of operating potential, the degree stepper switch, the concentric degree energization circuits, the particular light being ignited, the plurality of radial axes energization circuits, and the axis stepping switch is formed. It should be appreciated that only one light, at the intersection of the particularly selected axis and the particularly selected concentric degree group should be ignited at any one single time. To insure that one and only one light, in accordance with the setting of the degree and axis stepping switch, is ignited at any particular time, I have found that placing a properly poled current isolation diode 38, see FIG. 4, in series with each light is desirable. It should, of course, be appreciated that if the voltage drop across the ignited light is such that substantially all of the igniting potential is dropped thereacross, isolation diodes may not be needed. This is particularly true if a gas filled light is employed where the filler gas has an ionization level approximately equal to the source of operating potential. It can be appreciated that in this latter case very little voltage will be available to permit the ignition of any subsequent lights. On the other hand, if lights having very low voltage drops are employed, as in the case of the preferred embodiment, then it is evident that unless suitable precautionary measures are employed that sneak circuits may be formed between the other lights in the network to result in unsatisfactory
concurrent multiple light ignition. It has been found that in order to prevent the formation of sneak circuits a diode, such as 38, connected in series with the light and the ignition potential, with the plate of the diode 38 being connected to the positive terminal of the suitable voltage source, and the cathode being connected to the negative of the terminal, will permit only the properly selected light, at the intersection of the pulse concentric degree group and the currently pulse radial axis, to be ignited. In the hereinabove described manner the lights making up each of the radial axes are sequentially ignited beginning first at 90 degree concentric group, then the 85 degree concentric group, etc., terminating at the 5 degree concentric group, the inner most one surrounding fixation light 28.

In order to provide the means for patient recording of the test, suitable circuit connections by the plurality of leads 43 are made to each of the concentric degree groups, or as shown in FIGS. 5 and 7, to the leads connecting the concentric degree groups to individual contacts of the degree stepping switch. A normally opened patient operated switch 27 is operatively connected, see FIG. 4, between the radial axes and the recorder 23. In this manner a parallel circuit arrangement between the recorder 23, each of the network of lights, and the patient switch 27 is provided. Accordingly, upon the patient responding to the ignition of light switch 27 may be closed to provide a complete series circuit between the light, and the suitable operating potential, to make an appropriate mark on the recorder 23, at the correct point of light ignition.

Referring to FIG. 6, there are twelve axes on the circles and eighteen degree positions on each axis. For convenience of recording, the concentric light groups are indicated at each ten degree intervals, although there are twice that many actual positions on the chart. An example is noted in connection with a brain lesion in which case a patient is not able to see with his right or left eyes any large segment of a field of vision to the right of the apex. This chart merely illustrates the function of the apparatus, and is not a typical chart. As each axis is checked, the patient records where he sees the lights. For example, in FIG. 6 on axis 29 at 50, which is about the 72 degree circle, the patient first can see the light. As each further light is pulsed, the patient switch activates and a mark is then made. The series of dots or records are encircled in the manner indicated.

The recording device is actually a plotting device which mechanically or electrically records a similar position. It may be a pen and ink solenoid type or an electronic type on which a record is made on electro-sensitive paper of the record achieved by the patient during this visual field test.

In general, the perimeter hemisphere is a plastic hemisphere of perhaps one-third of a meter in radius. The adjustable chin rest shown allows either eye of a patient to be positioned at the center of the hemisphere, facing the concave side in such a way that each point on the hemisphere is one-third of a meter from the patient's eye being tested. The hemisphere has about a two-millimeter hole in the apex which serves as the fixation point, and there are a series of eighteen holes radiating from the center in each of the twelve directions or axes, exactly 30 degrees apart. The eighteen holes in line are 5 degrees apart, providing a hole every 5 degrees from the center hole in each of the twelve meridians. Behind each two-millimeter hole is an enclosed light socket containing a single contact bulb. The contacts on the bulbs are arranged in such a way that one contact of each of the 90 degree bulbs from each axis is joined together and connected to one line of the degree stepper. Likewise one contact of each of the 85 degree bulbs is joined together and connected to a second line from the degree stepper, and, in like manner, each of the concentric degree groups are connected to the corresponding position, of the degree stepper.

The second contact of each of the bulbs in each of the 360 degree meridian is joined together and connected any of the appropriate one of the heretofore described plurality of energizing circuits to selected contacts of the axis stepper. An isolation diode 38 is connected in series circuit with one line of each lamp. This arrangement activates one light at a time depending upon the setting of the degree stepper and the axis stepper at any given moment.

The patient switch can be a 12 pole, single throw switch, which is operated by means of a push button and held in the patient's hand. The button is pressed when a light is seen by the patient on the perimeter hemisphere and is not pressed when the patient does not see the light.

The patient switch can also be a single pole switch in the power supply of the recorder, in which case all lines to the recorder except power are permanently connected. The recorder could be of many types. One type, however, is an assembly of solenoids or contact means. Each is connected to inked felt writing nibs, one for each of the lights on the perimeter hemisphere and arranged in the same relative positions as the lights on the hemisphere. Electrically, the contacts on each solenoid are connected to the eighteen lines from the degree stepper and the twelve lines from the axis stepper (via the patient switch) in exactly the same fashion as on the perimeter hemisphere.

In this manner, when any given light on the perimeter hemisphere has been activated, its corresponding solenoid in the recorder is also activated, providing the patient activates the patient switch. The solenoid remains inactive if the patient does not activate the switch.

An alternate recording device might be one in which there is a sandwich of two printed circuit boards. On one board there would be eighteen concentric circles, each circle being connected to one line from the degree stepper. On the other circuit board there would be twelve radiating lines, each 30 degrees apart, and each connected to the corresponding line from the degree stepper. Between them would be inserted a sheet of paper which previously had been imprinted with an insulating oil cross-hatching so that the paper represents thousands of small cells, each electrically insulated from its adjacent cells. Prior to use, the paper would be immersed in a solution of starch and iodine and run through a roller so that it will be damp. Each cell of the cross-hatching would have its dampness insulated from the dampness of the adjoining cells. Rectifying diodes would be inserted in each of the twelve lines between the patient switch and the recorder so that a direct current passes from the axis plate to the degree plate in the recorder sandwich, but only in the position of the light on the perimeter hemisphere that is simultaneously activated. The direct current ionizes the potassium iodide and releases iodine which gives a blue color with starch. Alternate chemical indicators may be used as well.

A further alternate recording device makes use of a matrix or relays of single pole, single throw type, in which the relays are activated in a manner identical with the lights on the bowl perimeter. The output contacts on each relay are connected to a corresponding stylus electrode arranged in such a way that a sheet electro-sensitive paper, such as Western Union Deskfax paper, is between a metal sheet and the bank of recording styli. In this type of recording, the patient activates a single relay that controls the recording current that powers the contacts of the relay matrix.

In manual control operation, an additional control box is provided as indicated at 25, with a series of eighteen push buttons replacing the degree stepper and a twelve-position switch which replaces the axis stepper and holds a pad of charts so that the operator can record the visual field manually. For manual control, the operator sets the axis switch and pushes each of the eighteen buttons serially until the patient states that he has seen
a light. The operator then records on the chart the position at which the patient first sees the light. The manually operated visual field tester consists, then, of the perimeter hemisphere and the manual control box.

The operation of this device is particularly important in connection with the rapid and regular testing of patients for obtaining visual field patterns. When a patient learns how to operate the device, there is a considerable time saving on the part of the ophthalmologist as he need not attend to the detailed recording of each position. He is able to receive the visual field pattern of a patient and to make a diagnosis on the basis of the pattern established. If, however, a patient does not react properly, the ophthalmologist may take over and run the test manually or repeat the test at any position where he feels it is inaccurate.

This invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiments are, therefore, to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalence of the claims are, therefore, intended to be embraced therein.

The invention claimed is:

1. In an ophthalmic visual field tester, a substantially hemispheric perimeter bowl, a fixation light at the apex of said bowl, a network of normally extinguished lights visible upon illumination to an observation point near the geometrical center of said hemispheric bowl, means for locating an eye of the patient at said observation point, said network comprising radial groups of lights, each group disposed along an axis radiating from said fixation light along one of the predetermined number of great circular paths, said lights being equally spaced along said radial axes whereby corresponding lights of said radial groups define additional equally spaced concentric groups, a source of light operating potential, a first plurality of energizing circuits each common to a respective radial group, and a second plurality of energizing circuits each common to a respective concentric group, stepper switching means for sequentially connecting each of said first energizing circuits to said operating potential source, additional stepper switching means for sequentially connecting each of said second energizing circuits to said operating potential source.

2. An ophthalmic visual field tester as set forth in claim 1 wherein said predetermined number of great circular paths are equally spaced.

3. An ophthalmic visual field tester as set forth in claim 1 wherein said additional stepper switching means is operatively connected in circuit with a preselected contact of said first mentioned switching means.

4. An ophthalmic visual field tester as set forth in claim 3 including a current isolation means operatively connected in series with each said light.

5. An ophthalmic field tester as set forth in claim 3 wherein said patient operated recording means includes an acknowledge switch for actuation by said patient and electrically actuated marking means in series with said acknowledge switch said series arrangement of said acknowledge switch and said marking means in parallel with each said light.

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