

[54] **VIEWSCOPE FOR THE BLIND**

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250/216, 250/234, 340/407

[51] Int. Cl.....**H01j 39/12**

[58] Field of Search178/7.6, 7.3; 340/407;
250/221, 222, 234, 235, 236, 219 CR, 216;
35/35 A

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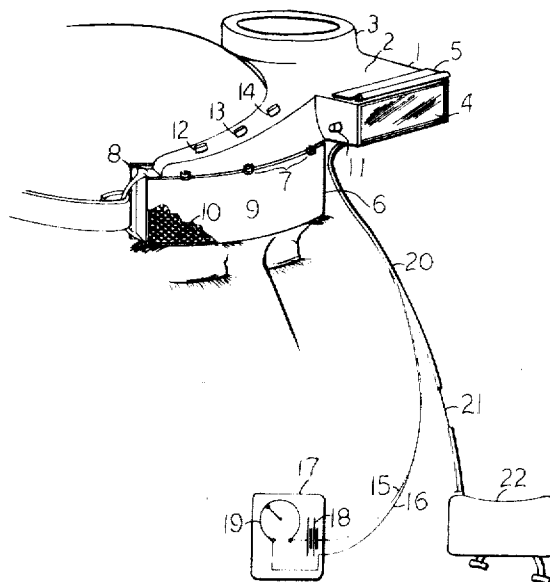
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[57]

ABSTRACT

A light-weight headworn scanning system of concave mirrors on a wheel, with a detector-capsule for both visible and infrared radiation, the generated signals from incoming radiation being used to convert the scanned object or scene into a touch-felt image on the skin. A fine wire brush revolving with the mirror-wheel distributes amplified electric signals from the detector to a circle of contacts whose wires lead to an individually form-moulded forehead panel or receiver made up of several hundred electro-motive components, each of which represents a particular tiny spot of the scanned scene and will be activated to touch and withdraw from the forehead skin according to the brightness or darkness of that particular spot in the scene. These electro-motive components of special new design make electrical connection in the system by simple insertion in a uniquely constructed panel, and are as readily removed for inspection. Focus is obtained by moving the detector-capsule nearer to or farther from the concave mirrors, and a plane mirror-(s) can be used to reflect rays from them in a backward direction to the detector in order to accommodate focal length in reduced space. A fan revolving with the mirror-wheel moves air to ventilate the space between the tactile component panel and the forehead.

15 Claims, 12 Drawing Figures



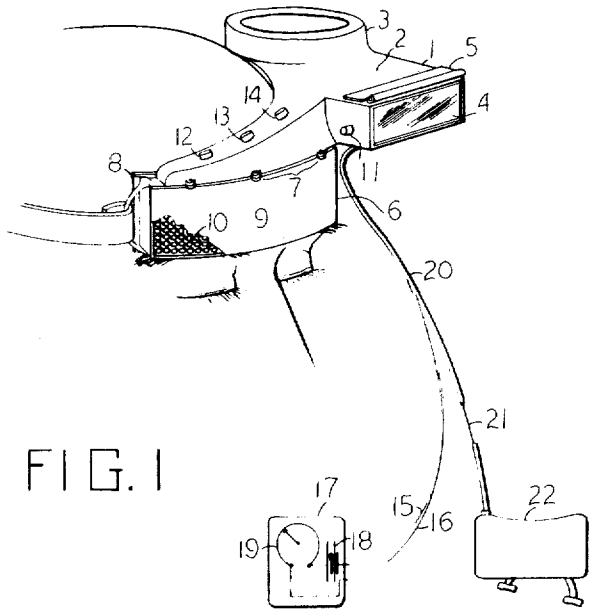


FIG. 1

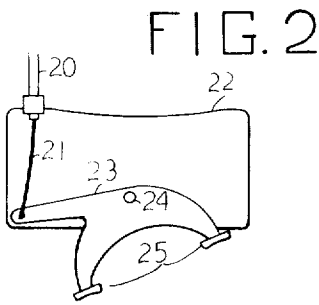


FIG. 2

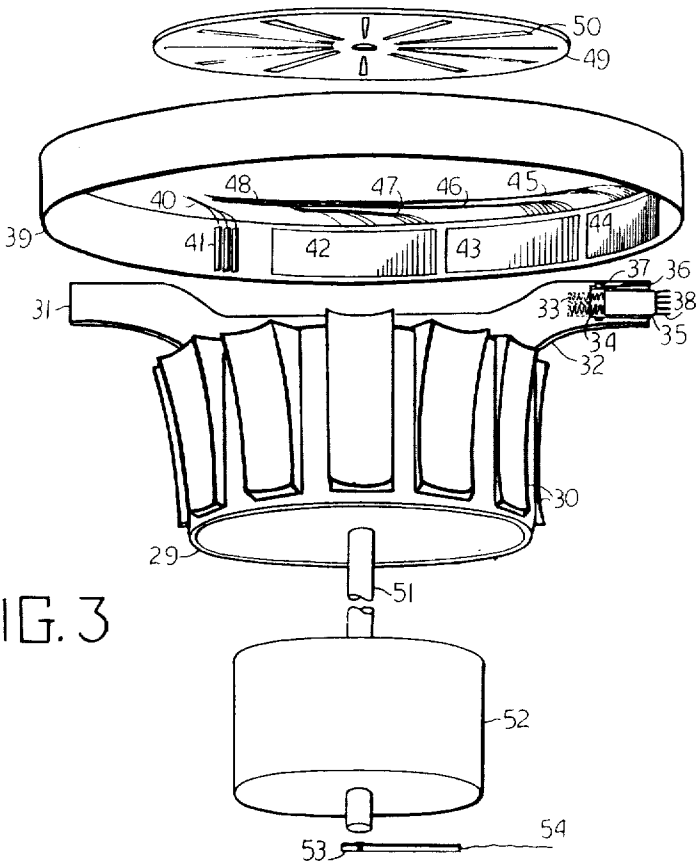


FIG. 3

INVENTOR
Thomas R. Pitt

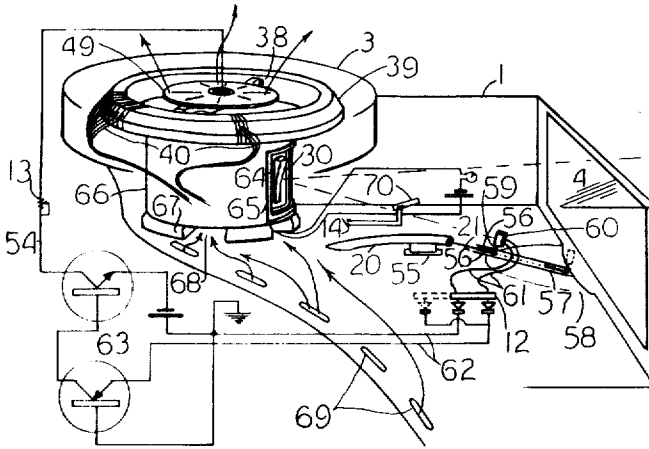


FIG. 4

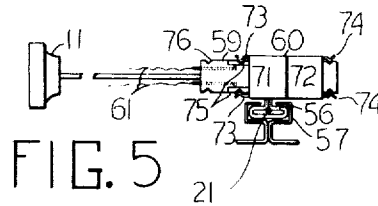


FIG. 5

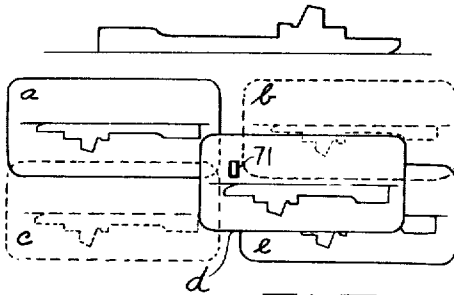


FIG. 7

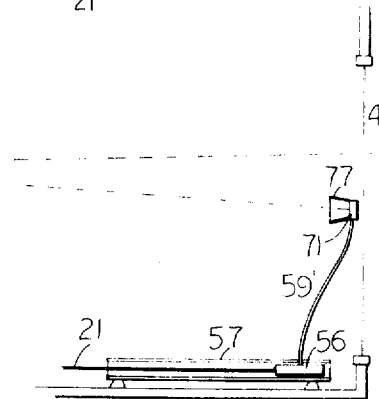


FIG. 6

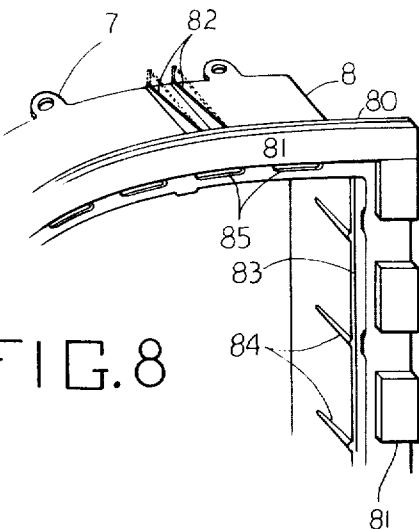


FIG. 8

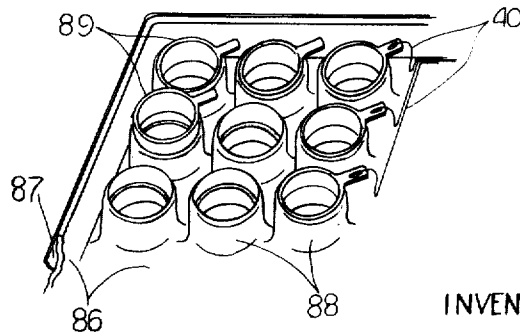


FIG. 9

INVENTOR

Thomson

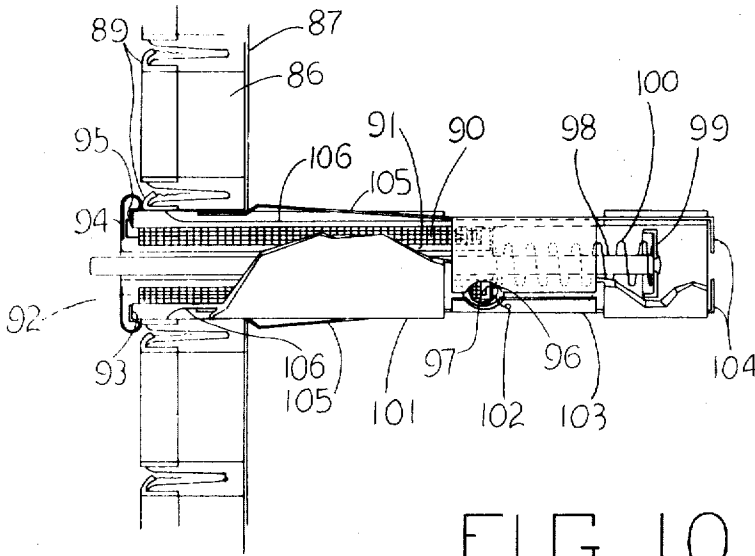


FIG. 10

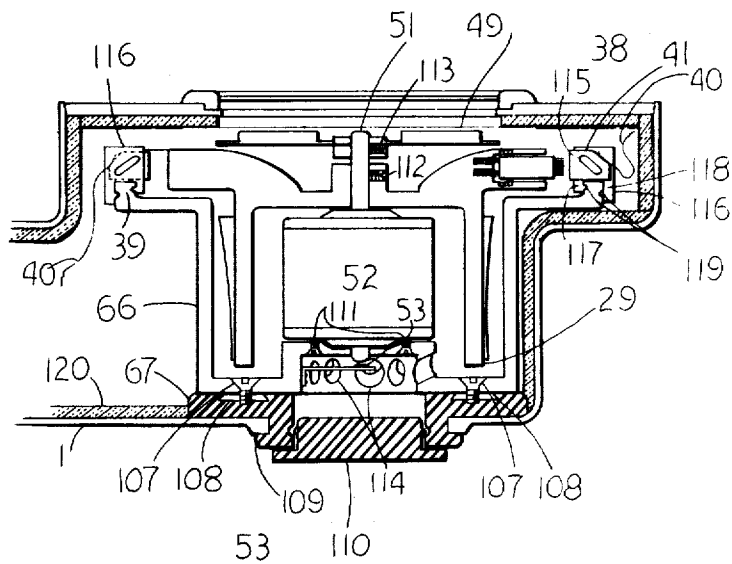


FIG. 11

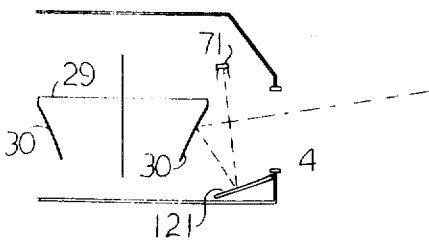


FIG. 12

INVENTOR

Morse Roll

VIEWSCOPE FOR THE BLIND

BACKGROUND OF THE INVENTION

1. Field of Invention

To help blind individuals to be aware of things around them, silent and scentless and not within their reach or touch, we must give them a sensitive detector of some kind. And if such detector instrument is to offer, as the eye of the seeing person does, an instant idea of location, size and general shape of the objects around, then it must be made to convert whatever it surveys or scans into an instant tactile pattern or touch-image for application to a sensitive skin area of the user. Ever since the discovery of the photoelectric principle many inventors have sought to develop various kinds of equipment offering a limited aid to the blind, and while it is in this field that may present invention belongs, it is distinct in being concerned with a practical, small and light-weight device for instant scanning of objects and scenes, and with sound functional design of equipment for impressing a corresponding touch-image of such on the blind one's forehead.

2. Description of the Prior Art

Passing over all partial aids such as hand-directed radar beams, finger-tip exploration of raised images or light-images projected upon a screen, photoelectric instruments for the reading of print which generate separate and distinguishable messages for each different letter of the alphabet, we are left with the consideration of whatever more advanced inventions are designed to present the blind one with a whole, all-at-once pattern of the object or scene before him, so that he can perceive it in the instant and, if his senses are acute enough, can recognize it for what it is without tedious point by point exploration and delayed interpretation. In my past developments on electronic instruments to aid the sightless I have used this instant-pattern type of instrument which uses a multicelled photoelectric screen in the viewer. In the present improved invention I use only a single radiation detector for conversion of the optical image into electrical impulses; the problem of their amplification by a single amplifier is thus overcome. The scanning system I now use provides many other advantages as will be seen here following.

The Television Camera, with its beautiful scanning of the beam in the Cathode Ray tube, gave inspiration to some inventors, and wide-spread publicity has been given of late to the work of certain doctors in California who use the TV camera for scanning, the resultant signals being fed to a bank of 400 solenoids with plungers placed in the back of a dentist's chair in which the blind person sits. The problem as stated by these inventors is the reduction of weight of equipment from 50 pounds or so as at present to a possible future 5 pounds. Obviously there is also the formidable problem of reduction in size.

The invention as here disclosed shows a scanning device quite distinct from any high voltage Television Camera or Cathode Ray device. Presently it weighs under 20 ounces for both scanner and tactile equipment combined. In addition, the extremely compact design allows the complete equipment to be carried easily on the head. I have thus overcome the problems of weight, bulk, ease of carriage, danger to the user

from high voltages and possible X-ray generation being carried daily so close to the body, as well as the problem of applying a touch-image of sufficient complexity to the relatively small area of the forehead which is just above the site of the natural eyes and where the nerves are close to the seat of vision in the brain.

BRIEF SUMMARY OF THE INVENTION

A light-weight head-worn scanning system of concave mirrors revolved on a wheel and focusing on a radiation detector cell (instead of a Cathode Ray tube system with complicated electric circuits and high voltage power supply) is mounted on the head of the blind person together with a receiving panel of tiny electromotive components which make, on the forehead, a pulsing pattern of the main features of whatever scene is being scanned. Instead of an electron beam picking up an electrical signal point by point as it is scanned across and down a screen of fixed frame upon which the optical image has been focused, in my invention it is the detector cell which remains in the one position as a reflected optical image is swept across it in a series of steps, each concave mirror representing a single scanned line. Mounted on the mirror-wheel is a distributor brush which passes over a circle of contacts to distribute amplified currents from the detector to the tactile or touch-image components in the receiver. A fan revolving along with the mirror-wheel ventilates the space between the forehead and the receiver panel to evaporate sweat and diminish its harmful effects upon the equipment. Focusing of the image is done by moving the detector cell backwards or forwards instead of moving the mirrors nearer to or farther away as in photographic cameras, projectors and other such apparatus of conventional optical setup. An important saving in size in the equipment can be achieved by the use of a plane mirror (s) so placed that it directs the radiation reflected from the concave mirrors backwards at a suitable angle thus taking care of focal length and eliminating the awkwardness of any protrusion otherwise needed for the cell mount.

A two stage transistor circuit amplifies the currents from the radiation detector cell before they are fed to the distributor for passage to the touch-image components. A dry battery or rechargeable block is carried in a case in the pocket for powering the small electric motor which drives the mirror-distributor-wheel and fan. Mercury or other style of tilt switches cut off power supply to the apparatus when the head nods in rest.

The touch-image components, which are fundamentally of the same kind as shown in my Canadian Pat. No. 743,764 are of a new and improved design in the present invention; they and the panel in which they are mounted are so constructed that any component may be inserted or lifted out quickly and easily for servicing or replacement without the soldering or unsoldering of any wires. The mounting panel and the frame on which it sits are so made that they can be heat-formed, by ordinary techniques, to exact conformity with the forehead upon which they are to be worn.

A main object of my invention is to furnish the blind individual with a scanner-type viewscope light-weight enough to be carried on the head with ease and small

enough in size that its wearing need offer no more awkwardness of movement than the wearing of a helmet or a top hat.

Another object is to supply a scanning system for use in a viewscope for the blind which allows the use of a sensitive infrared detector for night use, which long wave detection cannot be used in television camera systems.

Another object is to supply signals even in poorly lighted scenes where television cameras of the Cathode Ray tube type, Iconoscope, Vidicon and the like are useless.

Another object is to supply a suitable scanning system for a viewscope which needs only small batteries for power supply and has no dangerous high voltages or possible radiation which may be harmful to the body when kept close month in and month out.

Another object is to supply a ventilated forehead-worn panel of several hundred touch-image components any one of which can be removed for servicing if necessary and reinserted quickly and easily without soldering.

BRIEF DESCRIPTION OF DRAWINGS

FIG. 1 is a perspective view of the combined apparatus as strapped on the head, with hand-focus control attached, and with the pocket-carried power supply shown in diagram.

FIG. 2 The works of the hand-held focus control, cover removed.

FIG. 3 Exploded diagrammatic view of the motor, mirror-wheel, distributor and fan.

FIG. 4 Diagrammatic perspective of inside of scanner housing.

FIG. 5 Detailed view of detector-capsule carriage and carriage-way.

FIG. 6 Diagram of alternative detector cell location.

FIG. 7 Diagram of scanning method.

FIG. 8 Construction of receiver frame.

FIG. 9 View of part of touch-image component panel.

FIG. 10 Greatly enlarged sectional view of a touch-image component.

FIG. 11 Sectional view of scanner and distributor, distributor ring and contacts, housing and ring-support and fan.

FIG. 12 Diagram of alternative optical arrangement.

DETAILED DESCRIPTION

The viewscope imprints a live, continually moving picture of his scene upon the forehead of the blind person. Because of the scanning procedure it might be said that the picture is being rapidly and repeatedly sketched on the forehead, the number of times per second depending upon the rate of revolution of the scanning wheel, and this can be made very slow or quite fast as the wearer chooses. In the preferred embodiment this picture or touch-image is composed of only 25 dots to the square inch which, to use the photoengraver's terminology, is an exceedingly coarse "screen." Using the whole oblong of the average forehead we are able to make use of about six hundred dots altogether, and while on first thought this might seem an insufficient number for the composition of anything but the most elementary geometrical patterns, a further

consideration will show that even with this kind of coarse make-up we can present a rather astonishing representation of objects and scenes. Comparison can be made to an electric signboard made up of not four but only a mere two hundred light bulbs, upon which animated figures appear; although the bulbs are quite well separated from one another and therefore make a picture of separated light spots on the retina, the human mind easily fills in the gaps to create the impression of continuous lines; also, between the animation of the sign and its shifting image on the retina due to movement of the eye and of the head, the image-retention faculty of the retina produces a quite wonderful joining up and smoothing out of things.

For the blind person using my apparatus the forehead becomes the retina upon which, instead of the light-retention faculty, there is the momentary retention of feeling. Naturally the blind person also uses the same mental process by which the imagination fills in the gaps between spots to make them recognizable as continuous lines. However for anyone who has not worked with the blind and may therefore be unfamiliar with the almost unbelievable acuity of their sense of feeling, it may seem an incredulous thing that any human being could ever learn to interpret anything of the complexity of a "touch-image" based on a dot screen system. The real truth is that the blind, denied the facile and effortless judgements of vision, learn their own kind of substitute facility in the judgement of feeling, on which sense they are able to concentrate the kind of undivided attention which makes them aware of slight differences of feeling the seeing person would never notice and permits them to interpret complicated sets of feelings far beyond the average person's awareness.

Referring particularly to FIG. 1 of the drawings, the viewscope is shown mounted on the head of a man and supported by a stiff headband or crown structure which holds it in a set position in the same way that a well-fitted hat or helmet is maintained in place. The scanner housing 1 has a removable cover 2 with a turret-shaped part 3 which is open at the top for ventilation and cooling of the works. The scene to be analyzed is framed by the oblong aperture 4 which is covered by a window 4a of glass or transparent plastic. A smoked glass filter 5 can be swung down over the aperture when the scene being viewed is one of intense illumination.

The scanner and aperture provide simulated viewing of a scene in a direction forward of the person fitted with the apparatus, the scene subtending a predetermined lateral angle, which may be about 50°, and a sufficient vertical angle to include objects both above the horizontal plane and the foreground directly ahead.

The scanner housing is of odd shape as will be seen, with an extension which curves around the top of the forehead. This curving part is in effect a duct-work for the passage of air being drawn in the space between the skin of the forehead and the inside face of the receiver to be finally exhausted through the open top of the turret 3. The complete scanner housing is attached to the receiver 6 by screws which are threaded into the lugs 7 (shown better in FIG. 8.) A flanged frame 8 of the receiver has an outside cover 9 of fine metal screen, part of which is shown cut-away to expose a number of the small tactile electromotive components 10 (termed

touch-image components hence forth) which are mounted inside as will be shown later. (FIGS. 7 and 8).

A control knob 11, on the side of the scanner housing, is for converting over from light-reception to infrared radiation-reception so that even in pitch dark a certain amount of crude viewing is possible, a stove, a warm motor or a car, a boulder or a masonry wall retaining heat from the day's sunlight, to give just a few examples.

A polarity reversing switch 12 (FIG. 4), a potentiometer 13 for the control of output from the two stage transistor amplifier in the camera, and a bridging switch 14 for the automatic motor cut-off switch are all three mounted on top with their control knobs on the outside for quick and easy manipulation by the right hand.

Two wires 15 and 16 from the driving motor inside the scanner (FIG. 3) lead downwards to the pocket carried case 17 containing a drycell battery 18 or rechargeable block as power supply. A rheostat 19 with its knob mounted on the outside of the pocket case regulates the amount of current being fed to the motor. For a part of their way down, the motor wires lie alongside the flexible sheath 20 which contains the sliding steel focus wire 21 shown here in a break-away section of the length. This focus wire is attached to the sliding carriage on which the radiation detector-capsule is mounted in the scanner (FIG. 4) from whence it leads down to the handheld control 22 shown in detail in the following figure.

FIG. 2 shows the mechanism of the focus control 22 which, as will be explained, is so important to the blind person in the use of the viewscope. The case is moulded to fit the hand. The cable sheath 20 is fixed to the case and the sliding steel focus wire 21 is fixed to the rocker 23 which moves on the axle 24 and has two key tabs 25 to be operated by the first and little finger. The parts of the control are simple and they should be made rugged and long-wearing inasmuch as the focusing mechanism is in almost continuous use. A single example is given here: a sapling only a foot in front of the scanner can be felt on the blind person's forehead; so can he feel a large tree trunk a hundred feet off. The way he can tell the distance and size of the object is by working the focus one way or the other to get the clearest felt and best defined (not strongest) touch-image; when out of focus the nearby sapling makes only a faint blur of feeling; in focus it gives a clearly felt band. From the position of his focus keys then, the blind man knows by experience whether the object is close or far off.

Referring particularly to the exploded diagram of FIG. 3, radiation from a scene, entering the aperture, falls upon the hollow cylindrical mirror-wheel 29 which is made of aluminum or of light-weight moulded plastic with a reflective plated surface. The protruding ribs 30 are polished bands of concave surface, that is to say concave mirrors which in the preferred form are sections of a sphere of sixteen centimeters radius of curvature, giving a point of real focus 8 centimeters from the reflective surface. These ribs or oblong strips of concave mirror are spaced around the periphery of the mirror-wheel so that their centers are in a circle concentric to, and in a plane which is at right angles to, the axis of the mirror-wheel, but with their principal axes tilted in equal steps, the first slightly downward from

the horizontal and the others increasingly so. In the preferred embodiment I use 15. This means that in a single scanning revolution of the mirror-wheel, any image of an object being reflected to a screen and swept across will be stepped perpendicularly one increment for the sweep of each particular mirror. At the end of each revolution a cycle of 15 steps will have been completed and will start over again.

For a wheel of set diameter and concave mirrors of a given focal length, obviously the more mirrors placed around the circumference the shorter the sweep or scanned line must be.

In the proper sense of the word there is actually no screen in the system of my invention, for although a full optical image is being projected by the concave mirrors and is being swept around through a certain length of arc, only a tiny fraction of its total area is being used at any given instant, and that is the fraction of its which passes over the radiation-detector cell in that instant.

The mirror-wheel has two wings moulded or fitted on its open top, 31 being a counter balance which may have some of its material cut away during an operation to balance it with the wing 32 which is modified to serve as a distributor of amplified electrical currents from the detector cell.

Holes 33 shown by the dotted lines hold spiral springs 34 which exert an aligning pressure on the back end of brush-block 35 and keep it sprung lightly in place. A pin 36 serves as an axle for the brush-block which must have a certain amount of swing from parallel alignment with the wing. This axle slips into grooves 37 which allow for easy insertion and removal of the brush-block with its brush 38 of silver alloy wires whose ends are embedded in its substance. When the instrument is in operation the mirror-wheel is revolving and as the distributor brush 38 sweeps continuously around the distributor ring 39 it delivers the amplified photoelectric currents to the wires 40 which lead away from the silver contacts 41. These distributor contacts are arranged in a circle with a part of that circle being shown here in its proper division of contacts, with three such divisions being shown as 42, 43 and 44. It should be understood that each division represents a scanned line of the picture being transmitted from the scanner to the proper line of touch-image components in the receiver on the forehead, and there are thus as many divisions in the circle of contacts as there are scanned lines to the picture. The first contact of a division represents the leading edge of the picture and the last contact represents the trailing edge. The width of the aperture is therefore electrically determined by these contacts.

The individual wires 40 which take off from the contacts are shown leading into groups as in 45, 46 and 47. These groups are gathered together in the short cable 48 which leads to the receiver. A fan 49 with blades 50 is used to propel air for ventilation and cooling of the receiver and is fixed, along with the mirror-wheel, to the shaft 51 of the electric motor 52 which (as may be seen in FIG. 4) is entirely contained within the hollow of the mirror-wheel. A contact 53 is sprung against the bottom end of the motor shaft and has the wire 54 connected to it for delivery of the amplified photoelectric currents through the shaft to the distributor brush 38, such currents being conveyed by the metal body of the

distributor wing 32 if it is a part of a metal-cast mirror-wheel. However if the mirror-wheel and its wings are of nonconducting plastic, then the currents must be conveyed by a metal wire or strip in contact with the shaft and the brush.

While the wings 31 and 32 of the mirror-wheel are shown in this drawing with flat sides on a plane with the axis of the motor shaft 51, it should be noted that in the preferred design they are given a tilt like the blades of a propeller, with only the distributor brush being kept parallel to the plane of the motor shaft. They are thus made to help in the movement of air through the system and on up towards the fan 49 which finally exhausts it.

While I have shown the distributor brush as revolving around the inside of the distributor ring I do not mean to have it limited to that position in my design; the contacts can be ranged around the top flat of the ring or on the outside periphery if desired.

Referring to FIG. 4 particularly, 1 is the scanner housing which includes the turreted part 3 over the scanning and distributing unit shown in the previous figure. The oblong aperture 4 is covered by a window 4a of thin glass or clear plastic. The flexible cable sheath 20 rises out of the floor of the housing and is supported and held by the moulded block 55. The sliding steel focus wire 21 is attached to the carriage 56 which travels in the slotted way 57, the latter being fixed to the floor of the housing and slanting down in a slight angle in the depression or well 58. Preferably the way is slanted parallel to the principal axis of the middle mirror in the circle of stepped-down axes.

Fixed to the carriage 57 is a cross-piece or mount 59 upon which the detector-capsule 60 is mounted. An enlarged view of the slotted way, carriage and detector-capsule mounting is shown alongside in FIG. 5 to be described later.

Electric currents appearing in the capsule are conveyed by the pair of wires 61 to the polarity reversal switch 12 mounted on the curving duct of the scanner housing with its knob or flip-button on the outside in a handy location for the use of the viewscope's user, so that he may easily switch his instrument from the impression of a positive touch-image on his forehead to a negative one for a possible better interpretation of the scene being viewed. If for instance there is a scene white a black snowmobile against a white background of snow, this makes what must be called a negative imprint on the skin which the blind person finds harder to interpret than a positive image in which only the snowmobile is being printed. From the polarity switch the pair of wires 62 runs to the transistor two stage amplifier 63 shown here in a conventional diagrammatic circuit for such, one side being grounded and the other side through the amplifier being conducted by the wire 54 through the control 13 to the distributor brush 38 (FIGS. 1 and 3).

Polarity reversal is a feature of great importance and in such constant use that it means of change-over is best located in the hand control 17, which can be accomplished by a switch with wiring running up to the scanner to a small magnetic throw-over or solenoid and plunger action. However, this has been omitted from the drawing to avoid complication.

Radiation coming through the aperture falls on the revolving concave mirrors 30, one of which is shown just inside the window 64, covered with curved glass 65, which has been cut in the housing 66. This housing, which contains the mirror-wheel, driving motor and distributor, serves also as the support for the distributor ring 39 and its many contacts which have their individual take-off wires 40 gathered together in groupings (FIG. 3) which in turn are gathered into the cable 48 leading to the forehead-worn receiver.

The housing and distributor ring-support 66 is mounted on a gasket 67 of sponge rubber or foamed plastic which has ports 68 cut or moulded in it to allow the passage of air drawn by the fan 49. A series of vents 69 cut on a line close to the forehead line permits the passage of air, for ventilation and cooling, up between the skin of the forehead and the inside face of the receiver. Flow of air is shown by arrows in the drawing, coming up out of the floor vents and moving through the system to enter the ports 68 from whence it is drawn up through the interior of the scanner-distributor unit to be delivered outside. The circular glass cover of the window 65 prevents movement of air through that way, so that all must be drawn through the ports.

A mercury switch or other type of tilting cut-off switch 70 is fixed to the scanner housing floor and connected in the line of the motor power supply 15 and 16 (FIG. 1 and FIG. 3) and so made that when the apparatus is tilted far down, as when the wearer rests with head on chest, the power will be cut off. The bridging switch 14 for this cut-off circuit is located with its flip button on the outside of the scanner housing for emergency use when the wearer must look downward at a sharp angle.

Referring particularly to FIG. 5, the focus wire 21 is attached to the carriage 56 which travels in the top-slotted carriage way 57, the latter being fixed to the housing floor and slanting down into the depression or well 58 with the slant preferably parallel to the principal axis of the middle one of the circle of concave mirrors. Erected on the carriage is a cross-piece or mount 59 upon which the detector-capsule 60 can slide the width of a cell to either side in order to convert from the one band of radiation reception to another. In the preferred form the cell 71 is a hybrid assembly photovoltaic cell of selenium-silicon which gives a special response over a very wide range from the near infrared into the ultraviolet and is built for a peak response in the green to resemble the human eye; it is not much larger than $\frac{1}{8}$ th inch wide. The other cell 72, such as now in use in infrared cameras, is of high sensitivity in the infrared region.

The mount 59 is of insulator material and fixed to or homogeneous with the carriage itself. The spring contacts 73 for the photocell 71 and the similar contacts 74 for the infrared detector 72 make electrical contact with the metal strips 75 on the mount and it will be seen that these conductive strips are of such restricted length and so placed that contact will be made for each cell only when it is in the central position. In the drawing the infrared cell is shown displaced to the right with its contacts off the conductive strip and resting in a location notch 76 cut in the insulation material. It can also be seen that the contacts of the centralized

photocell are bearing on the conductive strips and the cell is thus ready to transmit currents when radiation falls upon it.

While the style of capsule mount shown here will accommodate only two detector cells it is obvious that with a different design, for instance a wheel, a number of different detectors can be mounted around the rim to give a more selective choice of radiation reception.

It is also to be noted that in my system the position of the detector cell need not necessarily be as shown in FIG. 4, down near the floor of the scanner and below and bottom line of the aperture. If the cell being used is not too big it may in fact be mounted in the center of the aperture and provided with a small horn frame to give a certain amount of light-baffling effect. However the horn cannot be made of very great depth without too much interference with the brightness of the optical image. Not much light-baffling is needed however; to suppress the effect of extraneous light, the level of the system's operation can be adjusted by means of the control 13.

The alternative arrangement of a detector cell 71 in the center of the aperture is shown in FIG. 6 where it is fixed on the mount 59' which is attached to or part of the carriage 56, the carriage way 57 being fixed to a flat floor so that the focusing wire 21 will move the cell forward or backward horizontally. A light-baffle or horn 77 frames the cell to shield it from diffused and unwanted radiation.

Referring particularly to the diagram of FIG. 7, the silhouette is shown of a lake freighter being viewed. This will make an elongated horizontal touch-image on the forehead with the deckhouse and funnel producing a small hump of feeling on the elongated pattern. And it might be suitable to stress here that in the overall consideration of my invention it should never be forgotten that while the kind of touch-image this equipment gives is nothing much better than a very elementary pattern of things as they exist in the scene or in front of the blind person, and while there is inevitable distortion in one way or another at times, these things are of no particular consequence to the blind one whose sense of touch can never have anything like the discernment of the naturally seeing eye. If a gull, flying overhead, is felt on his forehead merely as a spot of circling and floating motion, he is happy enough with that. He knows it is something flying above; he notes the character of its flight; he hears the birds's cry and knows it; if it flies close enough he feels the extension and movement of its wings. Although it has only been a small moving blob of feeling on his forehead, he has "seen" the gull.

Note that as it falls on the photocell 71 the optical image is inverted and reversed as to right and left; as the photocell looks at it, however, things to the left in the real scene appear at the left of the inverted image and the same obviously for the right. So that the image will be felt on the forehead upright, this inversion is corrected in the wiring from distributor contacts to touch-image components, the wires crossing over to accomplish electrically the same kind of cross-over taking place with the rays reflected from any concave mirror or lense.

In the usual type of scanning device it is customary to hold the picture within a fixed frame and to have the scanning beam or element move across the picture a

line at a time. In my invention it is the frame with its picture which moves across the still photocell a line at a time. Let it be considered that the photocell is in the center of an imaginary screen upon which the rotating concave mirrors of the mirror-wheel cast their successively stepped-down image of the object being viewed. The start of the scanning process is shown by the frame (a) which the first mirror on the mirror-wheel sweeps across the imaginary screen to the position (b), during which first sweep the bottom line of the inverted image (the top line of the real scene) has passed over and been scanned by the photocell 71. The process is repeated by the second mirror for the second line down and so on until the whole scene has been gone over from top to bottom, making one complete scanning. Then the process will start over again. A frame (d) of the inverted image is shown in the diagram about half way through one complete scanning just as it nears the end of one sweep or scanned line. In other words, the trailing edge of the image is approaching the photocell and about to pass off, whereupon the leading edge of the image from the next mirror will approach in the next stepped-down position. The dotted line frame (c) represents the image on the imaginary screen at the beginning of the last line of scanning, and (e) is the position of the frame at the end of that line and at the end of one total scanning for the whole picture. In these drawings I show only the horizontal type of scanning, but it need not necessarily be that kind. If for various reasons it seems best to make it so, the scanning unit can be set at an angle in the headpiece if the line-up of the touch-image components in the forehead panel and the succession of contacts on the distributing ring are made to correspond with the diagonal lines as scanned across the frame.

With particular reference to FIG. 8, the flanged frame 8 is of thermoplastic material preliminarily moulded to the curve of an average forehead. This is a corner view looking through the frame. Perforated lugs 7 of which there are several, are for screws which hold the scanner in position atop the receiver. A flange 80 rims the frame all around that edge which goes against the forehead. A padding 81 of leather or other soft material is stuck on the flange and is continuous all along the top but broken into divisions along the sides and bottom as shown to permit entry of air for ventilation. It is this padding which spaces the touch-image components a slight distance away from the forehead surface so that the skin will be touched only by the tips of the solenoid plungers as they are protruded in the making up of a touch-image. For dark scene, where there is no radiation reaching the scanner, there is nothing at all in contact with the forehead surface other than the receiver frame.

Ribs 82 are moulded on the top side of the frame and are originally of even depth as shown by the dotted lines, excess material being cut away during the fitting of the instrument to the user's particular slant of forehead. It will be understood that the line of vision should extend in a level direction from the scanner with the head in normal position. The ribs are therefore moulded with sufficient depth to allow their being cut or ground into wedges of substantial angle.

A rabbeting runs around the inside edge of the frame making a ledge 83 for the touch-image component

panel described in the following FIG. 9. The support of the panel is made surer by the ribs 84 which are moulded around the inside. Holes 85 along the shoulder of the frame allow for passage of air from the receiver into the scanner (FIG. 4) where it is drawn by the fan 49 (FIG. 3) for exhaustion through the open turret.

In the particulars of FIG. 9 the touch-image component panel 86, of moulded thermoplastic, has an outside gold-plated metallic coating 87 which makes contact with the ground of the amplifier circuit in the scanner and serves as a ground for all the touch-image components in the receiver. Several hundred hollow open-top turrets 88, only nine of which are shown here, are bored part way down to a larger diameter as shown in the bottom left-hand turret and the two lower middle turrets of the drawing. This enlarging of the diameter allows for the seating of lugged contact collars 89 five of which are shown properly seated. The sixth collar shown, the middle one on the left, is shown just barely entered and still not seated down. The contact collars are of silver with a gold-plating for surer contact and to protect them from the tarnishing and corrosive effect of sweat. Their inside diameter is the same as the original diameter of the turret holes so that the total bore will be smooth. In the preferred design they are split collars which can be sprung into place to hold their positions snugly. The wires 40 from the distributor contacts are laid in the valleys between the turrets, from which channeling each one rises in its order to be soldered to the lug of its proper contact collar. In the preferred design these lugs extend downward a little distance, as seen in FIG. 10, so that the points of solder along with all the wires will be embedded in and protected by a layer of wax such as is customarily melted in to fix this kind of wiring.

The way in which a touch-image component is socketed in its turret and the way contact is made with the conducting surface of the contact collar and the outer plated surface of the panel are shown in FIG. 10 to be described later.

It is to be noted that this flat moulded panel 86 containing some several hundreds of turreted holes, is slightly flexible but of such material stiffness that at ordinary temperatures it will hold to whatever curvature has been set in it during a fitting of the head-piece to the one who is to wear it. Just as a dentist must make a form of the gums and roof of the mouth for the fitting of dentures to an individual, so must the viewscope supplier make a mould of the blind person's forehead. The procedure is simple enough: conventional technique is used to make a plaster cast of the forehead, the skin being laid over first with a suitable layer of pliable and lightly adhesive material the thickness of which corresponds with the space which must finally exist between the skin and the tips of the touch-image components when in the withdrawn position for dark scene. In this negative mould or matrix a positive moulding is cast, upon which the combined receiver frame 8, with the touch-image component panel 86 installed, is formed by gentle oven heat, the total surfaces of both flange and panel being pressed down against the mould.

After cooling, the padding 81 is attached to the frame flange. After the shaping, any deformation of the turreted holes in the panel is, for nearly all of them, so

slight that it can be ignored. For a few that may have been distorted so far out of round that the touch-image components cannot be accommodated and properly seated in them, a restoration to roundness is achieved by the insertion of a fine-cutting hand reamer and giving it a twist or two as necessary.

After it has been properly shaped and fitted to the subject's forehead, and with his head held in the normal upright position, the ribs 80 are carefully marked and ground or cut off to allow for a level position of the scanner when seated upon them.

FIG. 10 is a greater magnified breakaway view of a touch-image component 10 as it sits socketed in the receiver panel 86. A solenoid 90 of fine enamelled wire is wound on a moulded plastic spool 91. The one end 92 of the spool is larger than the other and is grooved 93 on the inside face and coated on the outside face with a gold-plated sheath 94 to which one wire of the solenoid is soldered at 95. The smaller flange of the spool has a metal washer or plating 96 to which the ground wire of the solenoid is connected 97.

The solenoid has a steel plunger 98 with a steel cup washer 99 riveted to the one end. A helical spring 100 maintains the plunger in what is to be called with withdrawn position when no current flows in the solenoid. In the drawing the plunger is shown with its forehead-touching tip protruding slightly from the end of the component.

I cannot stress too strongly the importance of correct characteristics for the helical spring 100. Indeed the whole difference between successful operation of the instrument and failure rests in the selection of the right springs for this delicate job. They must have a strong enough tension at full extension to keep the plunger in the fully withdrawn position and yet be delicate enough to permit the start of its movement under the slight first pull of the solenoid resulting from the appearance of faint light upon the photocell. At the point of spring compression where the plunger is touching the forehead skin and depressing it slightly, the spring's counter force must not have become great enough to offer too much counter action to the magnetic pull. As much care and precision must be exercised in the business of these touch-component springs as is used in the selection of springs for the manufacture of photographic lightmeters, or of electrical instruments such as a fine volt-ohm millimeter for instance.

The plastic sheath 101 which encloses the solenoid, plunger and spring, has a perforation through which a connection to the ground wire of the solenoid is brought and soldered at 102 to the split collar 103 of phosphor-bronze or other spring metal. This collar, which clips around the outside of plastic sheath 101, has two arms 104 bent over at their ends to serve as a stopper for the plunger on its return stroke. The two legs 105 are gold-plated and serve as spring contacts against the metallic ground plate 87 of the panel 86 in which the touch-image components are inserted. As the helical springs bear on the washers of plate 87 thus grounded, all plungers 98 are also grounded. This is a necessary feature if the mild electrical potential is to be placed on them for an enhancement of the feeling of the touch-image on the forehead as described and claimed in my Canadian Pat. No. 743,764.

The plastic outer sheath 101 is reduced in diameter for a part of its length to accommodate the split metal collar 103 and is made with two channels 106 for the metal arms and spring contact legs of the collar. As shown, the sheath is mortised in the aforementioned groove 93 on the inside face of the flange of spool 91.

It will be seen from FIG. 10 how, when the touch-image component is pushed through its particular turret hole in the panel during assembly, the spring contact legs 105 are pushed down into their channels in the sheath during entry, springing out at the finish to exert a drawing pressure which helps in the final seating of the touch-image component and insures a proper pressure of contact both at the ground plate 87 and at the contact collar 89.

The plastic sheath 101 is manufactured from moulded tubing and is left open at the end. At any time during a servicing of the viewscope, a touch-image component may easily be pushed out of the turret hole in which it is socketed, without the necessity of unsoldering any connecting wires. The plunger may easily be taken out by springing aside the two bent-over stopper arms 104, which operation is best done with a special tool to avoid excessive bending or crimping.

The outside diameter of cup washer 99 is sufficiently smaller than the inside diameter of the casing to allow free movement in the casing without contact. For while the cup washer acts as a piston and must force some air out from between it and the spool 91 on a power stroke, it is not meant to act as any kind of efficient pump. It is meant only as a damping device on the plunger to keep it from making a banging impact on the skin and to keep it from beating a tattoo upon the appearance of a pulse train of current in the solenoid, as happens in the process of scanning. With such a pulse train the damping effect described prevents extended movement between the pulses, although permitting a certain amount. The pulse effect is felt upon the skin but is prevented from becoming a tattoo.

These solenoids tend to heat up slightly during operation of the instrument and the piston helps in their cooling by the forcing of a slight amount of air through the hole between the loosely fitting plunger and the bore of the spool. In such tiny components the movement of the air in each one of them in this way may seem ridiculously small but in its total throughout the whole forehead panel it is significant. It should be remembered that the ventilating fan of the instrument produces a negative pressure in the space between the component panel and the forehead, and the cooling air entering the open end of a component and being forced down through the solenoid hole by the piston, is helped on its way by this negative draft.

Referring particularly to FIG. 11, the motor and mirror-wheel housing 66 which serves as a support for the distributor ring 39, is mounted on a foam rubber or plastic ring-gasket 67 by means of the screws 107 and the nuts 108 which latter are moulded into the gasket with Ty-ply or other molecular-adhesion cement. The gasket itself is held securely to the floor of the scanner housing 1 by means of its shoulder 109 which expands over the rim of the hole moulded in the floor. The bottom end of the gasket hole is sealed by a plug 110.

The electric motor 52, weighing between 1 and 2 ounces, is mounted on a circular stand formed in the

bottom of the motor and mirror-wheel housing and is fixed to it by the screws 111. Very little power is needed to spin the mirror-wheel and the distributor and fan; an even lighter motor can be used but is apt to give unevenness of revolution when the scanner is being used at very low speed. The mirror-wheel 29 is fixed to the motor shaft 51 by means of the set screw 112; the fan 49 is also attached to the motor shaft at the top end by the set screw 113, air being drawn from inside the scanner (FIG. 4) through the channels 68 in the ring-gasket and holes 114 in the motor and mirror-wheel housing, much of it passing up between the motor and the inside of the mirror-wheel, on through the open top of the mirror-wheel to be exhausted finally through the open turret 3.

The spring contact 53 bearing against the lower end of the motor shaft delivers the amplified photoelectric currents through the shaft and through the aluminum of the mirror-wheel to the brush 38 from whence they are distributed to the silver contacts 41 of the distributor ring. These latter contacts are of stamped silver sheet with a punched-out center pattern 115 of suitable locating shape. They are separated from one another in the ring by plates 116 of micanite or other insulating material, the latter being shaped with a short leg 117 and a long leg 118 each with a toe on the inside which can be sprung into the holding grooves 119 which circle the rim of the ring support. Each insulating plate has a boss of the same pattern as that punched in the contact plates so that in assembly the latter will be accurately located and held firmly in place. It should be noted that the micanite plates are slightly shorter in width than the silver contacts so that in the assembled ring the silver contact surfaces are slightly raised or projecting out from the insulating surface. Also, they are fixed in a raised position above the top surface of the distributor ring 39 so that no contact is made with it. This is not necessary if the housing and ring support 66 is a non-conducting plastic moulding as in the preferred embodiment; but if the housing is of aluminum or other metal, then the contact plates must be insulated, either by an air space or by a ring gasket of insulating material laid on top of the distributor ring support.

The wires 41 run, one from each silver contact plate, to be gathered finally in the cable which runs from scanner to forehead receiver. The interior of the scanner housing is lined with plastic foam or other sound-insulating material 120 and the top of the turret with its grille is removable to allow for lifting out the motor, mirror-wheel and fan assembly for cleaning and servicing. Such disassembly is easily accomplished by removing the plug 110, inserting a screwdriver and undoing the screws 111 which are all that hold this particular unit in place.

In FIG. 12 it is shown how the incoming radiation from a scene, entering the aperture 4 and being reflected from the concave mirrors 30 of the mirror-wheel 29, can be made to reflect again from a fixed plane mirror 121, being redirected by it at a backward angle to the radiation detector cell 71, thus saving forward extension of the scanner housing and so making it less protrusive on the wearer's head. If desired a plurality of fixed plane mirrors can be used to redirect the reflected radiation or image to any part or corner of the

housing where it may seem most convenient to have the detector cell placed. The single plane mirror 121 shown in this FIG. 12 restores the inverted image from the concave mirrors, returning it to the upright, so that if projected on a ground glass screen and observed from the backside (as the detector-cell sees the image being scanned across it) the scene is normal, upright and with things on the left showing left and things on the right showing right. Whatever inversions and per-
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From these descriptions it should be evident that the user of the viewscope has a large measure of control in the matter of how the touch-image, his substitute vision, is being addressed to the forehead for this or that scene. The scanning operation of the mirrors in his instrument results in something akin to the drawing or tracing of patterns on the forehead and he can speed this up or slow it down over a wide range as suits his ability to interpret the feeling. By means of the smoked glass filter and by regulating the degree of amplification of the photocell signal he can cause an intensely-lighted scene to feel softer on his forehead, and can even dampen out detail that is useless or confusing in his attempt to interpret the touch-image. In the same way, for a weakly-lighted scene, he can increase the degree of amplification and so intensify the feeling.

In the preferred embodiment of my invention the tactile receiver is located over the skin of the forehead but, as in the case of a blind person with a scarred and insensitive forehead or perhaps an individual plagued by headache, the receiver can be placed over some other skin area such as the chest, the nape of the neck or back.

While admirably suited for a viewscope for blind use, the simple concave mirror scanner I have shown can also be put to very different use with other kinds of receivers such as, for instance, a printer in which the solenoid plungers make dots on paper instead of impressing an image on the skin, or an advertising electric sign-board in which the electric bulbs are caused to light up and to fluctuate in accordance with the radiation falling on the detector cell of the scanner.

The embodiments of my invention on which I claim an exclusive property or privilege are defined as follows:

1. Scene analysis apparatus for establishing tactile sensory perception by a surface of the human body, comprising,

a housing adapted to be carried upon the head,
 an aperture in said housing giving access for light rays to a space within said housing,

a rotating scanning member having a plurality of reflective focusing devices disposed about the periphery of said member, said devices comprising surfaces of a body of revolution having their generating axes equiangularly spaced about said rotational axis and intersecting said axis and being inclined thereto at progressively different angles,

means to rotate said member about a normally upright axis in said housing at an adjustable rate,

a light receptor disposed in the focal range of said focusing devices for receiving light values from scene coordinates in predetermined sequence,

amplifier means responsive to said light receptor signals,

a plurality of tactile sensory transducer elements corresponding in number to said scene coordinates and adapted for wear against said body surface for skin tactile sense response to said transducers, and,

means to actuate said transducer elements in correspondance with the predetermined sequence in which the scene coordinates are scanned, comprising distributor means connected to said amplifier.

2. Apparatus as claimed in claim 1 wherein said focusing devices comprise like concave mirrors and wherein the points of intersection of said generating axes with respective focusing surfaces lie in plane normal to said rotational axis.

3. Apparatus as claimed in claim 2 wherein said apparatus comprises head gear adapted to be worn as a crown with the rotational axis in the upright position when the head is in normally erect attitude, and said aperture opens forwardly ahead of the user when being worn.

4. Apparatus as claimed in claim 3 wherein said transducers are arranged for effecting tactile response over the forehead and temple areas of the head.

5. Apparatus as claimed in claim 3 wherein the lateral arc subtended by the scene at said rotational axis within the aperture limits corresponds approximately with the lateral arc subtended at said rotational axis when extended with respect to the array of transducer elements.

6. Apparatus as claimed in claim 2 wherein the light receptor is carried to one side of said plane, and said apparatus includes positioning means for selectively moving said receptor through the range of focal positions corresponding to near and distant object images, and said positioning means includes range estimation means arranged for tactile interpretation.

7. Apparatus as claimed in claim 4 wherein said head gear includes a pad having apertures, transducer elements retractably insertably received in said apertures, and said means to actuate said elements comprises distributor means carried by said scanning member effective to sequentially connect said elements with said amplifier means.

8. Apparatus as claimed in claim 7 wherein said transducer elements comprise moving plunger means reciprocable along respective aperture axes, biasing means displacing said plunger means into withdrawn position when said amplifier output is not connected to said element and electromagnetic means effective to actuate said plunger means to extended tactile stimulating position when said amplifier output is connected thereto.

9. Apparatus for use by a sight-impaired person for establishing image discrimination of objects in a scene having a predetermined directional relationship to the person, comprising,

a support structure adapted to be carried in fitted relation to the body, said structure including a housing,

an aperture in said housing opening in said predetermined direction and defining the margins of said scene,

rotating scan means in said housing adapted to scan the scene in transverse strips, comprising a plurali-

ty of angularly-related mirrors each having a point focus disposed for rotation about an axis of revolution oriented at right angles to said predetermined direction,

means to rotate said scan means at an adjustable rotational speed,

Light receptor means adjustably located in the focal range of said mirrors for receiving elemental image areas swept over said receptor means, said receptor having amplifying means selectably controllable to provide an output related to light input,

a multiplicity of electrically-actuateable tactile-response transducer elements arrayed as ranks and files and distributed over a generally-rectangular sensitive skin area of the body, said transducer elements having individual contact means disposed in fixed sectoral relation in said housing about said axis, and,

distributor means carried by said rotating scan means effective to apply said amplified outputs to respective tactile transducers in correlation with the imaging of the corresponding elemental scene areas at said receptor by way of said contact means.

10. The apparatus of claim 9 wherein the direction is forward and near the horizontal plane, and said axis of rotation is upright.

11. The apparatus claimed in claim 10 wherein said support structure is head band including extensions adapted to carry said array of tactile transducers arranged over the forehead and temple area, and said rotational axis is generally centered in the head.

12. The apparatus of claim 11 wherein said rotating scan means comprises an array of integral concave mirrors formed as depressions in a cylindrical shell body, and said distributor means comprises a conducting brush arranged to make connection in turn with said individual contact means.

13. The apparatus of claim 12 wherein said means to rotate said scan means comprises an electric motor mounted on said support structure within said housing, and further comprises rheostat means for varying the motor current to vary the speed of rotation.

14. The apparatus of claim 9 wherein the amplifying means provides alternative dark-response and light-response output signals when said receptor is illuminated.

15. Apparatus for use by a sight-impaired person to establish touch-image personal orientation with respect to objects throughout a zone having predetermined lateral angular span and a predetermined vertical angular span including a foreground, comprising the combination of:

a head support structure;

a multiplicity of tactile response transducer elements distributed in rank and file pattern over the forehead area and having a lateral extent equivalent to the said predetermined lateral angular span with respect to an upright axis in the head of the person; an aperture in said support structure opening forwardly of said axis and having a generally rectangular outline and subtending at said axis a scene having a corresponding lateral angular span;

a light receptor within said structure;

moving imaging means adapted for sequentially exciting said receptor with light received through said aperture from successive elemental areas of said scene and reflected by said moving imaging means;

and means effective to selectably energize corresponding tactile response transducer elements according to the relative light intensity detected, whereby to provide a rank by rank touch response stimulus of corresponding elements of the forehead area, in representation of a righted camera obscura image of the scene.

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