

[72] Inventors **Bill E. Dozer;**
Charles A. Ratcliffe, Both of Richland,
Wash.
 [21] Appl. No. **817,826**
 [22] Filed **Apr. 21, 1969**
 [45] Patented **June 1, 1971**
 [73] Assignee **American Sign & Indicator Corporation**
Spokane, Wash.

3,230,508 1/1966 Grijseels et al. 340/325X
 3,386,088 5/1968 Johnston 340/324
 3,416,134 12/1968 Gertler et al. 340/324X
 3,482,240 12/1969 Solari 340/325

Primary Examiner—John W. Caldwell
 Assistant Examiner—David L. Trafton
 Attorney—Wells & St. John

[54] **DISPLAY SIGN AND CONTROLS**
13 Claims, 16 Drawing Figs.

[52] U.S. Cl. **340/325,**
 40/31, 340/324
 [51] Int. Cl. **H04n 1/00**
 [50] Field of Search **340/325,**
 324; 40/31

[56] **References Cited**
UNITED STATES PATENTS

3,178,699 4/1965 Burton 340/325X
 3,197,765 7/1965 Simpkin 340/325X

ABSTRACT: A display sign comprising a plurality of modules each having a movable tape with desired indicia imprinted thereon. Motor-operated control means is provided within each module to selectively return the tape to a reference condition or "home". Operating controls are provided to selectively move the tape from this reference condition to a final condition wherein the desired indicia is displayed on the module. The controls include a code input having a signal representative of the number of steps required for such movement, a pulser circuit for driving the tape controls, counting means for monitoring the pulses and a comparator for comparing the input code to the number of pulses directed to a particular module.

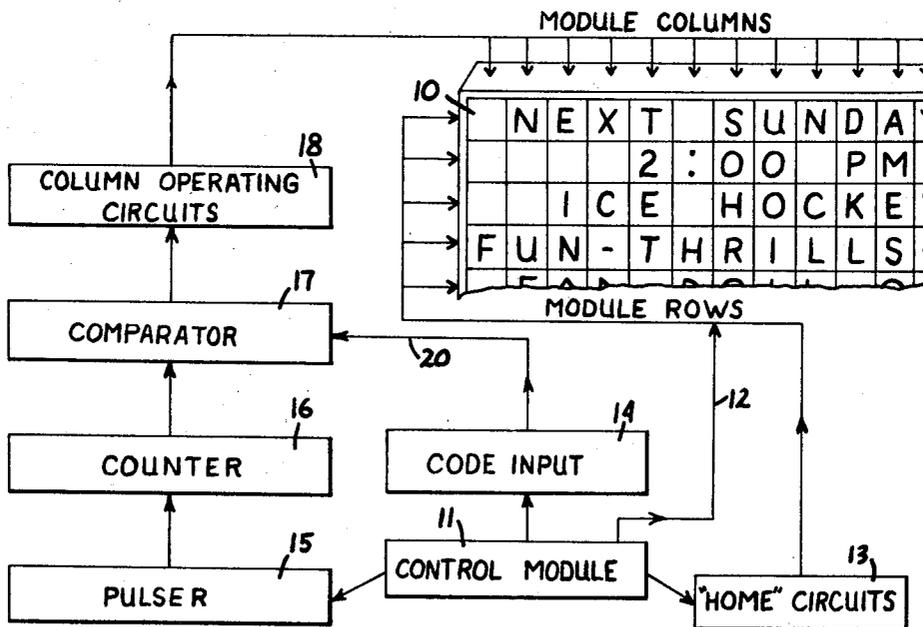


FIG-3

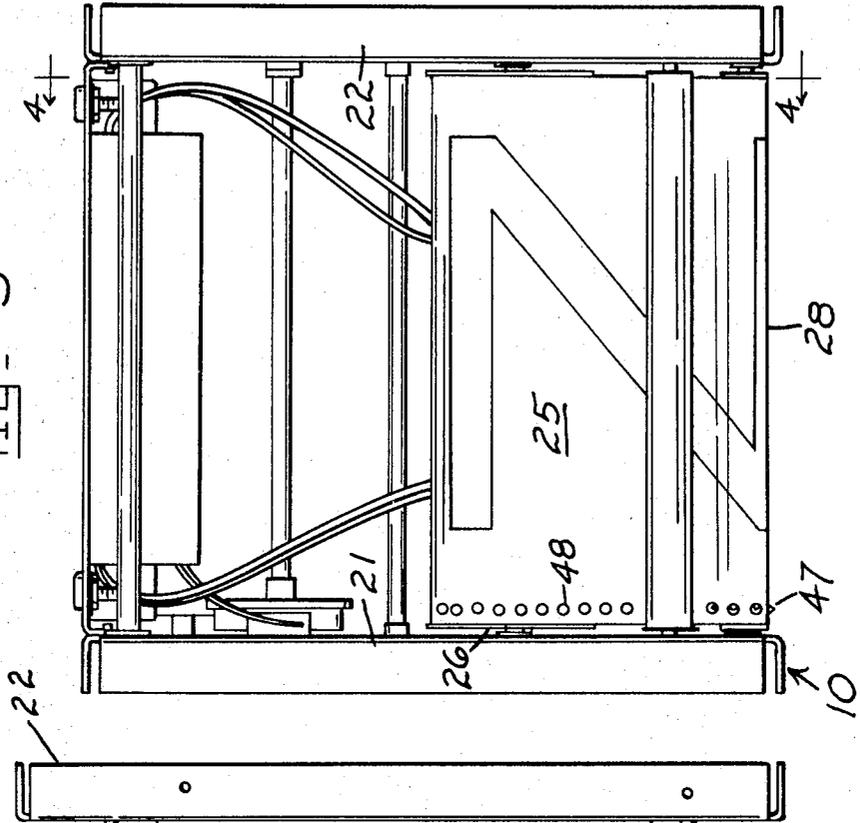
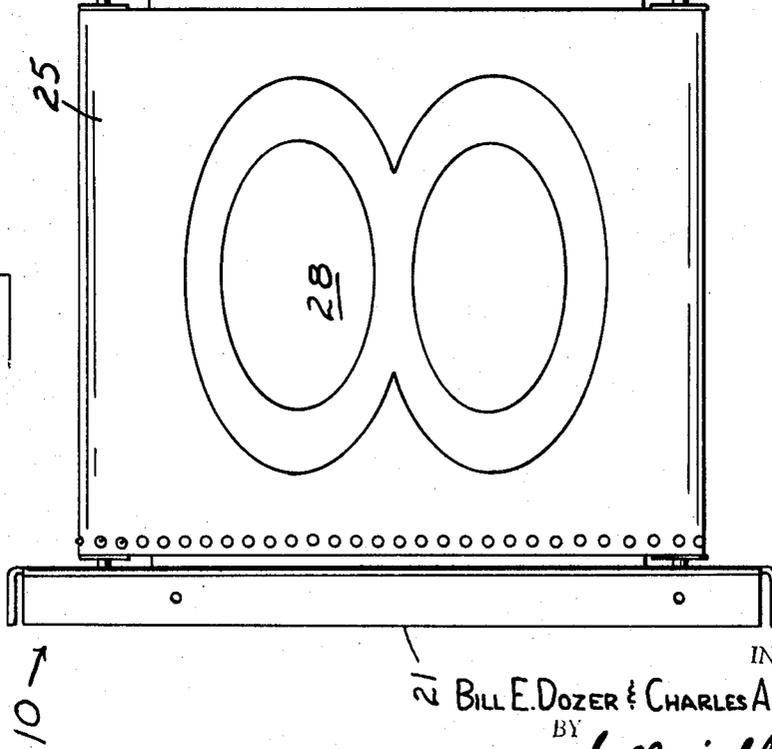


FIG-2



INVENTOR.

21 BILL E. DOZER & CHARLES A. RATCLIFF

BY

Hull & St. John
ATTYS.

FIG- 5

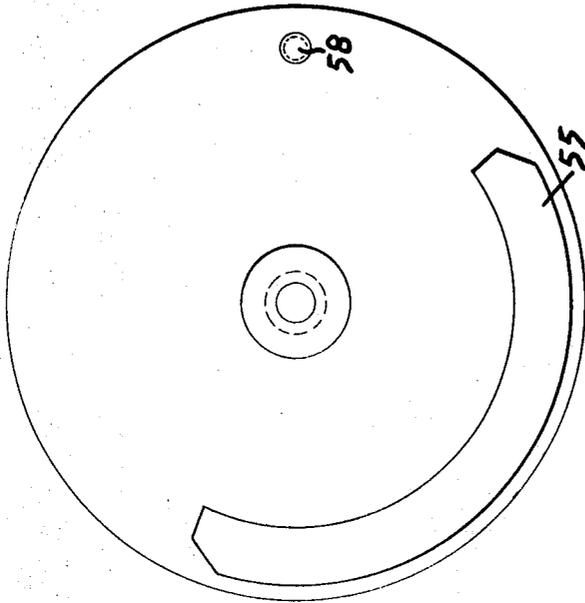


FIG- 6

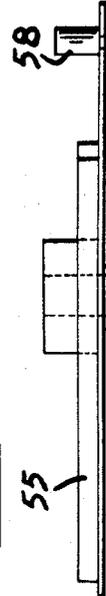
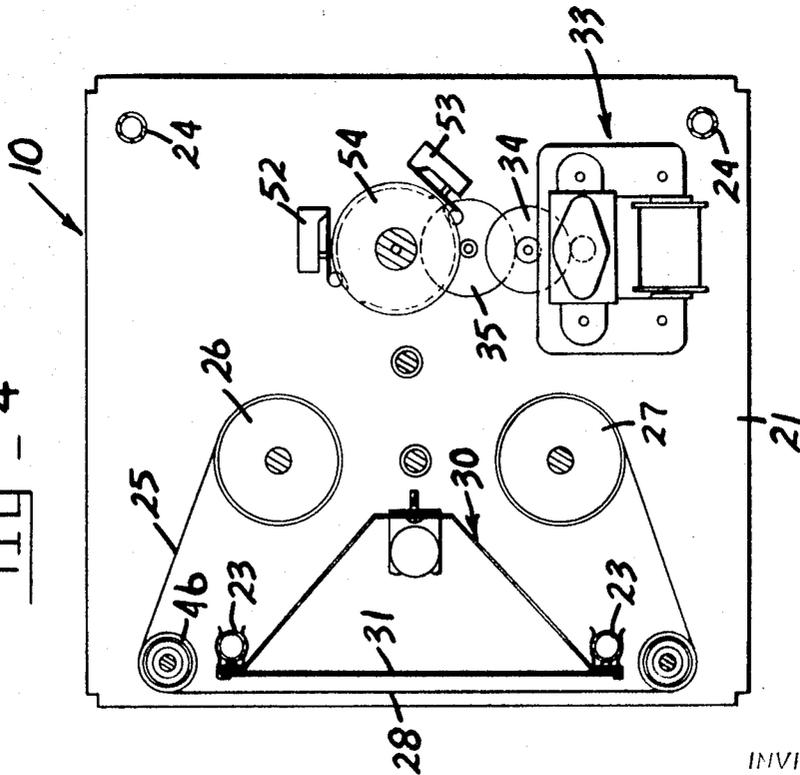


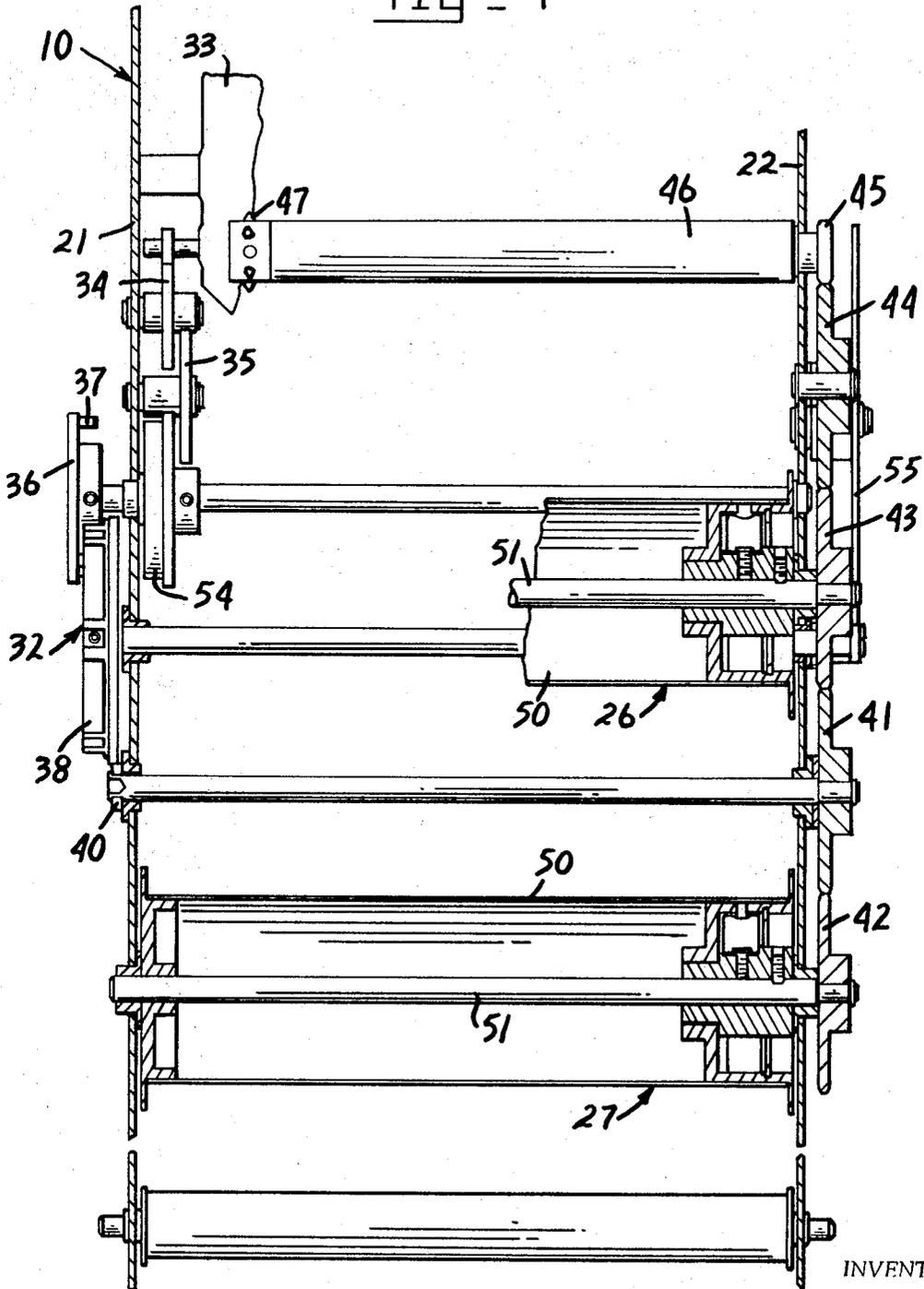
FIG- 4



INVENTOR,
BILL E. DOZER & CHARLES A. RATCLIFF

BY
Wells & St. John
ATTYS.

FIG - 7



INVENTOR.

BILL E. DOZER & CHARLES A. RATCLIFF

BY

Halle & St. John
ATTYS.

FIG- 9

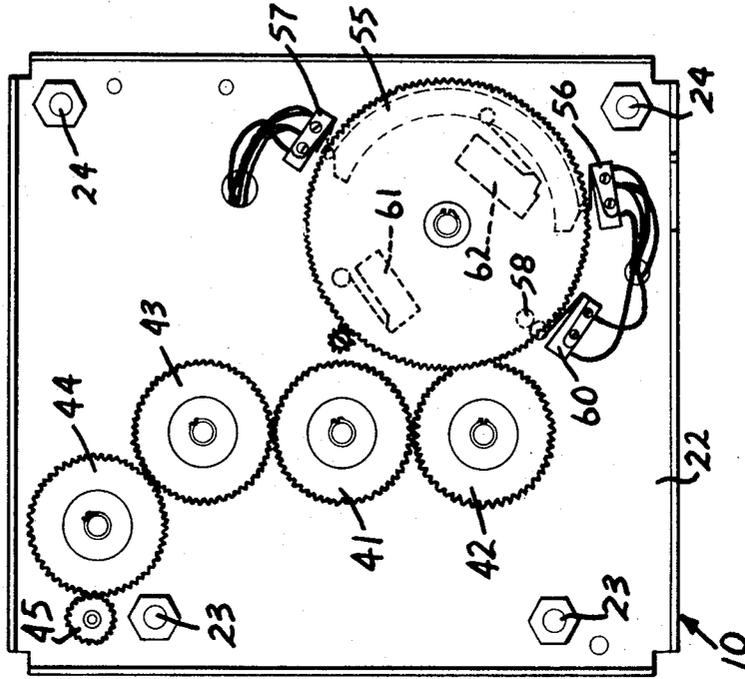
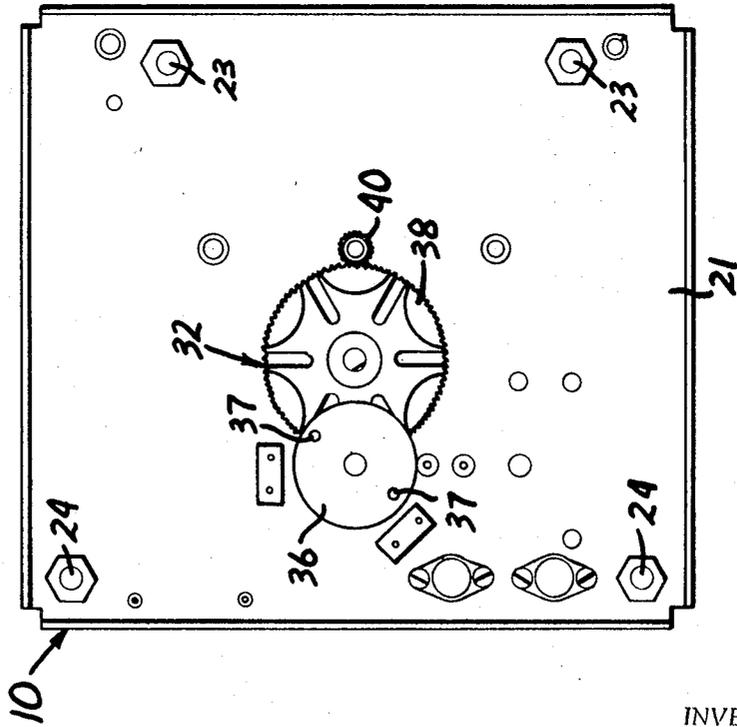


FIG- 8



INVENTOR.
BILL E. DOZER & CHARLES A. RATCLIFF
BY
Halla & St. John
ATTYS.

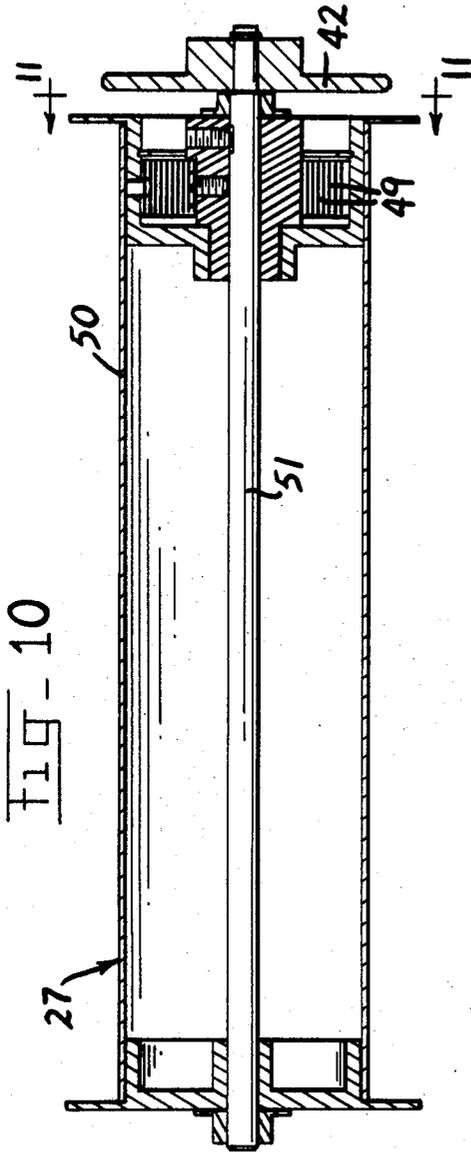


FIG-10

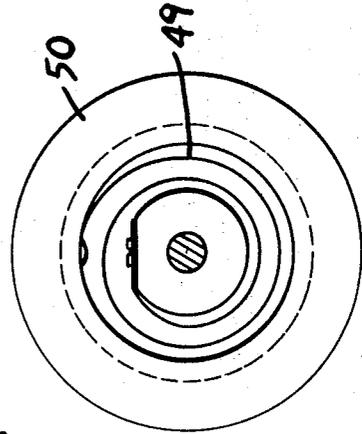
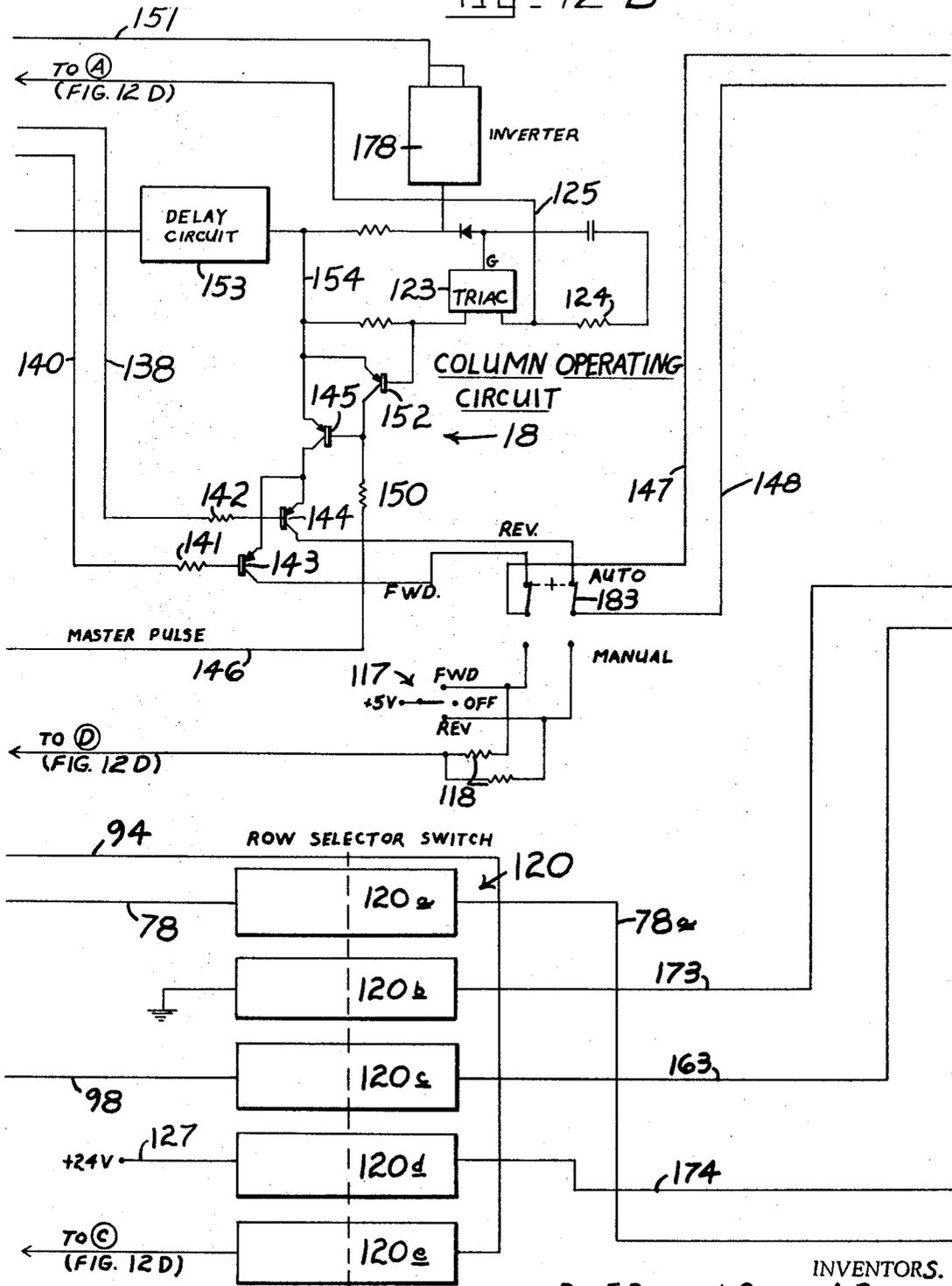


FIG-11

INVENTOR.
BILL E. DOZER & CHARLES A. RATCLIFF
BY
Halle & St. John
ATTYS.

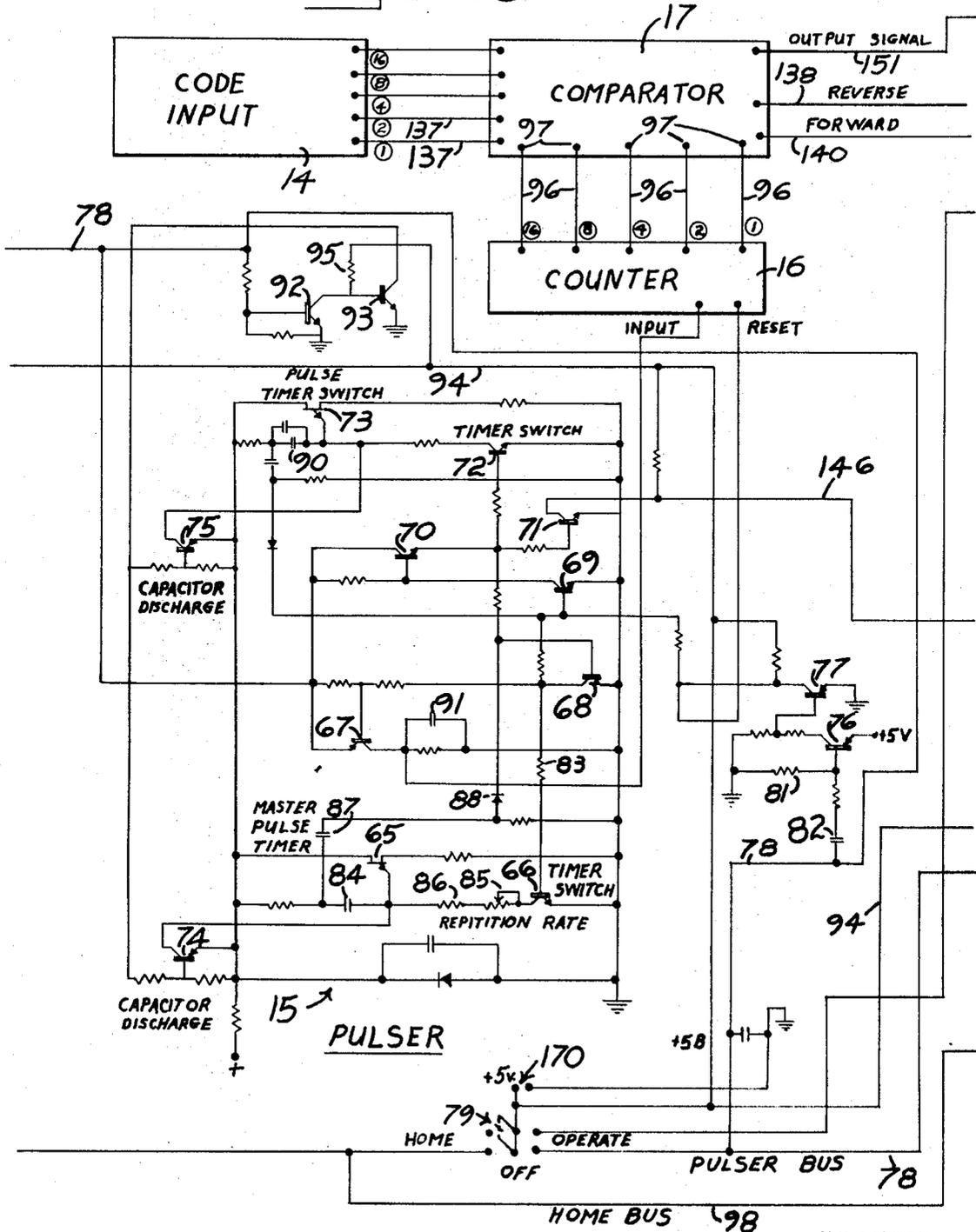
Fig. 12 B



INVENTORS.
 BILL E. DOZER & CHARLES A. RATCLIFF

BY
Halls & St. John
 ATTYS.

FIG-12C



INVENTOR.
BILL E. DOZER & CHARLES A. RATCLIFF
BY
Helen E. St. John
ATTYS.

DISPLAY SIGN AND CONTROLS

BACKGROUND OF THE INVENTION

This invention relates to a display sign having a plurality of tape modules arranged in horizontal rows and vertical columns. The individual tape of each module has alphanumeric indicia imprinted thereon. By moving each tape to a preselected final position, a word or other symbol can be displayed on the sign. Such a sign is particularly adaptable to use by theatres, sports arenas, etc.

In control of a large sign of this type, it is desirable to provide economic automatic controls which can be programmed and operated with a minimum of operator skill. It is also desirable to eliminate as much duplication of control circuitry as possible, this being accomplished herein by utilizing the identical control elements for operating a number of module rows.

One object of the invention is to provide a relatively simple electronic control for a large scale sign display of the type generally discussed above.

Another object of this invention is to provide such a sign control which does not require feedback from the sign.

Another object of the invention is to provide a flexible control circuit which can be used in conjunction with various types of input devices and which also permits manual operation of the modules when required.

SUMMARY OF THE INVENTION

The invention disclosed is primarily related to controls for a sign module having a visual display area, the module including a tape having indicia thereon within tape areas repeated along its length and means on the module that movably mount the tape for positioning the tape areas within the module display area. The control apparatus includes a tape drive means (motor and power train with associated mechanical switches and electronic components) to move the tape across the module display area. Homing means are provided to operate the tape drive means to position a reference tape area within the module display area. A code input means is utilized to provide a signal representative of the number of incremental steps the tape must be moved to shift it from its reference condition to a desired final condition. A pulser circuit is provided to produce a repetitive operating pulse signal for the tape drive means. A monitoring counting circuit and comparator are used to match the input code and the pulses provided to the tape drive means and terminate movement of the tape when its final condition has been achieved.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a functional block diagram of the present sign display and controls;

FIG. 2 is a front view of a single sign module;

FIG. 3 is a top view of the module shown in FIG. 2;

FIG. 4 is a cross-sectional view taken along line 4-4 in FIG. 3;

FIG. 5 is an enlarged view of the control cam assembly;

FIG. 6 is a side view of the cam assembly as seen from the bottom of FIG. 5;

FIG. 7 is a somewhat exploded schematic view of the drive train for the module;

FIG. 8 is a side view of the module taken from the left of FIG. 2;

FIG. 9 is a side view of the module taken from the right of FIG. 2;

FIG. 10 is an enlarged cross-sectional view through the center of a single drum assembly;

FIG. 11 is a sectional view taken along line 11-11 in FIG. 10; and

FIG. 12 is a diagrammatic circuit view of the controls for a single module, being comprised of our sections respectively identified as FIG. 12A, FIG. 12B, FIG. 12C and FIG. 12D.

GENERAL DESCRIPTION

The following discussion relates to a visual sign display wherein the display elements comprise individually powered sign modules arranged in horizontal rows and vertical columns as shown generally in FIG. 1. The sign shown at the top right-hand corner in FIG. 1 consists of a plurality of backlighted sign modules 10. The number of sign modules 10 in each row or column is dependent upon the type of message to be displayed and space requirements or limitations at a particular installation.

Each module 10 contains a movable tape 25 (FIG. 47) that is selectively positioned relative to the visual display area of the module. The tape 25 might have any type of visual indicia imprinted thereon, including alphanumeric symbols (as illustrated) or complete words, phrases or sentences. Examples of sign displays where such an apparatus might be used include theatre displays, outdoor or indoor advertising displays, sports arena score boards, airline departure and arrival displays etc.

FIG. 1 illustrates in functional block form the control apparatus for operating the modules 10. Where a large number of modules 10 is utilized, it is desirable to interrelate the controls and provide minimum duplication of elements. In such an installation, the modules 10 are wired in a cross grid system. The vertical wires indicated at the top of the sign in FIG. 1 control forward and reverse tape movement of the modules in each vertical column. The horizontal wires indicated generally at the left of the sign in FIG. 1 control "homing" of the modules and common motor and lamp-activating circuits for the modules of an entire horizontal row.

The control module 11, which normally is remote from the sign, contains all of the manually operated mechanisms used to operate the modules 10. These include row selector switch means used to direct the controls to the several rows of modules 10 by connections schematically illustrated at 12. In the sequence of resetting the modules within a row, it is necessary to first move all of the tapes of the modules to a "home" or reference condition, from which the location of all other display areas can be referenced. In the example of a module shown in FIGS. 2-11, the tape reference area is blank and is located at the center of tape 25, with letters and numbers arranged at each side of the reference area in both directions. As an alternative, the reference area might be at one end of the tape or at any other location within the ends of the tape. The "homing" of the modules in a row is generally controlled by the "home" circuits shown at 13. The individual tapes of all modules in a row are moved to "home" position simultaneously and then simultaneously started toward their respective desired positions, each module being stopped when this position is attained.

After the modules of a row have been moved to "home," each is stepped a number of times in a preselected direction so as to present its chosen display. The type of input control can be manual or automatic. The input signal is preferably in the form of an electronic code. Code input means 14 is utilized to simultaneously direct the coded signal for each module in a complete row by means of the lines schematically shown at 20. This signal corresponds to the number of incremental steps necessary to move each tape 25 within each module 10 from its "home" or reference condition to the desired display or final condition.

The input signal is fed to a comparator 17. Comparator 17 also receives a pulsed signal from a pulser 15, designed to produce a master pulse in a periodic sequence as required for proper mechanical operation of the row of modules 10. The pulses are received by a counter 16, which is reset as each row of modules is initially activated by the control module 11. The counted pulses are matched with respect to the signal from the code input circuitry 14 by the comparator 17.

The pulsed signal from pulser 15 is passed through column-operating circuits 18 which govern forward and reverse operation of the motors in each column of modules. When com-

parator 17 senses that the master pulses have matched the requirements of the code input 20 for a chosen column, the column-operating circuit 18 is conditioned to terminate movement of the module tape in the activated row. When movement of all tapes in a row has terminated, the process is then repeated to reset each succeeding row of modules.

THE SIGN MODULE

The details of a sign module are shown in FIGS. 2—11. The structural elements of the module include two sidewalls 21, 22. The walls 21, 22 are parallel and rigidly joined by front spacer shafts 23 and rear spacer shafts 24. The terms "front" and "rear," "top" and "bottom" will be used herein in reference to the intended orientation of the module in a sign display, the front of the module being that portion which faces outwardly in the display.

The sign indicia is imprinted on a length of tape 25 attached at opposite ends to drum assemblies 26, 27. The tape 25 includes a forwardly facing plane flight 28 which extends across a lamp unit 30 containing a suitable lamp and reflectors and including a plane translucent face 31 which defines the visual display area of the sign module. Indicia on tape 25 in flight 28 within this display area will therefore be backlit by the lamp unit 30.

The tape 25 is moved by a geared drive mechanism including a Geneva movement shown in FIG. 8 at 32. Power is supplied by a reversible electric motor 33 mounted to the inside surface of wall 21. The output of motor 33 is delivered through a pair of stepped down idler gears 34, 35 on the inside surface of wall 21 to a driving disc 36 of the Geneva movement 32. Disc 36 includes two driving pins 37 and is therefore rotated one-half revolution to cause each incremental movement of the driven Geneva gear 38.

The gear 38 is used to rotate a cross-shaft which has a small driving gear 40 on the outer surface of wall 21 and an enlarged driven gear 41 at its opposite end at the outer surface of wall 22. Gear 41 engages a gear 42 on the lower drum assembly 27 and a gear 43 on the upper drum assembly 26. The gears 41 through 44 are identical to one another. An idler gear 44 driven by gear 43 in turn drives a smaller gear 45 fixed solidly to the end of a sprocket shaft 46 (FIG. 4) which spans the space separating walls 21 and 22. At one end, the shaft 46 includes radially projecting sprocket teeth 47 (FIGS. 2, 3 and 7) which mesh with equally spaced apertures 48 formed along the corresponding edge of tape 25. The sprocket shaft 46 serves as the director monitor of the movement and positioning of tape 25 for both driving of the tape and indexing of its position relative to the display area of the sign module.

The driving connections to the drum assemblies 26, 27 do not apply a direct rotating force to the periphery of the drums to which the ends of the tape 25 are secured. As seen in FIGS. 10 and 11, each drum assembly includes an outer drum 50 to which the ends of the tape 25 are respectfully fixed and about which the tape is wound. The drum 50 is rotatably supported by bearings on the drum shaft 51 which in turn is fixed to the driven gear 42 or 43. Rotational movement of shaft 41 about its axis is yieldably transmitted to the drum 50 by means of a spiral spring 49 fixed at its inner end to shaft 51 and at its outer end to drum 50. The winding of spring 49 is such as to always provide proper tension to the tape 25 so as to maintain tape 25 in a reasonably taut position across the front of the sign module. Springs 49 are wound oppositely and are preset at the tape reference position so as to maintain proper balance in the tension of the tape 25 as it moves across the front of the sign module. The movement of the tape 25 is at all times directly controlled by the intermeshing of teeth 47 on the shaft 46 with the film apertures 48.

FIG. 7 schematically illustrates the drive train used in the sign module and the manner in which the various driving elements are interconnected across the two sidewalls of the module. All of the various moving components which control the operation of tape 25 are operated from the common drive

source, so that accurate indexing is possible by use of the single sprocket shaft 46 without the necessity of additional positioning monitoring devices.

The tape 25 in one embodiment of this invention has imprinted on it the letters of the alphabet and the numbers 1 through 9, plus several common symbols used for display purposes. These are arranged in any desired order on the tape within a plurality of tape areas that are repeated along the length of the tape in equally spaced positions. One of these areas is utilized as a preselected reference area, which will be referred to herein as the "home" or reference area of the tape. As an example, the reference area might be at the center of the tape and the various letters and numerals arranged outwardly from the center in the order in which each letter or numeral would most often appear in the material being displayed. Certain letters of the English alphabet are used generally with much greater frequency than others. To minimize the numbers of steps needed to move the tape 25 from the reference area to the desired sign display, one can make use of the statistical frequency in which the individual letters are used in the language by arranging the letters at both sides of the reference area in a descending order in relation to usage.

The design of the gearing disclosed is such that each one-half revolution of the disc 36 will result in the sprocket 46 being rotated an amount adequate to shift from one tape area to the next across the module display area at lamp unit 30. Thus the controls for the module must operate motor 33 for a period of time adequate to achieve the number of incremental steps corresponding to the position of the desired tape area relative to the reference area. This period can be related to a repetitive pulsed signal. With a reference area at the center of the tape, such movement must also take into account whether it is necessary to move the tape in one direction or the other from the reference area, referred to herein as either "forward" or "reverse" directions.

One method by which the instant module can be controlled is by simply providing a manually operated switch apparatus capable of selectively moving motor 33 in either the forward or reverse directions, relying solely upon visual inspection of the sign module to determine the proper placement of indicia before the module display area. This is entirely satisfactory in small installations and in those which are changed rather infrequently. It provides the greatest economy in control design.

Where more extensive controls are desired, certain position indications are necessary in order to operate control mechanism that would be automatically moving the tape 25 by energizing the motor 33. Essentially the indications relate to the position of the tape 25 relative to the reference area, the direction in which the tape 25 has been moved from its "home" position, and the angular position of the pins 37, which include some free movement when they are disengaged from the Geneva gear 38.

Electrical signals are provided by switches mounted on the walls 21, 22 and operated by the various unit members. A pair of switches 52, 53 (FIG. 4) are operated by a first cam 54 having a pair of diametrically opposite lobes about its periphery. Cam 54 rotates with disc 36. The lobes of cam 54 and the positions of switches 52, 53 are such in relation to the Geneva movement 32 that the switch 53 is activated at "position" (when a tape area is centered at the module display area). Switch 52 is also activated simultaneously at "position."

A larger diameter geared cam 55 (FIG. 9) is mounted at the outer surface of sidewall 22. The drive train design is such that cam 55 will be turned less than one complete revolution during maximum tape movement across lamp unit 30 from one end of tape 25 to the other. It is provided with an inwardly facing arcuate cam 55 having an outer peripheral surface selectively engaged by arcuately spaced switch assemblies 56, 57. The switches 56, 57 and the cam surfaces on cam 55 are positioned such that the switch 56 will be activated 60 the tape has been moved in a forward direction from the central reference area and the switch 57 will be activated when the tape has

been moved in a reverse direction from the same reference area. When the tape 25 is in its "home" position with the reference area centered in the module display area, both switch assemblies 56, 57 will be deactivated. In addition, a single pin 58 which extends inwardly beyond cam 55 is used to activate a switch 60 mounted on wall 22. The angular position of pin 58 and the position of switch 70 is such that the switch 60 will be operated only when the tape 25 is at the "home" position. Switch 60 is used to turn off the lamp unit 30 when the module is at the "home" position.

Two limit switches 61, 62 are mounted to walls 22 (FIG. 9) in the path of movement of pin 58. They are located so as to be respectively activated by contact with pin 58 when the tape 25 has been moved to its limit in either the forward or reverse direction respectively. They are preferably included in the control circuitry for motor 33 to deactivate the motor 33 and prevent the tape 25 from being pulled from either the drum assemblies 26, 27.

MODULE CONTROLS

FIG. 12 schematically illustrates the apparatus used to operate a module 10. In the drawing, the circuitry involved in the control of a single module is illustrated, it being understood that additional modules will be provided in rows and columns as previously discussed. While the control circuitry can be housed at a location common to the sign, the controls normally will be remotely positioned and wired to the sign. A single set of controls can be either switched or releasably connected to more than one sign unit.

As shown in FIG. 12A, the tape drive means includes a drive motor 33 shown as a shaded pole induction motor. Motor 33 contains a filed winding 155 and two shading windings 156, 157. When the field winding 155 has been energized, motor 33 will run in either direction upon shorting of the proper shading winding 156 or 157. If both windings 156, 157 are either shorted or left open, the motor will stand still.

Shorting of the windings 156, 157 is selectively accomplished by gate controlled conductive elements in the form of triacs 158, 160. The conductive terminals of triacs 158, 160 are respectively wired across the shading windings 156, 157. Triacs 158, 160 act as semiconductor switches, being normally open. When conducting current is applied to the gate terminal of either triac 158, 160, the shading winding associated therewith will be shorted to control motor direction.

Essentially, control of motor 33 involves the application of gate current to triacs 158, 160. A source of gate current is shown at 170 (FIG. 12C). After energizing of a row relay 105 which in turn energizes the filed winding 155 of each module in a horizontal row, the individual modules are controlled by operation of their triacs 158 or 160.

Since the module as illustrated contains no memory or feedback device to indicate to the control circuits the position of the tape 25 with respect to the display area of module 10, each setting of the module first requires that the tape be returned to a "home" or reference condition wherein the blank reference tape area is centered with respect to the module display area. This homing is accomplished by applying the current from source 170 through a holding circuit (FIG. 12D) that maintains the current at the gate of the required triac 158 or 160 until the tape 26 has reached this reference condition.

After being returned to this reference condition, the tape 25 of the module is stepped by successive pluses until the desired tape area is located at the module display area. This is accomplished by applying the current from source 170 in the form of a repetitive master pulse, again directing it to either triac 158 or 160, depending upon the direction in which tape 25 must be moved. The reception of each pulsed signal by one of the triacs causes motor 33 to move tape 25 one step across the module display area.

Depending upon the direction at which the desired tape area is located with reference to the tape reference area, the pulsed signal will be applied to either a forward bus 147 or

reverse bus 148 (FIG. 12B) leading to the modules in a vertical column. If the pulse is applied to the forward bus 147, it is directed through a diode 161 and resistor 162 (FIG. 12A) to the gate of the forward triac 158. If the pulse is directed through the reverse bus 148, it will be similarly directed through a diode 171 and resistor 172 to the gate of the reverse triac 160. Operation of triac 158 or 160 will begin movement of the tape by momentary operation of the motor 33. Movement of the tape away from the home or reference condition will result in either switch 56 or switch 57 being closed due to the resulting rotation of cam 55 (FIG. 9) as previously discussed. Contacts 56a of switch 56 are wired in series with the normally closed contacts of switch 53 (FIG. 4), which form a current-holding circuit through line 78a for the row of modules, which in turn is selectively connected to the pulser bus 78 by section 120a of the row selector switch 120. Contacts 57a of switch 57 are similarly connected with respect to the reverse bus 148 and switch 53. The contacts 56a or 57a operate in conjunction with switch 53 to hold conducting current at the gate of the preselected triac 158 or 160 until the tape 25 has moved one complete step. At that time, switch 53 will be momentarily opened, and operation of the motor 33 will be discontinued until another pulse has been received in either of the buses 147 or 148.

After tape 25 has been moved from the reference condition, the contacts of switch 56 or the contacts of switch 57 will be closed due to the angular position of cam 55. The contacts 56b and 57b are utilized in the module controls (FIG. 12A) to operate forward and reverse switching transistors 164, 165, to conduct gate current through line 163 and switch section 120c from a home bus 98 to return the tape 25 to its original or reference condition.

To prevent tape 25 from being driven beyond its limits, forward and reverse limit switches 61, 62 previously described (FIGS. 9, 12A) are wired in series with the motor winding 156, 157. One of the normally closed switches 61, 62 will open when tape 25 reaches the limit of its movement in either direction, and thereby prevent further shorting of the shading winding 156 or 157 associated with it.

A normally closed switch 60 (FIG. 9, 12A) is used in series with lamp unit 40 to selectively open the lamp circuit when the tape 25 reaches the reference condition.

HOMING CONTROLS

Return of the tape 25 in each module 10 to the "home" or reference condition in a complete row of sign modules is accomplished by applying a positive voltage to the line 163. The proper triac 158 or 160 is actuated through the control afforded by the switching transistors 164 or 165, which selectively complete the "home" circuit. Selection of transistors 164, 165 is accomplished through operation of the switch contacts 56b (closed in the forward direction) or 57b (closed in the reverse direction).

Because of mechanical construction, the contacts of switches 56 and 57 open shortly before the tape 25 actually reaches its reference condition or "home." To permit motor 33 to drive the module 10 completely to the reference condition, the normally open switch 52 takes over control of motor 33 when either direction switch 56 or 57 opens. Control is accomplished through a tristable integrated circuit 166. Circuit 166 operates as a memory, causing the proper switching transistor 164 or 165 to continue conducting until the true reference condition of tape 25 has been attained and the switch 52 closes.

As an example, as the tape on module 10 is homing from the forward direction, contacts 56b will be closed, thereby actuating transistor 165 and the reverse triac 160. This causes motor 33 to drive in the reverse direction and thereby move tape 25 toward "home." As tape 25 within the display area of the module begins to show the reference area, contacts 56b will open. However, the tristable integrated circuit 166 will hold transistor 165 on by holding line 167 at ground through the

selector switch section 120b and line 173 until the contacts 52 are closed. When this happens, line 167 is driven to a positive voltage, turning off transistor 165 and the motor 33.

The "home" circuit (FIG. 12D) is a controlled bus circuit used to provide a positive voltage signal to the modules. This signal in turn causes the respective modules in a row to be moved to their "home" or reference positions when OPERATE-HOME switch 79 is momentarily moved to the "home" position.

The "home" circuit operates in conjunction with the motor controls described above. Upon momentary movement of the OPERATE-HOME switch 79 a positive voltage supplied by switch 79 to the home bus 98. This energizes home bus 98 and turns on transistor 100 through the resistor 101. Transistor 100 then turns on transistors 102, 103 (a Darlington pair) through base resistor 104. This is a regenerative action, resulting in the home bus 98 remaining at a positive voltage and allowing all modules in the row chosen through switch 120 to complete their homing action.

The home bus 98 (and the row relays 104 and motors 33) would stay on indefinitely and tend to burn out the motors 33 if the units were left unattended. The home bus 98, therefore, is turned off with an electronic timer of about 1 minute duration. The timer circuitry is shown at FIG. 12D. When the home voltage comes on, transistor 107 is turned on by the current in its base resistor 108 and charging current for capacitors 110 flows in the collector of transistor 107. When the capacitors 110 are charged, unijunction 111 fires and transmits a pulse to the gate of the triac 112, causing it to turn on. Triac 112 then passes current to the base of transistor 113, turning it on and shorting the emitter-base junction of transistor 100. Transistor 100 then turns off, turning off transistors 102, 103. The home bus 98 then goes to approximately zero volts, turning transistor 107 off and stopping the timer. This also deenergizes transistor 106, opening the row relay common connection and thereby turning off the row relay 105.

The timing capacitors 110 associated with transistor 111 also have a discharge circuit connected to them similar to the previous ones. Its purpose is to reset the timer circuit. As long as the home bus voltage at bus 98 is 5 volts, transistor 114 is on, turning off transistor 115 and thus turning off transistor 116, and releasing the capacitors 110. If the home bus voltage is at zero, transistor 114 is off, and transistors 115, 166 are on, shorting capacitors 110.

It also is possible to kill the home bus voltage by two other circuits. If it is desired to operate a module 10 manually by use of switch 117 (FIG. 12B), +5 volts is applied from each of the switch terminals through resistors 118 to the base of transistor 113, turning it off and turning off the home bus voltage as described above. If it is desired to switch from a row that has just been homed to another row, it is desirable to kill the home voltage so that the new row will not be inadvertently homed. To do this, a section 120e of the row switch 120 is connected to transistor 121. When the row switch 120 is rotated, the voltage at section 120e momentarily drops between contacts, turning on transistor 121, which supplies gate current to triac 112, turning off the home voltage as before.

PULSER CIRCUIT

The pulser circuit (FIG. 12C) is one of the main control components, as the indicia displayed by each module 10 depends on the proper pulsing of each driving motor with the modules. The pulser circuit 15 includes transistors 65 through 75.

A reset circuit (transistors 76, 77) is utilized within the pulser to initiate the required counting operations of counter 16. When the master control switch 79 is turned from OFF to OPERATE, the pulser bus 78 is connected to the positive terminal at a power source 170. Transistor 76 is quiescently on prior to this, being saturated by the base current in resistor 81. When the pulser bus 78 goes to a positive value the charge on

capacitor 82 reverse biases transistor 76 for a preselected period of time. Transistor 76 turns off, turning off transistor 77 and the collector voltage of transistor 77 goes from 0 volts to the pulser bus voltage for a selected pulse period, such as 50 msec. This pulse is the reset pulse, and is initiated each time the OPERATE switch 79 is actuated. The reset pulse sets the pulser flip-flop circuit (transistors 68, 69) to its initial state and resets the counter 16 to zero count.

Continuing the operational steps in pulser 15, a positive voltage of about 5 volts has just been applied to the flip-flop circuit and base current has been applied to transistor 69 by the reset pulse, so the flip-flop circuit has the initial condition of transistor 69 being on and transistor 68 being off. With transistor 68 off, current flows through the resistor 83 to transistor 66, turning it on. The collector current of transistor 66 charges capacitor 84 through a manually adjustable potentiometer 85 and resistor 86. When capacitor 84 has charged to a preset voltage, unijunction 65 fires, discharging capacitor 84. This period of time can be any duration required, an example being about 0.7 sec., and is adjustable by use of the potentiometer 85. This period of time is the "nonpulse" or waiting interval between pulses to the modules.

When unijunction 65 fires, a short positive pulse appears at capacitor 87 and diode 88 and at the base of transistor 68, turning it on. With transistor 68 on, transistor 66 is off, and no further charging current goes to capacitor 84. Also with transistor 68 on, the transistor 69 goes off, turning on emitter follower 70, which turns on transistors 71, 72. When transistor 71 is turned on, its collector voltage drops to zero, producing a master pulse in line 146 which is directed to the column-operating circuits 18.

When transistor 72 turns on, it provides a charging current path for capacitor 90. The action of unijunction timer 73 is similar to that of the circuit for unijunction 65. Further, with transistor 68 on, transistor 67 is turned on, raising its collector voltage to +5 volts. When the timer 73 fires (after a time of about 0.6 sec. in one example) the flip-flop circuit is set to its initial state and the master pulse ceases. The collector voltage of transistor 67 falls to zero, and advances the counter 16 by one count. Capacitor 91 controls the negative fall time of the counter input pulse, insuring reliable counting. With the flip-flop circuit again in its initial state, the cycle is successively repeated, producing a waiting period (which modules use to finish a step), and a master pulse (which modules use to start a step). The counter 16 advances by one count at the end of each master pulse.

When the pulser bus 78 is not energized, the pulser circuit is quiescent and both timing capacitors 84 and 90 are held shorted by capacitor discharge circuits. When bus 78 is at zero volts transistor 92 is off and thus transistor 93 is on, as it receives base current from bus 94 (which is always at +5v.) through the resistor 95. Collector current from transistor 93 saturates transistors 74, 75 and they short the timing capacitors 84, 90 except when voltage is applied to pulser bus 78. This insures uniform timing intervals during the first timing cycle, compared to succeeding cycles.

COUNTER CIRCUIT

The counter circuitry 16 counts the pulses necessary to step each module from the display of the reference tape area to the display desired character. This is dictated by the position of the area containing the character on the module tape and the input from the code input apparatus 14. The counter 16 is preferably a binary ripple counter having five outputs bits. The counter circuitry is designed to be sensitive to negative transitions only. Initial reset and pulsing of counter 16 are described above. The counter outputs 96 are fed to the comparator inputs 97 which in turn are used to control the pulsing individual modules.

ROW RELAY CONTROLS

The next circuit described is the row control AND gate 122, seen at FIG. 12D. Its function is to hold the row relay 105 (of the row being operated) until the tapes 25 of all modules 10 in that row have been moved to their preselected display positions. A triac 123 (FIG. 105) fires when the module tape has reached the selected character (i.e. the counter count matches the desired input code count). When this triac 123 fires, the voltage across a resistor 124 rises from zero to about 3 volts. This information is transmitted in line 125 to one input of the row control AND gate. The output voltage of this gate (at the emitter of transistor 126) is high (about 4 volts) until all of the gate inputs are high, at which time the output voltage goes to zero volts.

The row relays 105 for the individual rows of modules are selectively connected to a +24 volt bus 127 through a section 120d of the row switch 120 and a line 174. The relay windings for each row are all connected together and wired at line 175 to common through transistor 106. Transistor 106 may be turned on by the home voltage at bus 98 as described above, or by the row control AND gate 122. When the gate output voltage is high, base current flows to transistor 106 through resistor 128 and turns it on, operating the selected relay 105. When the row control AND gate 122 is satisfied (all inputs high), the base of transistor 126 goes low, but the emitter lead is held high for about one-third second by capacitors 130. Thus there is some delay in turning off transistor 106 and the relays 105. This delay enables the modules 10 to complete their last cycle before motor power is removed by the relay.

Since the pulser bus voltage, used during forward or reverse operation, and the home voltage are never on at the same time, a circuit is included to make sure that these buses 78, 79 are connected to common during unused periods. When voltage at the pulser bus 78 is switched on by switch 79 during OPERATE, base current flows through resistor 131 to transistor 132 which connects the home bus 98 to common through resistor 133 (FIG. 12D). Similarly, during homing, base current flow through resistor 135 from the home bus 98 to transistor 134 which connects the pulser bus 78 to common through resistor 136.

CODE-OPERATED CONTROLS

The code input circuit is designed to produce a signal in binary format determined by the order of the characters on the module tape with respect to the blank or reference position at the tape center. The binary number produced at the output connections 137 of the code input circuitry 14 is the number of steps from blank in the forward (even) or reverse (odd) direction. The actual input of information to the code input 14 can be either made directly by a binary coded apparatus or card, or can be in the form of a different code with provision for changing the input signal to the type of code required by the circuitry of the comparator 17 and counter 16. As an example, a 12-bit IBM code received from manual switches or punched cards can be changed to the required binary format to produce the signal desired at the output connections 137.

The comparator circuitry must not only dictate the number of steps that the tape must move from the "home" or reference condition, but also the direction in which the tape must move. Using a binary code, comparator 17 is provided with suitable output connections 140, 138 to provide auxiliary signals indicating whether the count being monitored is "even" or "odd," thereby controlling module operation in either the "forward" or "reverse" directions with respect to the tape reference position.

In the example shown, the coded signal received from the code input circuitry will condition the circuit within the comparator 17 so that base current may be drawn through the resistors 141, 142 (FIG. 12B) from the base of either the "reverse" transistor 143 or the "forward" transistor 144 when its respective emitter is connected to the pulser output line 146 by the "master pulse" switch transistor 145. When this pulse

occurs, a positive pulse will be generated on the "forward" line 147 or on the "reverse" line 148 leading to the module column. The master pulse applied at transistor 145 goes from +5 volts to 0 during the pulse interval and draws base current in the switching transistor 145 through the resistor 150. Transistor 145 is thus saturated and its collector circuit turns on transistor 143 or 144, whichever has base current as controlled by the comparator 17.

A memory circuit is provided to indicate completion of the tape movement required at a module 10. When the comparator 17 produces an output signal indicating that the module tape has been pulsed the proper number of times, the output signal at the comparator output line 151 will go to zero volts. At this time movement of tape 25 in the module 10 should be stopped, even through the tapes of adjacent modules in the row continue to move. This is accomplished by memory triac 123 and the switching transistor 152. When the comparator output signal goes to 0 the output of an interposed inverter circuit 178 goes positive and pulls the gate of triac 123 positive. When the gate goes positive about 2 volts, triac 123 conducts, drawing current through the emitter-base junction of transistor 152 and thereby preventing the use of further master pulse input signals by transistor 145.

When the gate of triac 123 goes positive, a positive voltage also will appear across the resistor 124. This voltage signals the row control AND gate 125 that the particular module column has finished its required tape movement. Triac 123 remains "on" after being turned on until power to it is removed. This function is provided by the operation of the HOME-OPERATE switch 79 which opens the connection to the power source 170 upon movement of the switch 79 from the "operate" position to the "off" or "home" position, thereby releasing all of the triacs 123. A delay circuit 153 is interposed between the switch 79 and the line 154 to delay the application of the positive voltage for a period of approximately 100 milliseconds to prevent switching transients from incorrectly setting triacs 123.

GENERAL OPERATION

When the display on a sign is to be changed, the control circuitry is connected as shown schematically in FIG. 12. Switch 79 is initially in its "off" condition. Switch 183 is normally in its "automatic" position. The row to be changed is chosen by operation of the row selector switch 120, which then opens the circuits to all other rows on the display sign. The coded input material is directed to the code input 14 in the form of the card, tape or other manually programmed device. The operator then momentarily moves switch 79 to its "home" position, which will result in each module 10 in the row being operated so as to return the tape 25 thereof to the tape reference condition.

After homing has been completed, switch 79 is held in its "operate" position. This begins operation of the pulser 15 and resets counter 16. The comparator 17 monitors the pulsed signals directed to each module and terminates movement of each module when the signal matches the coded input for the module as provided by the code input 14. When all of the modules in a row have moved to their preselected positions, the switch 79 is returned to its "off" condition and the selector switch 120 can be utilized to repeat the procedure on each subsequent row of modules.

Switch 183 is interposed in the forward bus 147 and reverse bus 148 of each column operating circuit 18. It is used to selectively open the connections to these buses with respect to pulser 15 and the associated automatic control circuits. When positioned in its "manual" condition, switch 123 permits manual operation of a module 10 within a selected column. Forward or reverse movement is manually controlled by holding a manually operated switch 117 (FIG. 12B) in either its "forward" or "reverse" position. The module control will operate identically to the manner previously discussed with respect to the stepping of a module, the manually controlled

positive current signal replacing the pulsed signal is for automatic operation.

Having thus described our invention, we claim:

1. In a display sign apparatus comprising:

a sign module physically defining a visual display area; a tape having indicia thereon within a plurality of tape areas repeated along its length, one of said tape areas being a preselected reference area; and

means movably mounting said tape to said module for selective positioning of the tape areas within the bounds of said display area;

the improvement comprising:

tape drive means including a motor and power train operatively engaging the tape for moving the tape across the display area in incremental steps corresponding to the spacing of the tape area;

homing means operably connected to said tape drive means for selectively positioning the reference area of the tape within the bounds of the tape module display area;

code means having a plurality of input elements preset according to the indicia desired within the sign module display area, said code means including an output element for transmission of a signal representative of the number of incremental steps the tape must be moved to shift the tape between a reference condition wherein the tape reference area is within the bounds of the sign module display area and a final condition wherein the tape area containing the desired indicia is positioned within the bounds of the sign module display area;

selectively actuated pulser means including output means for carrying a repetitive master pulse signal produced thereby;

counting means operatively connected to the output means of said pulser means for monitoring the number of pulses produced thereby in the repetitive master pulse signal; and

comparator means operatively connected to the code means output element, to said counting means and to said tape drive means for terminating operation of said tape drive means when the number of master pulses monitored by said counting means equals the number of incremental steps represented by the signal at said code means output element.

2. The apparatus as set out in claim 1 wherein said tape drive means comprises forward and reverse motor circuits for respectively moving the tape across the sign module display area in opposite directions;

said code means being preset to provide a signal at the output thereof which is indicative of the direction the tape is to be moved between its original and final condition;

said comparator means having a first output means for transmission of the master pulse signal and second output means connected to the pulse-controlled circuit means for transmission of a signal corresponding to the required direction of tape movement as indicated thereto by the signal of said code means output element;

first switching means operatively connected to the first output means of said comparator means for transmission of the master pulse when actuated; and

second switching means operatively connected in series between said first switching means and the forward and reverse motor circuits of said tape drive means, said second switching means being operatively connected to the second output means of said comparator means so as to selectively be actuated by the signal transmitted thereby.

3. The apparatus as set out in claim 2 further comprising: means on the sign module operatively connected to the tape to provide an electrical indication of the direction the tape has been moved with respect to the tape reference condition.

4. The apparatus as set out in claim 2 wherein said homing means comprises a selectively activated bus adapted to

operate said forward and reverse circuits when connected thereto; and

alternately actuated switching means operatively connected to the tape and electrically interposed between said bus and said forward and reverse motor circuits respectively, said switching means being adapted to alternately complete the respective forward and reverse motor circuits of said tape drive means relative to the bus of said homing means dependent upon the direction in which the tape was previously moved across the sign module display area with respect to the tape reference condition.

5. The apparatus as set out in claim 4 wherein said alternately actuated switching means deactivates the forward and reverse motor circuits of said tape drive means upon positioning of the tape reference area within the bounds of the display area.

6. The apparatus as set out in claim 1 wherein said tape drive means comprises first and second drive circuits for respectively moving the tape across the sign module display area in opposite directions;

said homing means comprising a selectively activated bus adapted to operate said first and second drive circuits when connected thereto; and

switch means operatively connected to the tape for completing an electrical circuit between one of said first and second drive circuits and said bus dependent upon the direction in which the tape was previously moved across said sign module display area in relation to the tape reference condition.

7. The apparatus as set out in claim 6 wherein said switch means deactivates the first and second drive circuits of said tape drive means upon positioning of the tape reference area within the bounds of the display area.

8. The apparatus as set out in claim 6 wherein said switch means comprises:

a first switch operatively connected to the tape in such fashion as to be actuated upon movement of the tape in a first direction from the tape or reference condition, said first switch being electrically interposed between the bus of said homing means and the first drive circuit of said tape drive means; and

a second switch operatively connected to the tape in such fashion as to be actuated upon movement of the tape in a direction opposite to said first direction from the tape reference condition, said second switch being electrically interposed between the bus of said homing means and the second drive circuit of said tape drive means.

9. The apparatus as set out in claim 1 wherein said tape drive means comprises first drive circuit means for moving the tape across the sign module display area in a preselected direction of movement with respect to the tape reference condition; and

second drive circuit means for moving the tape across the sign module display area in a direction opposite to said preselected direction;

said homing means comprising selectively activated bus means for actuating said first drive circuit means; and

means operatively responsive to tape movement from the tape reference condition in said preselected direction said last-named means being electrically interposed between the bus means of said homing means and the second drive circuit means of said tape drive means.

10. The apparatus as set out in claim 1 wherein said tape drive means comprises:

a first gate-controlled conductive element interposed in the control circuitry of said motor adapted by application of conducting current to its gate connection to cause the motor to move the tape across the sign module display area in a first direction of movement from the tape reference condition;

selectively actuated conductive means interposed between the gate of said first gate controlled conductor element and the output of said gate comparator means;

first means on said module operatively responsive to tape movement in said first direction electrically connected in parallel with said selectively actuated conductive means to continue motor operation after reception of a master pulse at the gate of said first gate controlled conductive element; and

second means on said module indicative of the centering of each tape area with respect to the sign module display area, said second means being electrically in series with said first means and the gate of said first gate controlled conductive element for terminating motor operation upon such centering of each tape area.

11. The apparatus as set out in claim 10 wherein said tape drive means further comprises:

a second gate-controlled conductive element interposed in the control circuitry of said motor adapted, when actuated by application of conducting current to its gate connection, to move the tape across the sign module display area in a second direction of movement opposite to said first direction;

said selectively actuated conductive means being also interposed between the gate of said second gate-controlled conductive element and the output of said comparator means;

third means operatively responsive to tape movement in said second direction electrically connected in parallel with said selectively actuated conductive means to continue motor operation after reception of a master pulse at the gate of said second gate controlled conductive element;

5
10
15
20
25
30
35
40
45
50
55
60
65
70
75

said second means being also electrically in series with said third means and the gate of said second gate-controlled conductive element.

12. The apparatus as set out in claim 11 further comprising: first and second output elements in said comparator means for transmission of electrical signals indicative of the direction of movement required of the tape between the tape reference area and the tape final condition as preset by the input elements of said code means; first switching means controlled by the first output element of said comparator means and electrically interposed between said selectively actuated conductive means and said first gate-controlled conductive element; and

second switching means controlled by the second output element of said comparator means and electrically interposed between said selectively actuated conductive means and said second gate-controlled conductive element.

13. An apparatus as set out in claim 1 comprising a plurality of said sign modules;

said homing means comprising means to simultaneously position the reference area of each tape within the bounds of the tape module display area with which it is associated;

said tape drive means for each tape being activated simultaneously to move each tape between the reference condition and the final condition thereof as preset by said code means.