

[72] Inventor **William Brooks**
1042 Inverness Way, Sunnyvale, Calif.
94087

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Primary Examiner—James W. Moffitt

Attorney—Owen, Wickersham and Erickson

[54] **SHIFT REGISTER**
2 Claims, 1 Drawing Fig.

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G11c 19/00, H03k 23/32

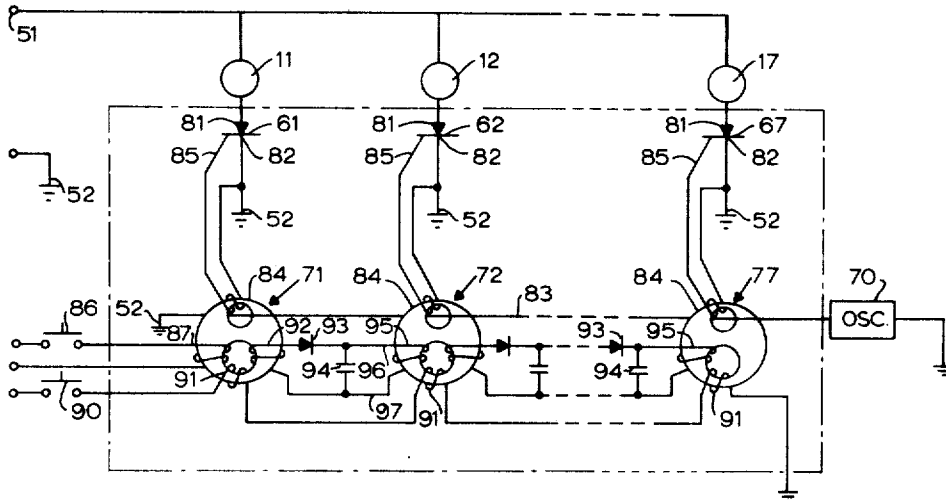
[50] Field of Search 340/174
CT, 174 SR; 307/221, 252, 284, 305, 314

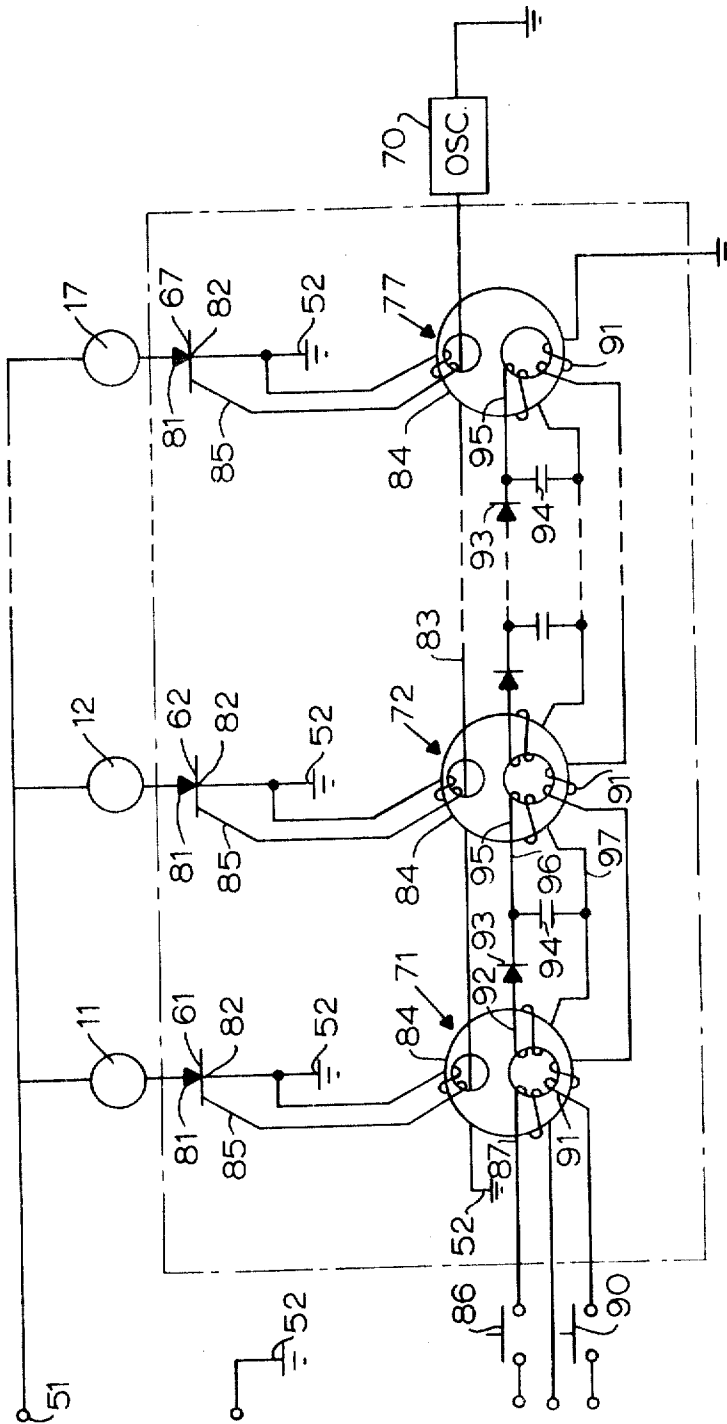
[56] **References Cited**

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3,283,312 11/1966 Marcus et al. 340/174

ABSTRACT: An electronic shift register used with a source of rectified alternating current, having a positive bus and a ground. A series of shift register stages are serially arranged between a first stage and a last stage, each stage having a silicon controlled rectifier and a transfluxor core associated together. Each silicon controlled rectifier has its cathode connected to ground, and a load is connected between its anode and the positive bus. Each transfluxor has a core and a primary connected to an oscillator and actuated thereby, a secondary connected to the gate of its associated silicon controlled rectifier, and first and second windings; each transfluxor except the one at the last stage has a third winding connected to the second winding of the succeeding stage. A shift control switch is connected in series with each of the first windings, and data input means is connected to the second winding of the first stage for feeding binary data thereto. The connection between each third winding and its successive stage includes a rectifier, and a condenser lies across between the connection and a return line.





INVENTOR.
WILLIAM BROOKS
BY
Oscar Wicksen & Wicksen
ATTORNEYS

SHIFT REGISTER

This application is a continuation-in-part of application Ser. No. 810,434 filed Feb. 4, 1969 and now U.S. Pat. No. 3,493,933, which is a division of application Ser. No. 557,148 filed June 13, 1966 and now U.S. Pat. No. 3,493,957.

This invention relates to improvements in electronic shift registers.

An electronic shift register of this type may be used in such variable message displays as a sign made up of many electric lamps and alternating between displaying the time of day and the current temperature. This type of sign changes from one static display to another. Other examples of this type are travel departure and arrival boards at air, rail, and bus terminals, stock quotation boards, score boards at sporting events, and changing advertising signs.

The invention may also be used in another type of variable message display, the continuously changing type, exemplified by a news dispatch sign in which a message begins at the right end and moves by small stages rapidly to the left end, giving the impression of a smoothly moving message.

The present invention applies to both of these types of variable message displays, to mixtures of them, and to other types as well. The message may be given by words, letters, numbers, symbols, pictures, or geometrical elements. It also applies to other environments or devices requiring a shift register.

The invention enables control of such displays and simplification of the control systems. Heretofore, variable message displays have used mechanical switching means, including complex electromechanical devices to operate mechanical switches, which in turn, were used to control lamps in the actual visual display board. The mechanical controls both limited the speed with which the messages could be changed and necessitated frequent adjustment and cleaning. Moreover, these mechanical control systems have been expensive, and their installation has required a large number of control wires; furthermore, the enlargement or expansion of such a display board was complex and expensive. The extensive wiring between the control means and the actual display was a major cost feature, particularly when the control device was to be remote from the display; for a separate wire had to be run from each display lamp to the control device. Not only was this expensive, but the display itself was necessarily bulky,—it could not easily be made small.

The present invention makes it possible to provide a less expensive, smaller, and simpler system for variable message displays, to impart a new flexibility to visual display, provide a visual display in which the control means is electronic instead of mechanical, and to enable remote control of display and multiple display spaces, in a system wherein the elements can be connected and controlled by a minimum of control wires. Displays may, by the present invention, be controlled remotely by radio or by telephone wires.

While shift registers are well known in the computer art, they have not, to my knowledge, heretofore been used in visual displays, and I have found that many important benefits may be obtained from their storage and transfer of information. By a shift register, I refer to a circuit in which information stored in a first element is transferred to a second adjacent element on each command shift. Such a shift register enables information to be received in serial form and loaded into the register so that at the conclusion of the serial input code, a meaningful message is stored in the register.

Other objects, advantages, and features of the invention will become apparent from the following preferred example.

The drawing is a fragmentary circuit diagram of a shift register embodying the principles of the invention.

Shift registers using vacuum tubes or magnetic cores or transistors or other semiconductor compound elements are well known in the art and any true shift register having sufficient stages may be used in this invention. It may be remarked that some circuits which are called shift register in the literature are really nothing but ring counters, which transfer a count from stage to stage of each transfer command. Many of these ring counter circuits allow more than one stage to be on

at any one time. However, such ring counters do not transfer a count when two successive stages are in the same stage whereas a true shift register will. Thus, while a large number of circuits have been published showing silicon controlled rectifiers in ring counters, and while some of these have mistakenly been called shift registers, they are not properly so termed.

The drawing shows a preferred installation for a single figuregram with a novel shift register. Only three lamps 11, 12, and 17 are shown here, other lamps used in the figuregram being omitted to save space. Between a top power line 51 and ground 52 the lamps 11, 12, and 17 are in series with respective silicon controlled rectifiers 61, 62,...67. In this instance I use a series of magnetic devices 71, 72,...77 known as transfluxors, which are multiaperture magnetic core transformers having the property of continuous readout of the state of the magnetic flux in the core without destroying the stored flux settings. (Transfluxors are described by J. E. Rajchman et al. in an article entitled "The Transfluxor" in Proc. IRE Volume 44, pp. 321—332, Mar. 1956.)

The transfluxor cores are made of square-loop magnetic material, the magnetic flux of which is saturated at some value of drive. The core switches very rapidly. If a drive is applied which drives the magnetic flux down (negative) to a value A and is then removed, the core flux remains in its "down" or negative position after the drive is removed, because of the memory property of the square loop material. A subsequent drive in the opposite direction first overcomes some reluctance and then switches quickly up to a point B, and, when that drive is removed, the flux in the core remains at point B. In the shift register of this invention, the shift line drives all cores to the low point A at every shift pulse. If any particular core is already at point A, no change of flux occurs; if it is at point B, it changes to point A and in so doing induces a voltage, which is used in this invention to perform the shift.

Transfluxors give an advantage because the silicon controlled rectifiers then can be operated from raw unfiltered rectified alternating current. Each time the rectified voltage drops to zero, the silicon controlled rectifiers stop conducting, and in shift registers made up only of ordinary square-loop magnetic material, an output is obtained only when the shift line is energized; so with ordinary magnetic shift registers, the data must be read in each half cycle if the message is to remain in the visual display. In the transfluxor shift register of this invention, a continuous output is available from an oscillator 70 to sense the states of the cores, and if the data in the shift register remains the same, the oscillator 60 retriggers the silicon controlled rectifiers on the next positive half cycle.

In the figure, each lamp 11, 12,...17 is connected to an anode 81 of its silicon-controlled rectifier 61, 62,...67. The cathodes 82 are connected to ground 52. The oscillator 70 is connected to the transfluxors 71, 72,...77 by a line 83, comprising the primary of the transformer action thereof. Each transfluxor 71, 72,...77 by a line 83, comprising the primary of the transformer action thereof. Each transfluxor 71, 72,...77 has a secondary 84 connected across between the cathode 82 (at ground 52) and the gate 85 of the respective silicon controlled rectifier 61, 62,...67. A single code input 86 is connected to a winding 87 of the first stage 71 only, and a single shift control 90 is connected to the windings 91 in each stage. A transfer winding 92 in each stage 71, 72,... except the last stage 77, is connected to the winding 95 of each stage 72,...77 except the first stage 71, through a rectifier 93, with a condenser 94 across the leads 96 and 97 for the windings 92 and 95.

Typical values or types are as follows:

Component	Value or type
Lamps 11, 12, . . . 17	40 to 150 watts.
SCR 61, 62, . . . 67	2N3528.
Transfluxors 71, 72, . . . 77	RCA Type 0163M5.
Oscillator 70	10 kc. or higher frequency.
Rectifier 93	1N4003.
Condenser 94	0.01 microfarads.

If a core such as that of the transfluxor 71 contains a "zero" (is at point A as described a few paragraphs earlier), no voltages are induced in the transfer winding 92 of that core when the shift line drives all the windings 91 to "zero" (or point A). However, if the core contains a "one" (is at point B) and is driven to "zero" (point A) by the shift line, then a voltage is induced in the winding 92 so long as the flux is going from B to A. The induced voltage causes a current to flow through the rectifier 93 and be stored in the capacitor 94. After the shift pulse has driven all cores to the "zero" or A position, the capacitor 94 discharges if it has a voltage and thereby drives the succeeding core (e.g., in the transfluxor 72) to point B, the rectifier 93 causing this voltage pulse to affect only the succeeding transfluxor 72 and not the transfluxor 71 which was previously at point B. Thereby, each data-set put into the first transfluxor 71 is transferred step by step to the succeeding transfluxors 72...77, one step at each shift.

Thus, in this device, the data are loaded into the transfluxor shift register at the input 86. At each shift pulse the input windings 87 on each core are driven unidirectionally to set the core in a given flux state. If the core is not already at that end of the hysteresis loop, then the set pulse drives the core through its loop and in so doing, couples a voltage into the transfer winding 92 for the next core. In this manner a datum is transferred from core to core, and when the set pulse finally sets the core, no transformer action can occur between the oscillator 70 and the output winding 84 to the silicon controlled rectifiers 61, 62,...67. Each half cycle the silicon controlled rectifiers 61, 62,...67 are triggered according to the serial code which is stored in the shift register transfluxors 71, 72,...77.

The electronic shift of these shift registers is or can be quite rapid. It can be quite slow and steady, or it can be rapid and intermittent. Therefore, the message can be made to travel quickly to any portion of the sign and stop. During the rapid travel the display elements (the lamps) do not glow brightly enough for the eye to see them, so that the visual effect is that the message suddenly appears on the display. In this manner, variable message displays can be made to flash on and off. Similarly, cartoons can be created on the display with a rapid sequence of frames while the animation technique similar to that used in motion pictures creates the same general effect. Multicolor effects can be obtained by using three lamps (for example, blue, green, and red) at each lamp location, the three being located close to each other and rapidly scanning on the three colors in sequence with the brightness of each color adjusted so that the eye sees a hue which combines with the others. This technique is somewhat similar to that used in

three-color printing sometimes called full-color halftone.

The codes and examples described above are not to be construed as limits on the shift register technique of this invention. For example, certain types of display elements presently use a projection principle in which a single lamp selected from a matrix of lamps is made to illuminate a mask which acts like a film in a picture projector and throws an image onto the screen. A series of these units may be placed side by side to form lines of copy, and the shift register serial code, consisting of pulses, spaced so that one lamp per display element is selected, may be used to obtain the desired effect.

To those skilled in the art to which this invention relates, many changes in construction and widely differing embodiments and applications of the invention will suggest themselves without departing from the spirit and scope of the invention. The disclosures and the description herein are purely illustrative and are not intended to be in any sense limiting.

I claim:

1. An electronic shift register, including in combination:
a source of rectified alternating current, having a positive bus and a ground;

an oscillator,

a series of shift register stages, serially arranged between a first stage and a last stage, each stage having a silicon controlled rectifier and a transfluxor core associated together,

each said silicon controlled rectifier having a cathode connected to ground, an anode, and a gate,

a load connected between each said anode and said positive bus,

each said transfluxor having a core and a primary connected to said oscillator in series with the primaries of the other transfluxors and actuated by said oscillator, a secondary connected to the gate of its associated said silicon controlled rectifier, and first and second windings, and all said transfluxors except the one at the last stage having a third winding, each said third winding being connected to the second winding of its succeeding stage by a main lead and a return lead,

a shift control switch connected in series to each of said first windings, and

data input means connected to the second winding of said first stage for feeding binary data thereto.

2. The shift register of claim 1 wherein the connection between each said third winding and its successive stage includes a rectifier in said main lead followed by a condenser across said main lead and return lead.