United States Patent

[11] 3,573,813

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[45] Patented **Apr. 6, 1971**

[73] Assignee **Tektronix, Inc. Beaverton, Oreg.**

[54] **LIGHT IMAGE DISPLAY APPARATUS INCLUDING SELECTIVELY ILLUMINATED LIGHT PIPING ELEMENTS**
15 Claims, 8 Drawing Figs.

[52] **U.S. Cl.** **340/380,** 340/324, 178/30
[51] **Int. Cl.** **H04l 23/00,** H04l 3/00
[50] **Field of Search** 340/380, 324.1; 178/30

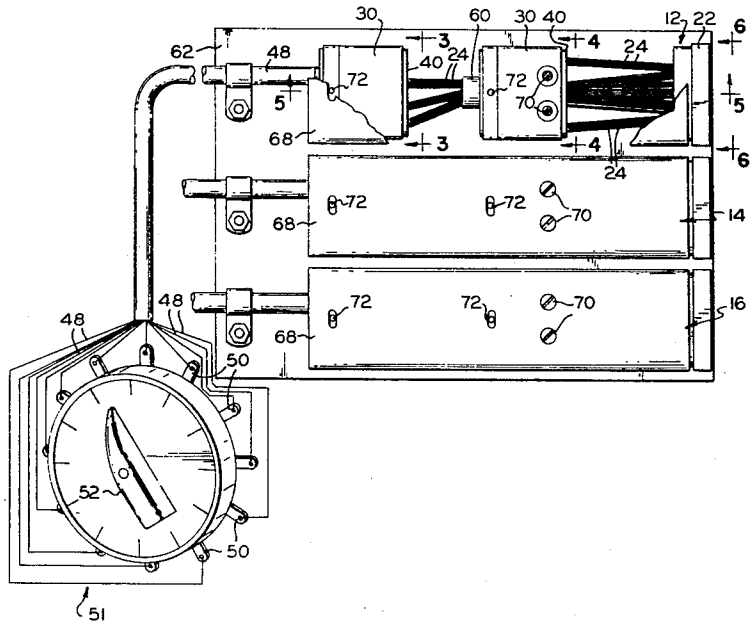
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Primary Examiner—Harold I. Pitts
Attorney—Buckhorn, Blore, Klarquist and Sparkman

ABSTRACT: A light image display apparatus is described in which a plurality of light transmission elements are employed together with means for selectively applying light to the input ends of such elements in order to form a light image display by the illuminated output ends of such elements and to successively produce different images in the same display area by illuminating different combinations of elements. The light transmission elements may be flexible fibers of plastic or glass which are arranged in optically noncoherent bundles with the input ends of all elements in a bundle being irradiated simultaneously by the same light source and with the output ends of such elements being supported in different relative positions and spaced over a greater area than the input ends. The display apparatus may be used as a switch position readout for the switches on a cathode-ray oscilloscope controlling its vertical amplifier gain and horizontal sweep rate by turning light bulbs on and off with such switches to selectively illuminate the light transmission elements and thereby produce light image displays of the switch positions. The switch position readout displays are positioned adjacent the faceplate of the cathode-ray tube employed in such oscilloscope, so that they may be viewed or photographed simultaneously with the electrical signal waveform produced on such tube to indicate the horizontal and vertical scale units of such waveform.



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SHEET 1 OF 2

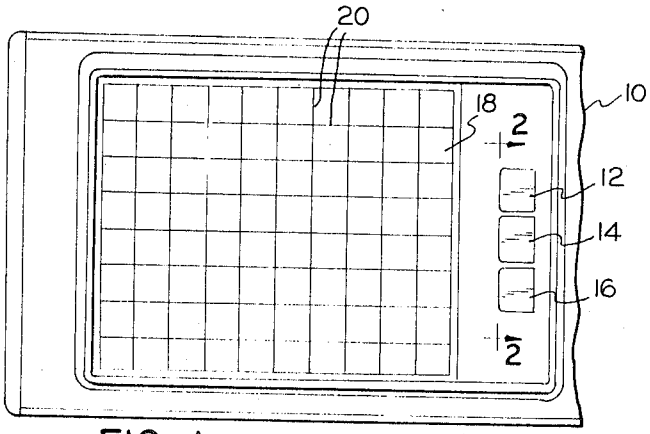


FIG. 1

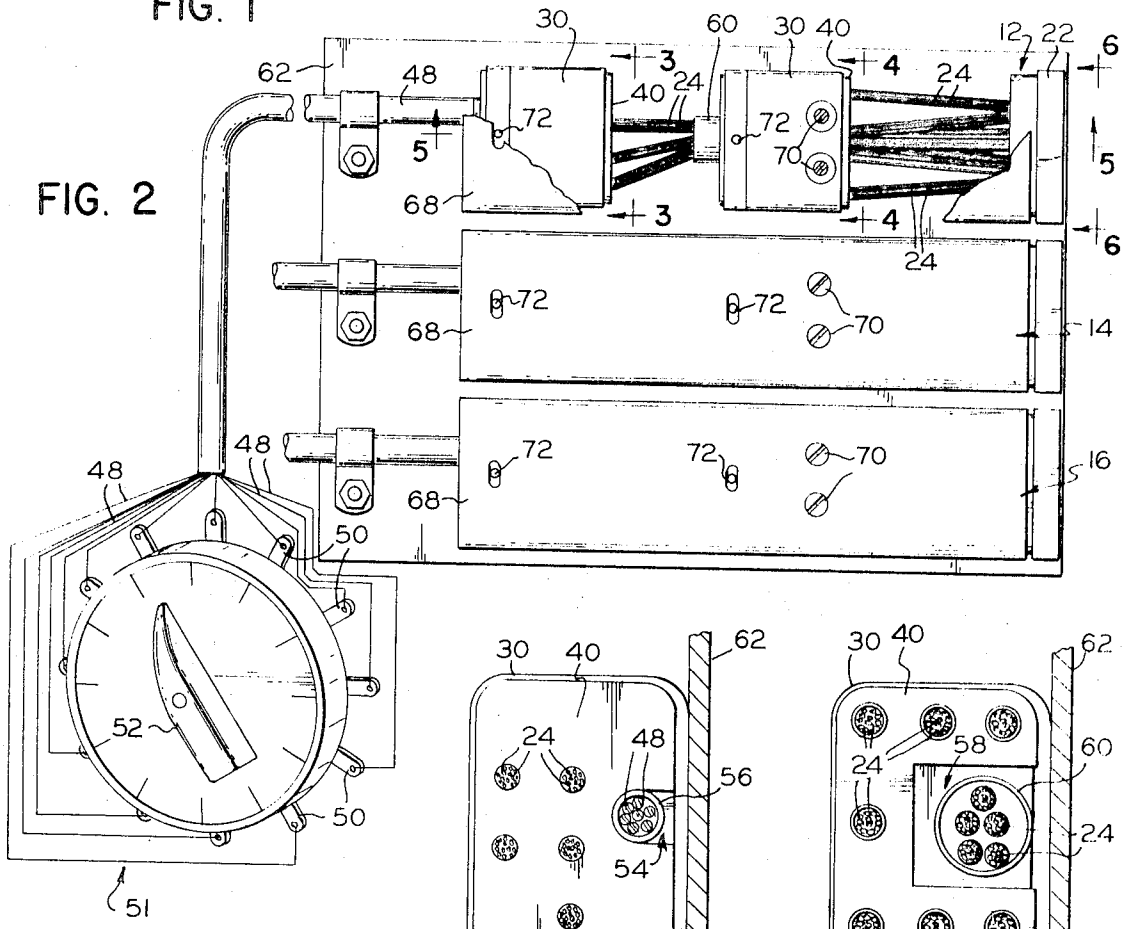


FIG. 2

FIG. 3

FIG. 4

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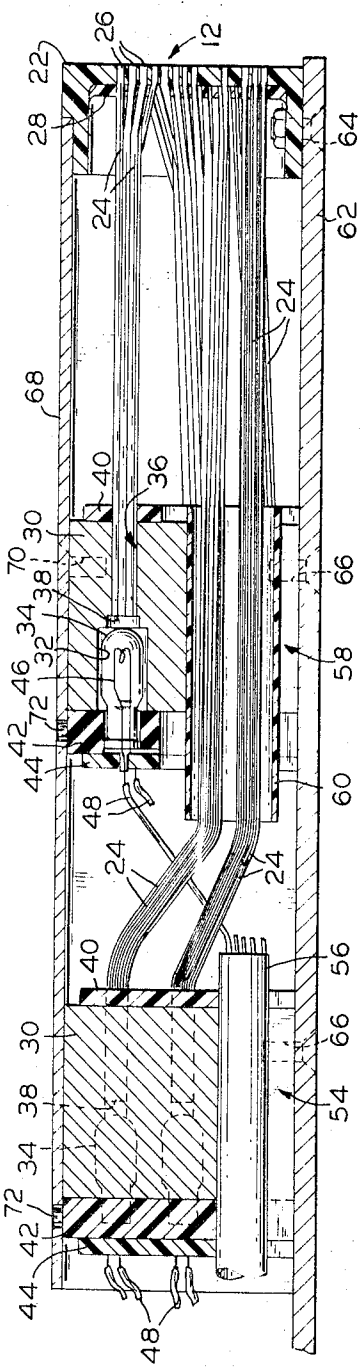


FIG. 5

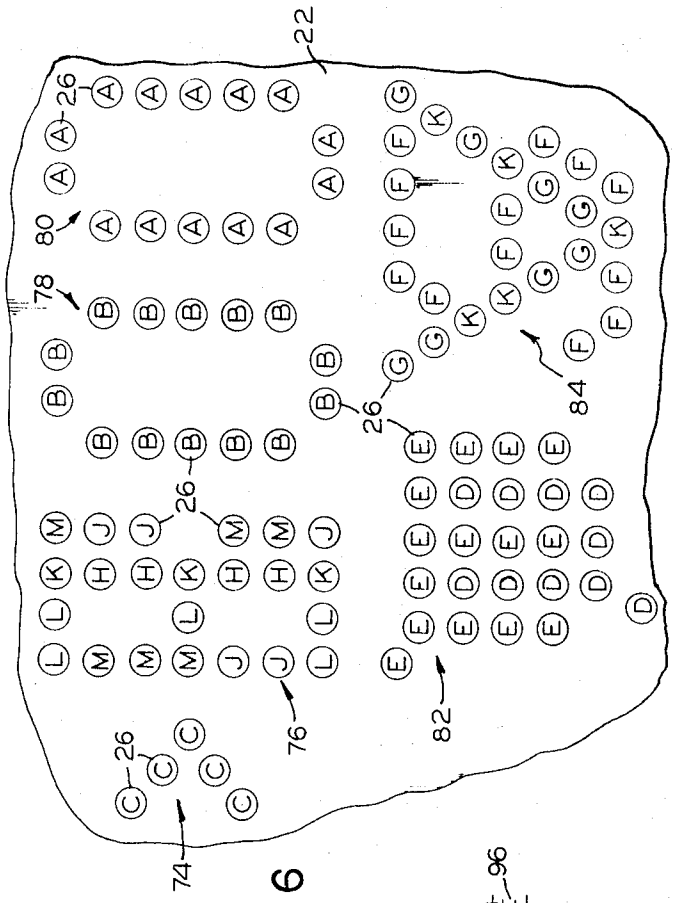


FIG. 6

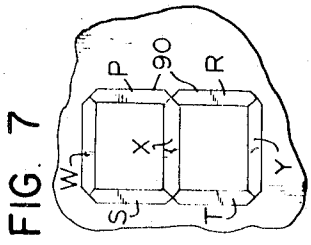


FIG. 7

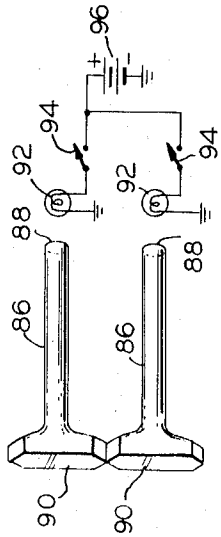


FIG. 8

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LIGHT IMAGE DISPLAY APPARATUS INCLUDING SELECTIVELY ILLUMINATED LIGHT PIPING ELEMENTS

BACKGROUND OF THE INVENTION

The subject matter of the present invention relates generally to light image display apparatus in which the display image is formed by the illuminated output ends of light transmission elements, and in particular to a display apparatus which includes control means for selectively illuminating such elements so that a plurality of different light images are formed successively in the same display area by different combinations of illuminated elements.

The display apparatus of the present invention differs from that of conventional light image display apparatus which are either of the image transmission type in which coherent bundles of fiber optic elements are employed to transmit light images from the input end to the output end thereof, or the display illumination type in which light pipes are employed merely to transmit light from a source to a separate display member to illuminate such display member. In neither of these conventional apparatus is the light image display formed by the selectively illuminated output ends of the light pipes in the manner of the present invention.

The light image display apparatus of the present invention is especially useful as a switch position readout device to indicate the position of a movable contact of the switch. Thus several of the present display apparatus may be mounted in a position remote from the switch, such as adjacent the faceplate of a cathode-ray tube in a cathode-ray oscilloscope and used to indicate the position of the switches controlling the horizontal sweep rate and vertical amplifier gain of such oscilloscope. This enables the light image display of the switch position readout to be viewed or photographed simultaneously with the electrical signal waveform produced on the phosphor screen of the cathode-ray tube, such display indicating the units of the horizontal and vertical scales of such waveform to enable faster and easier interpretation of the waveform characteristics. Thus the switch position readout display eliminates any possible error in reading the switch settings on their dials or in interpreting a photograph of the waveform at a later time when the horizontal and vertical scale units do not appear in the photograph.

The light image display apparatus of the present invention has several advantages over the above-mentioned prior art apparatus. Thus the present apparatus provides an extremely compact display which occupies very little space on the front panel of the oscilloscope. In addition, it employs light transmission elements which need not be in the form of coherent fiber optic bundles, since such elements do not transmit images, but merely form images by their illuminated output ends. As a result of using noncoherent fiber optics the present display apparatus is less expensive to manufacture. A further advantage of the present invention is that it is of uncomplicated structure but is extremely versatile since it is capable of producing a plurality of different light images successively in the same display area by selectively illuminating different combinations of light transmission elements at least some of which form parts of several different images. The decoder display apparatus described in U.S. Pat. No. 3,109,065 of J. T. McNaney is somewhat similar in operation to the present display apparatus but is of a much more complicated and expensive construction. Thus such decoder employs 64 input matrixes of light conducting elements which are interconnected with the light conductive elements of a single output matrix so that each output element has 64 input elements connected thereto. In spite of its large size and complicated construction this decoder is only capable of producing one character at a time.

It is therefore one object of the present invention to provide an improved light image display apparatus which is simple, inexpensive and is capable of producing a plurality of different light images.

Another object of the present invention is to provide an improved light image display apparatus which is compact and versatile, that employs a plurality of light transmission elements and means for selectively illuminating the output ends of such elements to produce different light images successively in the same display area.

Still another object of the invention is to provide a light image display apparatus which forms light images without the use of coherent fiber optics.

A further object of the present invention is to provide a light image display apparatus which can be employed as a switch position readout device.

An additional object of the present invention is to provide a light image display apparatus which may be employed in a cathode-ray oscilloscope as a switch position readout adjacent the faceplate of a cathode-ray tube to indicate the settings of its vertical gain switch and horizontal sweep rate switch so that the waveform produced on such tube and the switch position readout display may both be simultaneously viewed or photographed, thereby reducing errors in interpretation of the waveform's characteristics.

BRIEF DESCRIPTION OF DRAWINGS

Other objects and advantages of the present invention will be apparent from the following detailed description of certain preferred embodiments thereof and from the attached drawings of which:

FIG. **1** is an elevation view of a portion of the front of a cathode-ray oscilloscope employing three of the light image display apparatus of the present invention as switch position readout devices;

FIG. **2** is a vertical section view taken along the line **2–2** of FIG. **1**, showing one of the display apparatus, and schematically showing the electrical switch connected thereto with parts broken away for clarity;

FIG. **3** is a vertical section view taken along the line **3–3** of FIG. **2**;

FIG. **4** is a vertical section view taken along the line **4–4** of FIG. **2**;

FIG. **5** is a horizontal section view taken along the line **5–5** of FIG. **2**;

FIG. **6** is an enlarged elevation view of the front of one of the display apparatus of the present invention taken along the line **6–6** of FIG. **2**;

FIG. **7** is an elevation view of the front of another embodiment of the display apparatus of the present invention; and

FIG. **8** is a perspective side view of the apparatus of FIG. **7** schematically showing part of the light source control circuit associated therewith.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

As shown in FIG. **1**, a cathode-ray oscilloscope **10** may be provided with three of the present light image display apparatus **12**, **14** and **16**, mounted on the front panel of the oscilloscope adjacent the faceplate **18** of a cathode-ray tube in such oscilloscope. A conventional graticule scale **20** formed by a plurality of intersecting horizontal and vertical lines is provided on the interior surface of the faceplate **18** or on a separate external member over such faceplate. The divisions of the graticule scale **20** indicate the horizontal and vertical dimensions of any electrical signal waveform produced on the phosphor screen which is supported on the inner surface of the faceplate **18**. At least two of the display apparatus **12**, **14** and **16** are employed as switch position readout devices, respectively, for the vertical amplifier gain switch and the horizontal sweep rate switch of the oscilloscope. These display apparatus produce light image displays of the positions of the above-mentioned switches which control the vertical and the horizontal circuits that cause deflection of the electron beam within the cathode-ray tube to form the signal waveform in a conventional manner. Thus the switch position readout dis-

play produced by the display apparatus **12** can indicate the units of the horizontal axis of the graticule scale **20**, for example, in seconds per division, while display apparatus **14** indicates the units of the vertical axis of such graticule scale, for example, in volts per division. The third display apparatus **16** may be employed to convey other information regarding the waveform display, or in the case of a dual trace oscilloscope it may indicate the position of a second vertical amplifier gain switch controlling the formation of a second waveform.

As shown in FIGS. **2** to **5**, each of the display apparatus **12**, **14** and **16** include a display member **22** at its front end and a plurality of light transmission elements or "light pipes" **24** of light transparent material which extend through openings in the display member so that their output ends **26** terminate at the front surface of such member. The display member **24** is made of a light opaque material and the light transmission elements are fixedly secured to such display member by a "glue" layer **28** of any suitable light opaque material such as epoxy resin, to prevent light coupling between such elements.

The light transmission elements **24** may be in the form of cylindrical fibers of flexible light transparent glass or plastic material which may be coated with material having a high index of refraction. For example, the elements **24** may be made of a clear styrene plastic fiber having an acrylic plastic outer coating, and the display member **22** may be made of a black resin plastic to increase contrast between the light image display and its background.

Each display apparatus includes a pair of support blocks **30** made of light opaque material, such as aluminum, supported in alignment with the display member **22** with one of such blocks positioned between the display member and the other block. Each of the support blocks is provided with a plurality of cavities **32** in its rear surface and within each cavity a light bulb **34** is mounted. A passageway **36** extends from the front surface of such block to an opening in the bottom of each cavity **32**. The input ends **38** of the light transmission elements **24** are mounted within the passageway **36** so that light emitted from light bulbs **34** is applied to such input ends. The light transmission elements **24** may be arranged in bundles of elements and the bundles inserted in passageways **36** so that all of the input ends of the elements in each bundle are simultaneously illuminated by the same light bulb. In FIG. **6**, all of the output ends **26** of the light transmission elements in the same bundle have been indicated by the same letter for purposes of clarity.

A pair of opaque plastic guide plates **40** having holes drilled therethrough for different ones of the bundles of light transmission elements **24** are employed to hold such elements after they are separated into the proper bundles. The guide plates are fastened to the front of the two support blocks **30** by screws or snap-on tabs projecting from such guide plates into holes in the fronts of the support blocks. A pair of light bulb mounting plates **42** of opaque plastic material are provided, each having openings therethrough in which the bases of the light bulbs **34** are mounted. The mounting plates **42** are attached to the rear surfaces of both support blocks **30** by screws or snap tabs in a similar manner to guide plates **40**. A pair of printed circuit boards **44** are attached to the rear of the mounting plates **42** and are provided with a pair of holes adjacent each light bulb to enable the two leads of an incandescent filament **46** of such bulb to be soldered thereto.

As shown in FIG. **2**, a plurality of electrical leads **48** are connected between the printed circuit board and the stationary contacts **50** on one switch wafer of a rotary switch **51** whose movable contract is rotated by a knob **52**. The switch **51** may be the vertical amplifier gain switch or the horizontal sweep rate switch of the oscilloscope, and has other wafers (not shown) with stationary contacts corresponding to contacts **50** that control one of the deflection circuits of such oscilloscope. Thus the light bulbs **34** are turned on and off by rotation of the switch knob to selectively illuminate the output ends of the light piper **24** and produce a display indicating the position of the movable contacts in the switch.

As shown in FIG. **3**, the rear support block **30** and its associated guide plate **40**, printed circuit board **44** and mounted plate **42** are all provided with U-shaped apertures **54** through which extend the lead wires **48** attached to the printed circuit board **44** of the front support block, such lead wires being surrounded by a plastic insulating sleeve **56**. Similarly FIG. **4** shows a larger rectangular aperture **58** provided through the front support block **30** and its associated guide plate, mounting plate, and printed circuit board to enable the bundles of light transmission elements for the rear support block to pass therethrough, such light elements being surrounded by a protective sleeve **60** of plastic material.

The display member **22** and two support blocks **30** are attached to a mounting plate **62** by bolts **64** and screws **66**, respectively, as shown in FIG. **5**. A light opaque cover **68** of aluminum is provided over the top and sides of these members to form therewith a light-tight housing for the light transmission elements **24**. The cover **68** is fastened to the front support block **30** by screws **70**, and tabs **72** projecting from the top of both mounting plates **42** which extend through holes in the housing for alignment purposes.

The switch position readout display on the front of the display member **22** of the display apparatus **12** connected to the horizontal sweep rate switch, is shown in FIG. **6**. The display has six character display areas which are, beginning in the upper left-hand corner, (1) >, (2) 1,2 or 5, (3) 0, (4) 0, (5) *m* or μ and (6) V or S. Thus the first character display **74** in the shape of >, the symbol meaning "greater than," is formed by the output ends **26** of five light transmission elements **24**, which have the same reference letter C indicating they are all from the same bundle and all illuminated by the same light bulb. The second character display **76** is capable of producing the light images of a 1, a 2, or a 5, depending on which combination of the elements **24** in bundles H,J,K,L,M is illuminated, so that a plurality of different characters may be formed successively on the same display area. A light image of the character 1 is produced when the K and H light transmission elements are illuminated. A light image of the character 1 is produced when the L, K and J elements are illuminated. A light image character 5 is produced when the K, L, M elements are illuminated. It should be noted that in the second character display **76**, the K and L elements are common to at least two different characters and the K elements are common to all three characters. Thus some light pipes form parts of several different characters in the present display apparatus.

The third character display **78**, and the fourth character display **80** are both only of the character 0. However, a fifth character display **82** is capable of producing light images of the characters *m* or μ which respectively stand for "milli" and "micro." Thus when the elements E are illuminated, the character μ is displayed. A sixth character display area **84** is provided for displaying the characters S or V, which respectively stand for Seconds and Volts. Thus when the elements K and F are illuminated, the character S is displayed, while when the elements G and K are illuminated the character V is displayed. In the sixth character display **84** the elements K are common to two different characters. Also it should be noted that the K elements are present both in the second display **76** and the sixth display **84**, even though the K elements are all in the same bundle which is illuminated by a single light bulb.

Another embodiment of the display apparatus of the present invention is shown in FIGS. **7** and **8**, which may be employed to produce a light image of all 10 digits from 0 to 9 by selectively illuminating different combinations of seven light transmission elements **86**, each having an input end **88** and an output end **90**. The light transmission elements **86** forming the parts of the character display can each be in the form of a bundle of light pipes or fibers, as in the embodiment of FIG. **5**, or they may be formed of a single light guide member. The output end **90** is molded into an elongated substantially rectangular shape, which may be larger and of a different shape than its input end **88**, which, in most cases, would be circular. Thus the output ends **90** may be molded on one end of cylindrical members of light transparent glass or plastic material.

The light guides **86** may be selectively illuminated by turning on light bulbs **92** positioned adjacent their input ends **88** by closing switches **94** connecting the filaments of such light bulbs to a battery **96** or other source of electrical current in a similar manner to the embodiment of FIGS. **2** to **6**. However, it is also possible to employ a single light source, together with a movable mask or shutter mechanism which selectively transmits light from such source to the input ends **88** of the light guide members. One such mask could be in the form of a rotary mask plate of light opaque material provided with 10 radial rows of apertures which rotates with the switch shaft to selectively illuminate the output ends **90**. Thus the input ends **88** of the elements **86** are each aligned with one aperture in each row, except in those switch positions in which the element is not to be illuminated.

The operation of the display apparatus of FIG. **7** is as follows to produce light images of all the 10 numbers 0 to 9. To form a 1, light guides P and R are illuminated. To form a 2, light guides W, P, X, T and Y are illuminated. To form a 3, light guides W, P, X, R and Y are illuminated. To form a 4, light guides S, X, P and R are illuminated. To form a 5, light guides W, S, X, R and Y are illuminated. To form a 6, light guides W, S, T, Y, R, and X are illuminated. To form a 7, light guides W, P and R are illuminated. To form an 8, all of the guides are illuminated. To form a 9, guides W, P, X, S and R are illuminated. To form an 0, guides W, P, R, Y, T and S are illuminated. Thus 10 different characters are formed in the same display area by selectively illuminating different combinations of seven different light guides **86**, the output ends of which each form parts of several different characters.

It should be noted that while the light bulbs are shown operated by mechanical switches, they may also be operated by electronic switches such as transistors, to enable the display apparatus of FIGS. **7** and **8** to be employed as the readout of an electrical pulse counter. To further increase the speed of operation of the display other light sources which have a faster response time, such as light emitting diodes can be employed in place of the incandescent lamps. In addition, while the switch position display apparatus of the present invention has been shown mounted in a position remote from the switch, because of its miniature size, such display apparatus may be mounted directly on the center portion of the knob controlling such switch. This is especially useful when the invention is employed to indicate the scale units of an electronic counter, voltmeter, ammeter, portable television receiver or other small electronic instrument.

It will be obvious to those having ordinary skill in the art that many changes may be made in the above-described preferred embodiments of the present invention without departing from the spirit of the invention. Therefore the scope of the present invention should only be determined by the following claims.

We claim:

1. A light image display apparatus, comprising:

a plurality of light transmission elements having input ends and output ends, said elements being optically separated so that light is not transmitted from one element to another element;

support means for supporting the light transmission elements so that the output ends of elements are positioned in display groups with the output end of each element forming part of at least one image display and with at least some output ends each forming parts of a plurality of different characters in the same one display area, and for supporting the input ends of said elements in different relative positions than their output ends; and

control means for selectively applying light to the input ends of said elements in order to illuminate the output ends of the selected elements and cause said illuminated output ends to produce a light image display, and for changing the light image display by illuminating different ones of said elements, said control means producing the light images of said different characters successively in said one display area by selectively illuminating different combinations of said output ends.

2. A display apparatus in accordance with claim **1** in which the light transmission elements are made of a flexible light transparent material and have the same number of input ends and output ends.

3. A display apparatus in accordance with claim **1** in which the control means couples the input ends of several light transmission elements in a display group to a single light source.

4. A display apparatus in accordance with claim **3** which also includes a switch means for changing the connections in an electrical circuit, and said control means includes a plurality of light bulbs which are electrically energized when the control means is operated by movement of said switch means to produce a different illuminated character display for each switch position which indicates the position of said switch.

5. A display apparatus in accordance with claim **2** in which the light transmission elements are in the form of a plurality of separate bundles of said elements with the output ends of the elements of each bundle together forming a single part in several different characters and all of the input ends of the elements of a bundle being simultaneously irradiated with light from the same light source in one position of the control means.

6. A display apparatus in accordance with claim **1** in which the light transmission elements are in the form of single individual light guides each of which has an output end in the shape of a single part in several different characters, and the input ends of the light guides are each irradiated with light by the control means in a separately controllable manner.

7. A display apparatus in accordance with claim **5** in which said elements are fibers of uniform cross section along their length so that the input end and the output end of each element are both of the same size and shape.

8. A display apparatus in accordance with claim **6** in which the light guides are of nonuniform cross section along their length and have output ends which are larger and of a different shape than their input ends.

9. A display apparatus in accordance with claim **1** in which the support means includes a display member of light opaque material having a plurality of separate holes extending therethrough from the back to the front of said display member, and the light transmitting elements are mounted within said holes with their output ends terminating adjacent the front surface of said display member so that the illuminated ones of said output ends form the display.

10. A display apparatus in accordance with claim **9** in which the control means includes a plurality of light bulbs mounted within cavities provided in one side of a support block of light opaque material and switch means connected to said light bulbs for selectively switching them on and off, and the input ends of the light transmitting elements are mounted within passageways extending from the opposite side of said support block to openings in the bottom of said cavities so that said input ends are irradiated by light emitted from said bulbs.

11. A display apparatus in accordance with claim **10** in which the electrical leads of the light bulbs are attached to a circuit board secured to said one side of said support block.

12. A display apparatus in accordance with claim **11** which includes at least a pair of support blocks with associated light transmission elements, light bulbs and circuit boards, one of said pair of support blocks being positioned between the display member and the other support block, and said one support block being provided with an aperture through which extend the light transmitting elements of the other support block.

13. A display apparatus in accordance with claim **4** in which the output ends of the light transmission elements are supported adjacent the face plate of a cathode-ray tube in a cathode-ray oscilloscope which is controlled by said switch means.

14. A display device in accordance with claim **13** in which the switch means changes the connections of a deflection circuit which controls the deflection of the electron beam of said tube to vary the scale of the image produced on the phosphor screen of such tube and the display device produces a light image of a character display indicating said scale.

15. A display apparatus in accordance with claim 14 in which the switch means includes at least two switches connected to the horizontal deflection circuit and the vertical deflection circuit of said oscilloscope, and each switch is connected to a similar display device which provides switch position readouts for such switches by forming two separate illuminated character displays.

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,573,813 Dated April 6, 1971

Inventor(s) ANDREW R. BRUNS, PETER J. UNGER & ROBERT L. ROSSI

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Cover page [72] "Andrew R. Burns" should be --Andrew R. Bi
"Robert J. Rossman" should be --Robert L.
man--;

Column 3, line 16, "24" should be --22--;

Column 3, line 23, "high" should be --low--;

Column 3, line 51, "are" should be --may be--;

Column 3, line 67, "contract" should be --contact--;

Column 3, line 74, "piper" should be pipes--;

Column 4, line 1, "Fig. 3" should be --Figs. 3 and 5--;

Column 4, line 2, "mounted"should be --mounting--;

Column 4, line 6, after "sleeve 56" should be --which,
however, may be omitted--;

Column 4, line 38, "A light image of the character 1"
should be --A light image of the character 2--;

Column 4, between lines 51 and 52 insert --character "m"
is displayed, while when elements D are illuminated, the--

Column 5, line 60, after "output ends of" insert --said--

Signed and sealed this 19th day of October 1971.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Acting Commissioner of P