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[54] **SIGNAL LIGHT-PHOTO SENSITIVE PROBE CONTROL SYSTEM**

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[73] Assignee: **Marathon Oil Company**, Findley, Ohio

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[52] U.S. Cl. **340/147 R, 307/117, 250/213**

[51] Int. Cl. **H04q 9/00**

[58] Field of Search **340/163, 324 A, 225, 147 R; 250/213 A, 217 SS, 211, 215; 307/117**

[56] **References Cited**

UNITED STATES PATENTS

3,686,505	8/1972	DePasquale	250/215 X
3,760,373	9/1973	Bartz	250/213 A

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[57] **ABSTRACT**

Light sources, e.g., light emitting diodes (LED) are located on a control panel, e.g., a graphic control panel, so that each light source represents a remote element and indicates whether the element is on or off or in one position or another. The LEDs are pulsed in sequence and sensed with a photo cell pen to actuate the remote element represented by the LED which is sensed by the pen. The pulsing is accomplished by a sweep-type activating (or deactivating) circuit and the time measured from the beginning of each sweep at which each LED is energized (or de-energized) identifies the particular LED.

10 Claims, 5 Drawing Figures

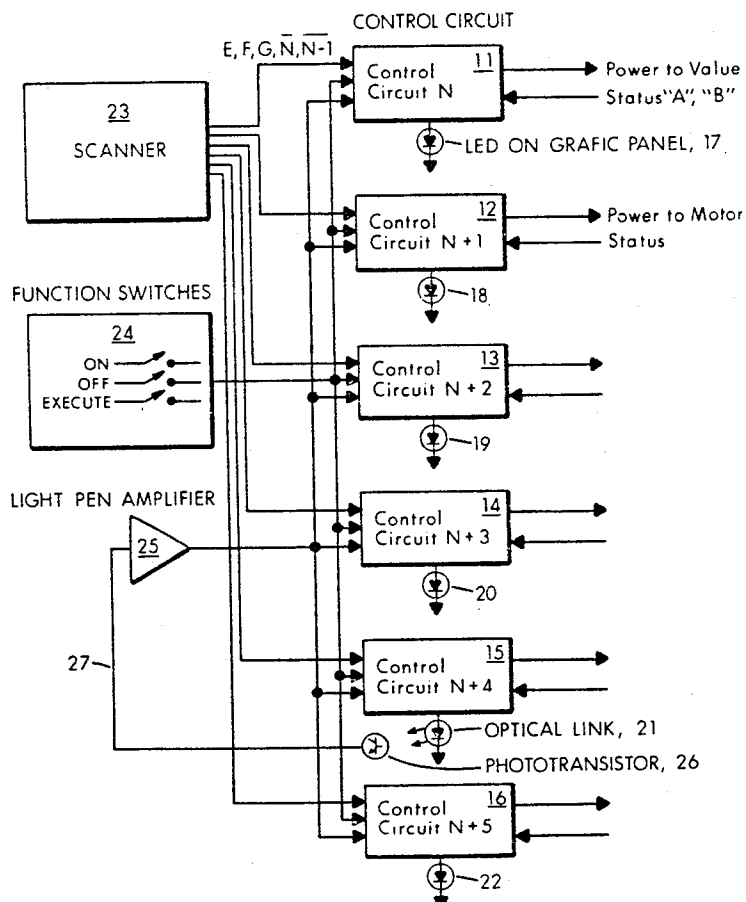


Fig. 1

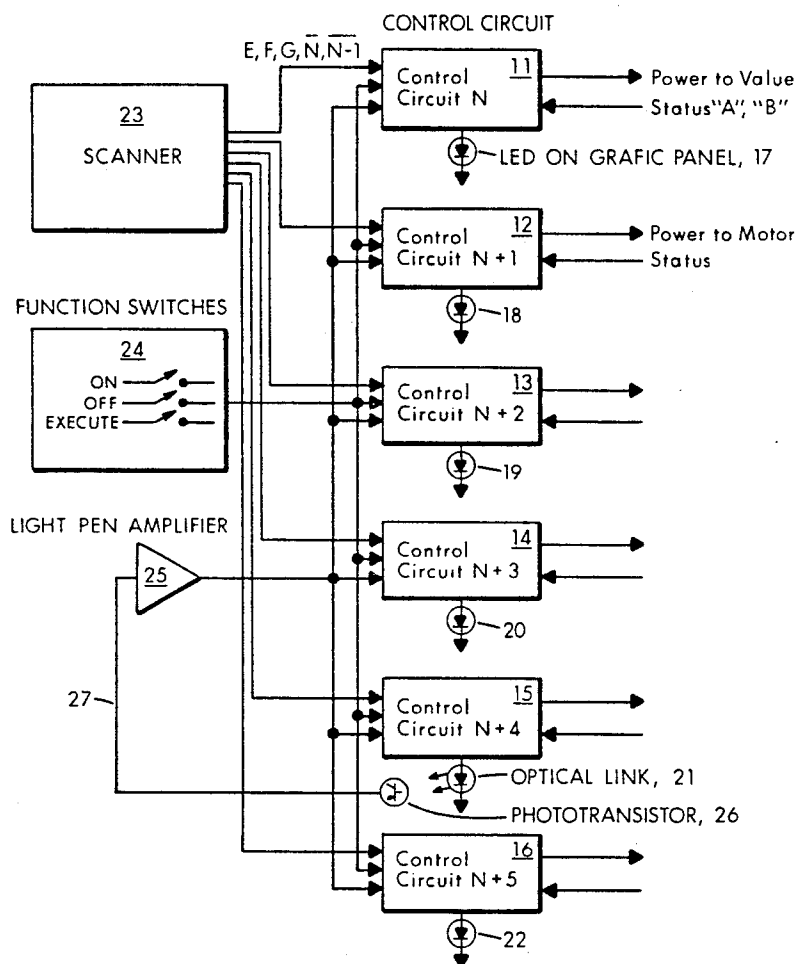


Fig. 2

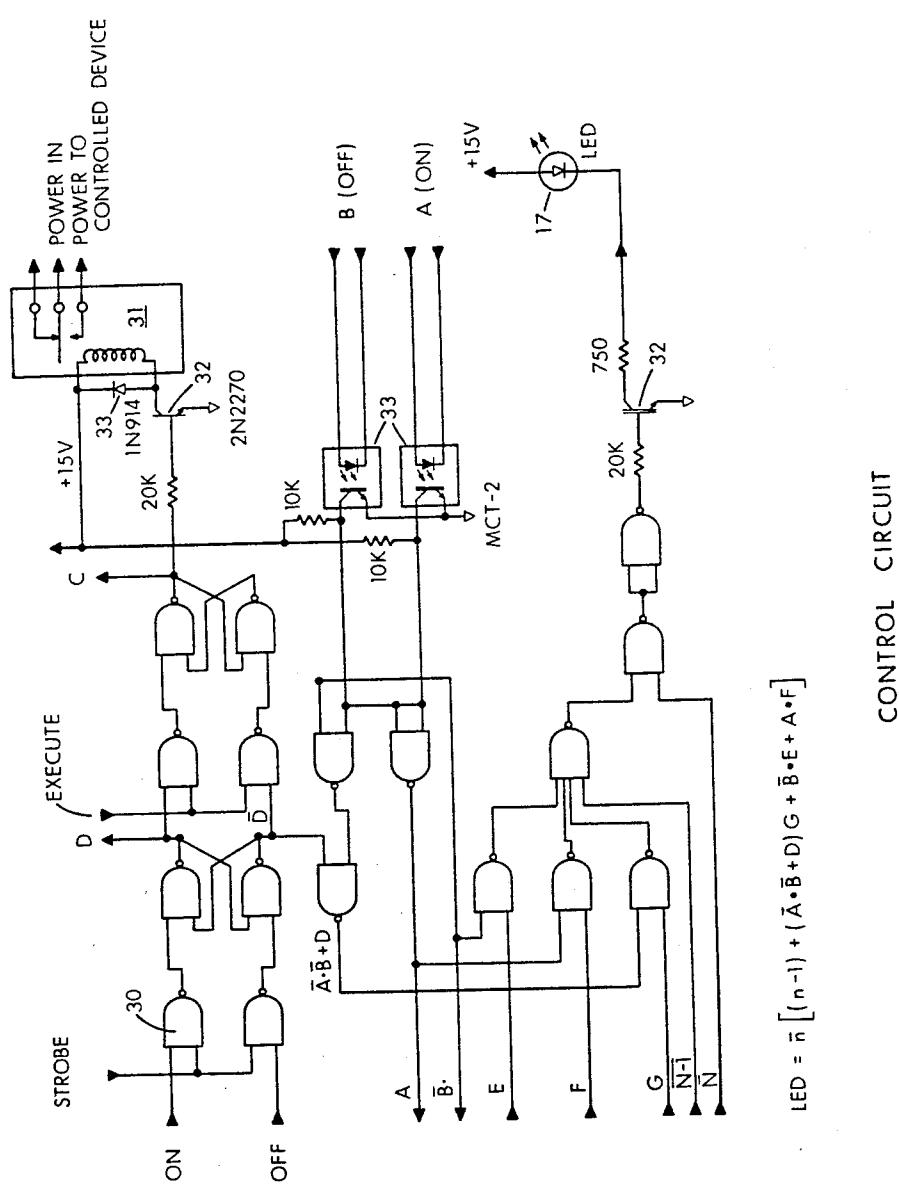
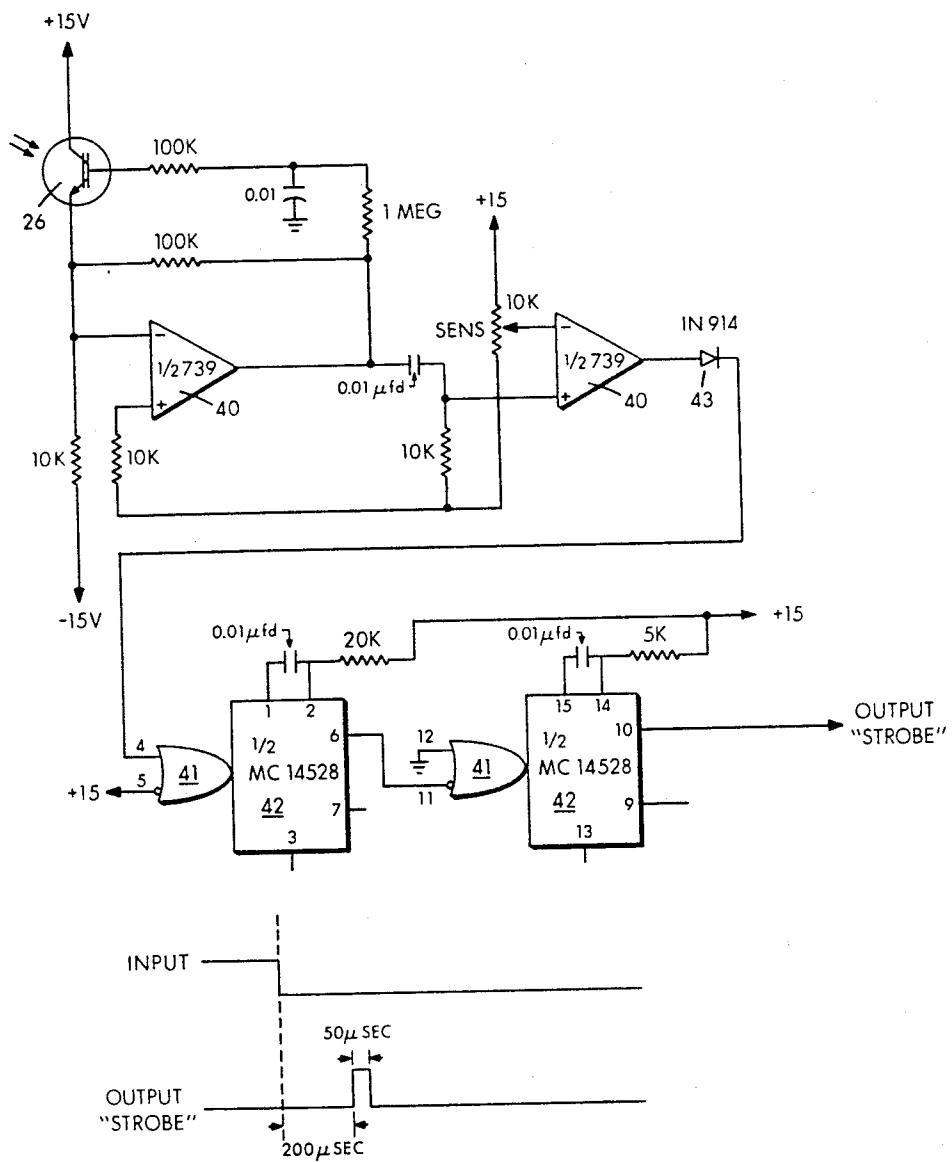
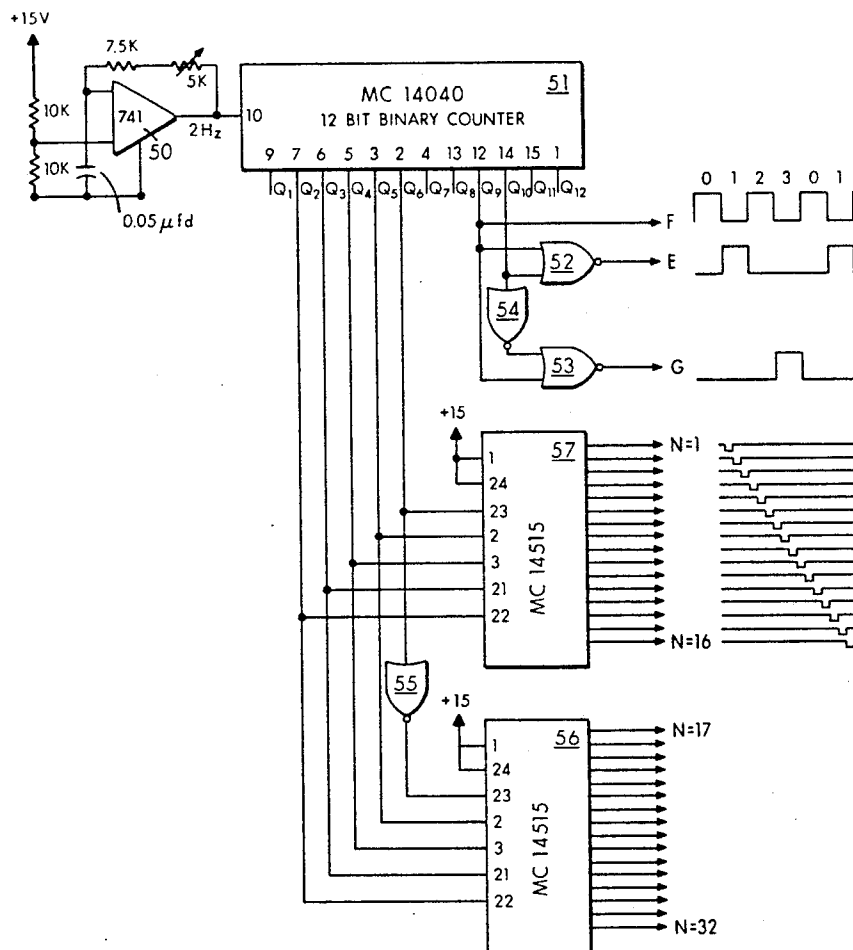


Fig. 3



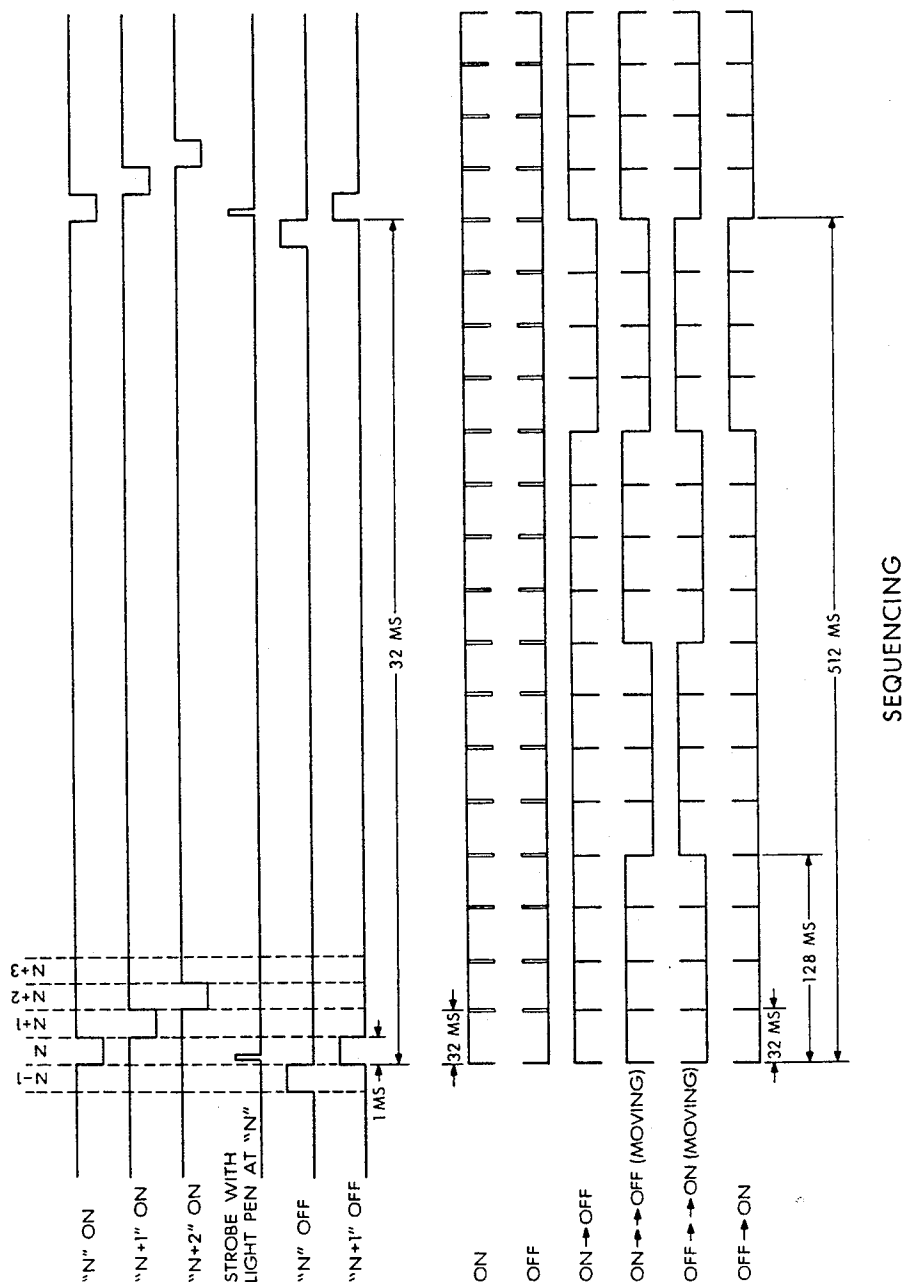
LIGHT PEN CIRCUIT WITH PULSE DELAY AND SHAPING

Fig. 4



SCANNER

Fig. 5



SIGNAL LIGHT-PHOTO SENSITIVE PROBE CONTROL SYSTEM

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to the field of remote control systems, more particularly to the light-actuated remote control systems.

2. Prior Art

In the past, cathode ray tubes have been used as graphic panels to control process functions as described, e.g., in Vol. 71, *Oil and Gas Journal*, pg. 139-140 (Mar. 22, 1971). Also various display systems for remotely controlling actual systems have been described in the U.S. patent literature, e.g., in U.S. Pat. Nos. 2,507,921, 2,566,873, 2,692,921, 2,725,552, and 3,422,329.

However, no previous use of light emitting diodes as the display elements in interactive graphic process control panels have been found in the prior arts. The LEDs offer the advantages of lower cost (no computer is necessarily involved in the system) and ease of circuit maintenance (cathode ray tube-light pencil mechanisms are generally more complex than those utilized with the present invention).

UTILITY OF THE INVENTION

The present invention is useful for a wide variety of remote control applications including particularly control of flow-type industrial processes, e.g., refineries, chemical plants, air conditioning systems, penitentiaries and military and industrial security systems, lighting systems, traffic control, electrical power distribution systems, etc.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic diagram of a complete control panel according to the present invention.

FIG. 2 is a detail of the circuitry of one of the control circuits shown in FIG. 1.

FIG. 3 is a detail of the circuitry of the light pen (photo sensitive probe) shown in FIG. 1 and the related pulse shaping circuitry.

FIG. 4 is a detail of the circuitry of the scanner shown in FIG. 1.

FIG. 5 is a sequencing diagram primarily directed to the operation of single individual LED.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Apparatus

Referring to FIG. 1, a series of control circuits 11 through 16 are each connected to an element, e.g., a valve motor etc. (not shown) so as to actuate that element upon receiving a signal into said control circuit. Each control circuit has its own individual LED 17-22 which is, in this example, illuminated when the remote element being controlled by the control circuit is in the on or activated status.

A scanner, 23, sequentially pulses each of the LEDs 17-22 in a series of energizing sweeps. Function switch 24 provides a double check safeguard if switch 24 is in the on position, the light pen 25 is inoperative to vary the status of an LED which is in the off position. Also, the execute switch in function switch box 24 must be pressed in order to execute each individual command to the control system. Optionally, function switches of

box 24 could be eliminated as they merely provide redundancy to minimize operator error.

Light pen amplifier 25 is connected to its photo transistor or other photo sensitive sensing element 26 by a flexible cable 27 which permits the photo sensitive element 26 to be placed in proximity with any of LEDs 17-22. Upon placing probe 26 in proximity with e.g., LED 17, with function switch of box 24 in the on position and pressing execute switch of box 24, the valve (not shown) controlled by control circuit 11 to which LED 17 is connected, will be changed to "on" or "open" status.

Control Circuit

FIG. 2 shows the detailed circuitry of control circuits 11-16. The primary elements are Nand gates identical with that shown as element 30. These can be the model MC14011 Quad 2-Input Nand Gate, manufactured by Motorola Semiconductor Products, Inc. Relay 31 is a conventional single pole double throw relay, transistor 32 can be a 2N2270, diode 33 can be a 1N914, optical couplers 33 can be model MCT-2 manufactured by Monsanto, LED 17 can be the model MV5020 light emitting diode manufactured by Monsanto Commercial Products Co. of Cupertino, California. The Boolean equation which must be satisfied in order for LED 17 to be illuminated on each sweep is shown at the bottom of FIG. 2. Inputs and outputs are defined as follows:

EFG, $\overline{n-1}$ and n are inputs from the scanner circuitry defined in more detail in FIG. 4; A and B are status indications received from the controlled element as shown in FIG. 1 with respect to control circuit 11; "Strobe" is the output from pulse circuitry shown in more detail in FIG. 3; outputs A, B, C and D are status outputs for optional telemetering to a remote location; "Execute," "On," and "Off" are signals from functions which are in box 24 shown in FIG. 1.

Referring to FIG. 3, photo transistor 26 can be a model QS 506 manufactured by Quantum Sensing of Bohemia, New York; operational amplifier 40 can be the model 739 manufactured by Fairchild Semiconductor of Mountain View, California; elements 41 and 42 are contained in a single package as a dual monostable multi vibrator, e.g., the model MC14528 manufactured by Motorola Semiconductor Products, Inc.; diode 43, e.g., a 1N914 merely serves to protect the multi stable vibrator 41-42 from negative-going signals. At the bottom of FIG. 3 is shown a schematic sequence diagram showing the input to the circuitry of FIG. 3 together with the output provided by the circuitry of FIG. 3 in response to that input.

Referring to FIG. 4, this figure shows in more detail the circuitry of scanner 23 of FIG. 1. The operational amplifier 50 is used as 2 kilo hertz oscillator to drive the twelve bit binary counter 51 which can be a model 14040 manufactured by Motorola Semiconductor Products, Inc. The operational amplifier 50 can be a model 741 manufactured by Fairchild. The NOR gates 52-55 can be the model MC 14,001 Quad 2-Input NOR Gate manufactured by Motorola Semiconductor Products, Inc. Decoders 56 and 57 can be a 4-bit to 16 line decoder such as the model MC 14515 manufactured by Motorola Semi Conductor Products, Inc.

MODIFICATIONS OF THE INVENTION

It should be understood that the invention is capable of a variety of modifications and variations which will

be made apparent to those skilled in the art by a reading of the specification and which are to be included in the spirit of the claims appended hereto. For example, various statuses of the controlled devices can be indicated by causing the corresponding LEDs to blink at different pulse rates, e.g., by energizing them on every second, ever third, or every nth sweep generated by the scanner 23. For example, the LED can blink when it is in the process of changing between positions, can be lit with every sweep (visually appearing to be constant illumination) when it is activated and can be off when the control device is de-energized.

The LEDs can be set in a conventional schematic control panel to indicate the type of device being controlled and its position in the system as a whole. LEDs can be set on a map or street diagram to indicate the geographic positioning of the device being controlled, e.g., a traffic signal, two or more LEDs can be utilized to indicate various statuses of a single control device, e.g., one LED being energized when the device is on, one when the device is off and one when the device is in the process of changing between on and off. The LEDs can be differently colored or differently shaped, e.g., they can be in the form of numerals where various numbered elements such as tanks in a tank farm are to be controlled. By the use of LED seven segment alphanumeric readouts, e.g., the Man-4 manufactured by Monsanto, the LEDs can themselves be used to output numerical data from the area where the device is being controlled. For example, the level in a storage tank can be shown on a control panel and this level can be increased by merely applying the light pen to the illuminated digits until the desired digital reading is reached. Similar techniques can be utilized to vary pump discharge pressures, the degree of turn in a ship's rudder or other device which is to be positioned at a particular angle, etc.

What is claimed is:

1. In a remote control system for operating various elements located some distance away from a control panel, the improvement comprising in combination
 - a. a control circuit means for controlling each of said elements,
 - b. a light source corresponding to each of said elements to be controlled, said light source being switched on by said control means when said element is in a first status and switched off when said element is in a second status,
 - c. a light sensitive probe adapted for being placed in proximity with any of said light sources,
 - d. an electrical system which successively sweeps each of said light sources in synchronization with a distinctive period of time measured from the be-

ginning of each sweep, whereby the time as measured from the start of each sweep, at which said light probe receives a signal from one of said light sources is indicative of which of said light sources is then being energized.

2. A system according to claim 1 which additionally comprises:

- (d) Means for actuating the element corresponding to each of said light source, said means being responsive to said light probe receiving light from said light source at the time, measured from the start of each sweep, characteristic of that particular light source.

3. A remote control system according to claim 1 in which said light sources are light emitting diodes.

4. A remote control system according to claim 2 in which said light sources are light emitting diodes.

5. A system according to claim 1 wherein said light sensitive probe is responsive to the position of a function switch which can be set for the status desired for the particular element to be controlled by placing said light sensitive probe in proximity with a particular one of said light sources.

6. A system according to claim 1 wherein said electrical system successively sweeps said light sources in a manner such that said light sources flash at a rate which is indicative of the status of the corresponding element to be controlled.

7. A system according to claim 2 wherein said means for actuating the element corresponding to each of said light sources comprises a control circuit comprising in combination Nand gates so arranged that a particular light source will be illuminated on each sweep of said electrical system when and only when the following Boolean equation is satisfied:

$$LED = \bar{n}[(n1) + (\bar{A}\bar{B} + D)3 + \bar{B} \cdot 1 + A \cdot (0+2)]$$

Wherein $n-1$ and n are inputs from said electrical system, and A and B are status indications received from said element to be controlled.

8. A system according to claim 1 wherein said light sensitive probe comprises circuitry having provision for pulse delay and shaping.

9. A system according to claim 1 wherein said electrical system which successively sweeps said light sources to energize or de-energize each said light sources at a distinctive period of time comprises in combination a binary counter, an operational amplifier and suitable NOR gates.

10. A system according to claim 1 wherein said light sources are set in a schematic diagram indicative of the interrelationship or relative positioning of the elements to be controlled.

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